NAVY
SBIR FY08.1 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 (8AM to 5PM EST). 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 website before **10 December 2007.** 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
N08-001 thru N08-040	Mrs. Janet McGovern	NAVAIR	navair.sbir@navy.mil
N08-041	Mr. Nick Olah	NAVFAC	nick.olah@navy.mil
N08-042 thru N08-059	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N08-060 thru N08-086	Mr. Steve Sullivan	ONR	steven.sullivan@navy.mil
N08-087 thru N08-102	Mr. Steve Stewart	SPAWAR	steve.stewart@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 website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I GUIDELINES

Follow the instructions in the DoD Program Solicitation at **www.dodsbir.net/solicitation** for program requirements and proposal submission. Cost estimates for travel to the sponsoring activity's facility for one day of meetings are recommended for all proposals and required for proposals submitted to MARCOR, NAVSEA, and SPAWAR. The Navy encourages proposers to include, within the 25 page limit, an option which furthers the effort and will bridge the funding gap between Phase I and the Phase II start. Phase I options are typically exercised upon the decision to fund the Phase II. For NAVAIR topics N08-001 thru N08-040 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, email 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 website. 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 website 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 $250K 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 $750K 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 website 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 Law (PL102-564) permits Phase III awards during Phase II work, the Navy may match on a one-to-four ratio, SBIR funds to funds that the company obtains from an acquisition program, usually up to $250,000. The SBIR enhancement funds may only be provided to the existing Phase II contract. If you have questions, please contact the Navy Activity SBIR Program Manager.

PHASE III

Public Law 106-554 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 website http://www.onr.navy.mil/sci_tech/ahd_usage.asp. This website provides guidance and notes approvals that may be required before contract/work may begin.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

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

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

____2. Your technical proposal has been uploaded and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 a.m. EST 9 January 2008.

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

____4. For NAVAIR topics N08-001 thru N08-040, the base effort does not exceed $80,000 and 6 months and the option does not exceed $70,000 and 6 months. For all other proposals, the Phase I proposed cost for the base effort does not exceed $70,000 and 6 months and for the option $30,000 and 3 months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

Navy SBIR 08.1 Topic Index

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N08-001 TITLE: AN/ASQ-233 Magnetic Anomaly Detection (MAD) Light Weight Towing System for Light Weight Helicopters and Small, Vertical Take Off Unmanned Aerial Vehicles (UAVs)

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

ACQUISITION PROGRAM: PMA 264-Joint Multi-Mission Electro-optical System (JMMES)-ACAT IV; PMA-290

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

OBJECTIVE: Develop a very light weight towing system to enclose, deploy, and tow the AN/ASQ-233 magnetometer from manned and unmanned small rotary wing and fixed wing aircraft.

DESCRIPTION: Current state of the art towing reels, tow cables, and tow bodies designed for the AN/ASQ-233 magnetometer are too large, too heavy and too unstable for use by small rotary wing and fixed wing manned and unmanned aircraft. These aircraft are constrained in available payload weight and their ability to handle large aerodynamic forces. A novel approach is sought for a light-weight, small, very stable, non-magnetic tow vehicle, non-magnetic tow cable, and reeling machine.

The system should consist of a non-magnetic, stable tow vehicle; non-magnetic tow cable; and light weight reeling machine that can deploy and tow the MAD sensor at speeds between 50 - 350 knots from small rotary wing and fixed wing manned and unmanned air vehicles (UAVs). The solution technology must be stable in 3-axes to ± ½ degrees while being towed, and not add more than 10 pounds to the AN/ASQ-233 magnetometer/sensor package. One of the key mechanical requirements that is very difficult to achieve with current technology is a very light weight < 40 pounds for the entire system (tow body, tow cable, reeling machine) while meeting the aerodynamic qualities above.

PHASE I: Develop a towing system conceptual design and demonstrate feasibility to meet these requirements for use on small rotary wing and fixed wing manned and unmanned air vehicles.

PHASE II: Design and demonstrate a prototype light weight towing system and test stability in a wind tunnel environment.

PHASE III: Build an engineering development model of the light-weight towing system. Obtain flight clearance for use on NAVAIR R&D aircraft and test in conjunction with the Joint Multi Mission Electro-Optical System (JMMES) program on SH60R, SH60S, and the Fire Scout. Transition technology to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High performance towed magnetometers find application in geological survey systems used for mineral, water, oil, and treasure hunting surveys.

REFERENCES:
1. SH-60 LAMPS MK III Seahawk, http://www.fas.org/man/dod-101/sys/ac/sh-60.htm

2. Air Anti-Submarine Warfare ASW Sensors, http://www.globalsecurity.org/military/systems/aircraft/asw3.htm

3. Underwater Detection and tracking Systems, Chapter 9, http://www.fas.org/man/dod-101/navy/docs/fun/part09.htm

KEYWORDS: Magnetometers; MAD; ASW; Fire Scout; Tow body; Tow cable

N08-002 TITLE: Advanced Insensitive Munitions (IM) Compliant Initiation System

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

ACQUISITION PROGRAM: PMA-201 - Precision Strike Weapons; PMA-259 - Air-to-air Missile System

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

OBJECTIVE: Develop an advanced initiation system that is IM compliant and capable of initiating high performance insensitive energetics which pose a problem for current initiation systems

DESCRIPTION: Current weapon systems must meet Insensitive Munitions (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 modifications in the warhead case design resulting in many weapons which are capable of meeting several of these requirements but still few that meet all of the required responses.

A new approach to initiation is needed that does not result in a susceptibility 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. The 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.

PHASE I: Model a idealized initiation system and demonstrate components that will achieve the desired characteristics to meet the system needs. Test results combined with modeling efforts shall demonstrate feasibility of operation against a standardized insensitive munitions explosive fill. Exit criteria for successful Phase I completion shall be the demonstration of an initiation system capable of initiating a IM fill and modeling data showing the design does not detonate when impacted by a shaped charge. Companies must be able to demonstrate capabilities to design electrical firing circuits, perform explosive modeling and explosive testing to be considered for this effort.

PHASE II: Mature the Phase I components into a functional system and generate a test system capable of matching the performance modeled. Component and system level testing shall be performed to demonstrate the performance goals are met and to establish performance variations. Design validation hardware and operational test support will be provided to the government for demonstration testing in a weapon application. Detailed test reports showing the performance of the test hardware will be provided along with a final report documenting the effort. Two sets of prototype hardware will be delivered at the end of the effort to support phase three transition efforts.

PHASE III: Coordinate the transition of developed technologies with PEO-W, PMA201 and PMA259 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, Fuze Design, Safety Criteria for

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

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

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

6. NAVSEAINST 8020.8C

7. NAVSEA OD 30393

8. MIL-HDBK-1512 (USAF), Electroexplosive Subsystems, Electrically Initiated, Design Requirements and Test Methods

9. MIL-STD-1576(USAF), Electroexploissve Subsytem Safety Requirements and Test Methods for Space Systems

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

N08-003 TITLE: <u>Graphical Trace Object (GTO) Tool</u>

TECHNOLOGY AREAS: Information Systems, Human Systems, Weapons

ACQUISITION PROGRAM: PMA-280 - Tomahawk Weapons System Program, ACAT 1C

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

OBJECTIVE: Develop an innovative technology concept to visualize and analyze software in real-time.

DESCRIPTION: Develop a mechanism that provides a visual means to analyze the dynamic nature of software, both local and distributed, for purposes of debugging and optimization. The analyst using the GTO Tool would need the ability to graphically display the objects in an application as it runs, traverse the objects in the application, observe the objects as they are instantiated or deleted, graphically display calls to an object, display pointer possession, set triggers, visualize the contents of an object, visualize orphaned objects, and display memory leaks. In addition, the system must allow the operator to graphically traverse memory, both heap and stack, and display the contents in human readable fashion, when appropriate. The developed system should include the capability of performing quantitative performance analysis, including the number of times each object method is called, the number of times memory is allocated and deleted, and should support the ability to make timing measurements. The system should support both single and multi threaded applications.

PHASE I: Develop an innovative concept to visualize a running software application in real-time. Demonstrate the technical merit of the proposed solution.

PHASE II: Develop, demonstrate and validate a prototype of the GTO Tool and innovations developed in Phase I. Evaluate the utility of the approach in providing improved analysis.

PHASE III: Develop and mature the prototype capability for use in the development of the Tactical Tomahawk Weapon Control System (TTWCS) in a major upgrade scheduled to be done in v.8, and other programs that would benefit from the technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Recently there has been much interest in understanding complex software once it has been coded and deployed. This product could be used by analysts to optimize and debug new software, as well as understand large, complex legacy systems. While advances in standardization of software design notation supports the ability to provide greater understanding of the developed systems (structure) and the current state of the art debugging tools provide low level run-time analysis (execution), no existing tool bridges the gap between structure and execution. It is an area that shows promise in improving the overall quality of complex systems.

REFERENCES:

1. Visualizing Dynamic Software System Information through High-level Models; Robert J. Walker, Gail C. Murphy, Bjorn Freeman-Benson, Darin Wright, Darin Swanson, and Jeremy Isaak http://delivery.acm.org/10.1145/290000/286966/p271-walker.pdf?key1=286966&key2=5973180411&coll=GUIDE&dl=ACM&CFID=65860855&CFTOKEN=76265636

2. A Principled Taxonomy of Software Visualization; Blaine A. Price, Ronald M. Baecker, Ian S. Small http://kmdi.utoronto.ca/rmb/papers/p9.pdf

3. JIVE Visualizing Java in Action; Steven P. Reiss http://csdl2.computer.org/comp/proceedings/icse/2003/1877/00/18770820.pdf

KEYWORDS: Software Visualization; Dynamic Analysis; Software Design; Software Architecture; Analysis Tools; Debugging

N08-004 TITLE: Thin Film High Temperature Sensors

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: JSF - Joint Strike Fighter Program

OBJECTIVE: Design and develop a thin film sensor that is low profile, conformal coated and can be applied to retro and forward fit applications.

DESCRIPTION: Previous research and development efforts in the high temperature community have focused on bulk, micro, and other state-of-the-art construction techniques for employing sensors in turbine engines. Sensors derived from thin film materials able to survive on a rotating component (such as a blade or disk) and to survive temperatures from 400°F to 2500°F or higher are necessary to advance the state of the art. The sensor must be non-intrusive, low profile and very thin (microns). Sensor must be easily attachable and able to withstand high g loads while conformally coating the application area. The thin film should also attach to static components such as vanes. Focus should be placed on thin film sensors that can measure temperature, strain vibration and pressure. Any sensor type should have minimal error readings due to water impingement, dust, sand and other foreign substances found in the operating environment.

PHASE I: Define the feasibility of the proposed material for the thin film application and the sensor types. Describe and demonstrate the ability of the thin film material properties and deposition techniques for the application environment. Experimentally demonstrate the feasibility of the proposed thin film sensor at a laboratory scale. Provide a technology insertion plan and a cost / benefits analysis.

PHASE II: Expand upon phase I results and include detailed information on material properties of the thin film if not previously available. Additionally, establish baseline information or better for the thin film's corrosion resistance and other suitable properties relevant to the application environment. Develop a reliable process for affixing the thin film on the materials within the application environment. Fabricate and characterize full prototype devices in a laboratory environment and in a representative turbine test bed system such as a burner rig or other applicable device.

PHASE III: Conduct necessary qualification testing of the technology to merit further investment and consideration for military turbine engine platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Both military and commercial turbine engine manufacturers and operators have a need for advanced sensors.

REFERENCES:
1. Pulsed Laser Deposition of Thin Films, Edited by Douglas B. Chrisey and Graham K. Hubler. New York: Wiley-VCH, (May 2003), 648.

2. Nix, W.D. "Mechanical Properties of Thin Films." Metall. Trans. A., Vol. 20A, no. 11, (November 1989), 2217-2245.

KEYWORDS: Thin Film; Sensor; Turbine; High Temperature; Conformal Coating; Low Profile

N08-005 TITLE: Innovative Techniques of Modeling and Simulation for Commercial Derivative Aircraft Upset Recovery

TECHNOLOGY AREAS: Air Platform, Information Systems, Space Platforms

ACQUISITION PROGRAM: PMA - 290, Multi-Mission Maritime Aircraft

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

OBJECTIVE: Develop a methodology for simulating large commercial transport aircraft at unusual attitudes, typically experienced during an aircraft upset. This methodology should be applied to a representative Navy aircraft (P-8A) and utilized to develop a robust simulation which should accurately represent aircraft response in these extremes. Simulation capabilities would then extend to flight dynamics analysis and simulation, as well as potential training applications.

DESCRIPTION: Militarized versions of commercial platforms are growing in popularity due to many logistical benefits in the form of COTS parts, established production methods, and commonality for different certifications. Commercial data and best practices are often leveraged to reduce procurement and engineering development costs. While the benefits are clear, these militarized aircraft are operated at significantly different conditions and in significantly different manners than their commercial counterparts in flight. Therefore they are at much higher risk of flight envelope exceedance. This risk may lead to departure from controlled flight and/or aircraft loss.

The risk of departure from controlled flight for military aircraft is mitigated by piloted simulation training and engineering analysis of typical aircraft response. Military aircraft simulation databases are developed to include high angles of attack (AoA) and sideslip due to the dynamic nature of their missions. Current FAA certification for commercial aircraft simulators allow for considerable extrapolation of wind tunnel data from low AoA and sideslip conditions out to these more extreme attitudes. Extrapolated data does not typically capture the complex aerodynamics and physical phenomena present at extreme attitudes and results in a non-representative simulation at these conditions. Such extrapolation has been acceptable for the commercial community and the FAA, due to the assumed low probability of experiencing these conditions during a typical commercial flight profile. The poor quality of extrapolated wind tunnel data for highly dynamic maneuvers is compounded by the fact that accounting for scaling factors in large commercial-type aircraft is extremely complex. This results in simulation databases which are of very low fidelity at, or near, stall and departure conditions.

The flight environment of a military aircraft, in addition to the flight conditions, is also significantly different from that of a commercial aircraft. The military flight environment includes additional considerations and threats such as extreme weather conditions or Man-Portable Air Defense Systems (MANPADS). Current commercial simulations do not have any representation of damage due to ballistic impact, a condition which could also lead to upset conditions and possible aircraft loss due to departure. Furthermore, increased pilot workload in threat environments has historically uncovered aircraft deficiencies. Such deficiencies likely have not been discovered in the benign commercial environment. While loss of aircraft has numerous intangible effects, the financial loss of a single aircraft could top $150M, which would be a significant impact to today's conservative budgets.

Without high fidelity modeling and simulation of upset conditions, commercially derived military aircraft are at significantly higher risk for departure and loss. Innovative solutions to aerodynamically model large commercial aircraft for upset conditions such as high AoA, high sideslip, and ballistic damage, as well as capability to accurately account for scaling factors, is necessary to develop realistic engineering and training simulations. Such simulations should significantly reduce the risk of departure from controlled flight, loss of aircraft, and ease the flight clearance process. The characteristics of commercial derivative aircraft are exemplified by the P-8A Multi-mission Maritime Aircraft (MMA) aircraft, and the largest benefits of initial investigation are likely to be yielded from this platform. Innovative modeling techniques should be applied to a 737 airframe to augment planned pilot training. The database produced would also be utilized by flight dynamics engineers.

PHASE I: Review state of the art modeling methodology and commercial loss of control accidents. Accident data can be found via internet sources (Ref 1-7), including the NTSB. Identify AoA and sideslip expansion ranges of interest for upset conditions, above and beyond current modeling and training systems. Propose a methodology to obtain aircraft forces, moments, and all applicable data required for simulation at these expanded AoA and sideslip conditions. Determine the feasibility of an innovative approach for model development and simulation of large commercial aircraft for these attitudes with specific application to 737-NG and P-8A. Propose methods for validating data collection and implementation of data into engineering and training simulations.

PHASE II: Collect and validate aircraft forces, moments, and all associated applicable data for simulation development. Typical collection methods include wind tunnel investigation, CFD analysis, and/or in flight investigation. Typical methods could be supplanted by innovative methodology that aligns with current NAVAIR practices in certifying and testing military aircraft. Develop a prototype simulation tool which allows for analysis of aircraft flight dynamics in extreme attitudes, as well as pilot training.

PHASE III: Transition the technology to applicable programs such as the P-8A and other large commercial aircraft. Provide simulation testing support to ensure accuracy of modeling and demonstrate functionality to government engineers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This database development has potential application in the training of commercial transportation and shipping pilots to adapt to extreme altitudes sometimes encountered in unusual atmospherics or due to aircraft system failures and ballistic damage. A number of incidents including, but not limited to, USAir flight 427, AA flight 587, and the DHL cargo flight missile impact have prompted industry interest in upset training. Preliminary courses have been developed and employed, but none with the fidelity proposed herein. A potential reduction in commercial aircraft loss due to loss of control accidents is apparent and desired.

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KEYWORDS: Upset Recovery; MMA; P-8A; Upset; 737; Simulation

N08-006 TITLE: Rotary Wing Dynamic Component Structural Life Tracking

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-261 - Health and Usage Monitoring; PMA-275 - V-22 Program; PMA-276

OBJECTIVE: Develop an innovative system for tracking the structural life of rotary wing dynamic components in support of condition based maintenance (CBM) and unique identification (UID) mandates.

DESCRIPTION: To extend the life of today's rotary wing aircraft, dynamic component removal, refurbishment and replacement must be optimized. To accomplish this, an accurate and up-to-date system must be developed to establish the current and past history of each fatigue critical aircraft component. With the fleet-wide deployment of Health and Usage Monitoring (HUMS) aircraft flight data recording systems, complete ground-air-ground flight data is now known throughout the life of the aircraft. This data coupled with an appropriate innovative fatigue life tracking algorithm and novel data management system, can provide the fleet with individual component fatigue life monitoring. As components move from aircraft-to-aircraft the fatigue life can follow the component by storing it on a component-specific sensor. Once developed, maintenance credits for dynamic components can be given and premature retirement due to unknown aircraft usage history can be eliminated.

The end goal for this topic is a innovative and flexible management tool that engineers can use to quickly assess the life of individual aircraft components in the fleet. The tool should include the following components: design of an innovative fatigue life tracking algorithm, a novel data management system, and component specific sensor for storing the data. As part of this effort, evaluate current state of the art component sensor technology for applicability in an aircraft environment. Since HUMS systems and capabilities differ between aircraft platforms, the system should have an open, adaptable architecture. The tool should leverage as much actual aircraft usage and load data as possible to minimize conservatism required in the fatigue life determinations, but since data is inevitably lost, gap filling methods should be included. Consideration should also be given to the fact that these components could move between aircraft.

PHASE I: Demonstrate the feasibility of using novel concepts for calculating individual component fatigue damage using HUMS data. Develop a proof-of-concept plan for tracking the structural life of individual aircraft dynamic components. Evaluate existing Navy data management systems to determine their feasibility and practicality of interfacing between systems. Define initial fatigue life tracking algorithm and database architecture.

PHASE II: Develop a prototype of the fatigue life tracking algorithm and data management system and demonstrate the capability of the system. Collect data from an instrumented prototype rotary wing aircraft and integrate the data with the flight by flight data from the aircraft's flight data recording system. Demonstrate that the algorithms developed track the dynamic component fatigue damage accumulated on a flight by flight basis. Convert the fatigue damage data into fatigue life data and store it within the component sensor.

PHASE III: Refine development based on knowledge gained in Phase II. Develop the complete flexible management tool package with a users manual, and the hardware and software for the system to be integrated into one or multiple US Navy platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This software tracking system will have broad application in both the commercial and military industry where life limited components are used.

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2. DFARS 211.274: Item Identification and Valuation; http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/dfars/dfars211.htm

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KEYWORDS: Aircraft; Rotary Wing; Fatigue; Inspection; Structures; Component; Software; Hardware; Sensor

N08-007 TITLE: Polarimetric Sensor for Airborne Platforms

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA-265 - F/A-18 SHARP and ATARS

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

OBJECTIVE: Using the optimum imagery format, develop a lightweight, low cost electro-optic (EO)/infrared (IR) polarimetric sensor.

DESCRIPTION: The evolution of technology in the area of imagery collection has created the opportunity to extend and enhance the capability of traditional reconnaissance efforts in current tactical collection platforms. Polarimetric imaging is a form of remote sensing that relies on the relative intensity of the polarized components of reflected radiation from natural radiation sources in an uncontrolled environment. The topic seeks to explore various forms of polarimetric imagery and the information that may be gleaned from such imagery in order to exploit the polarization properties of targets and backgrounds [e.g., improvised explosive device (IED) detection]. Sensor output should be interoperable with existing DoD processing systems. Size, weight, and power (SWAP) will be limited to existing air platform resources as detailed in the reference materials. Data exchange should utilize interoperable network communication standards. These standards should include, at a minimum, those cited in the references.

PHASE I: Determine the polarimetric imaging format for use with existing tactical air reconnaissance systems and analyze the feasibility of developing a sensor variant for formatted data collection. The candidate format and sensor should meet existing reconnaissance system size, weight, and power limitations while complying with existing imagery sensor performance standards (e.g. NIIRS).

PHASE II: Using the format and sensor packaging technique identified in Phase I, develop a prototype of the polarimertic sensor. Provide detailed analysis of the sensor performance in a laboratory or static aircraft environment. Provide parametric data to show that the sensor meets size, weight and power limitations required for use in tactical reconnaissance systems.

PHASE III: Develop a polarimetric sensor design package for integration into a tactical reconnaissance system such as the shared reconnaissance pod (SHARP). Conduct flight testing of the sensor on a Navy aircraft to show that the sensor meets all performance requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Military, civil and commercial users can utilize lightweight, small volume, polarimteric sensor capability for a number of applications. This type of sensor can be used to track the movement of potential terrorist threats on our borders and those seeking to enter the country illegally through comparative imagery analysis. Polarimetric sensors would provide a significant value in the DEA's drug interdiction efforts through the tracking of drug shipments to and within a country's borders. It would also help border patrols in monitoring changes/disturbance of the national borders that would be uniquely detected by using polarized imagery.

REFERENCES:
1. "FORCEnet Architecture and Standards Volume II Technical View", Office of the Chief Engineer (SPAWAR 05), 31 December 2004 Available at:
enterprise.spawar.navy.mil/getfile.cfm?contentld=810

2. SHARP Pod Structure and pod subsystem, 05 August 2003

3. Size, Weight, and Power for SHARP sensors 01 July 2001

4. NIIRS Rating scale, Date

KEYWORDS: Polarimetric; SWAP; Imagery Sensor; Polarized Imagery; Remote Sensing; SHARP

N08-008 TITLE: Commandable Mobile Anti Submarine Warfare Sensor (CMAS)

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

ACQUISITION PROGRAM: NAVAIR PMA-264 Commandable Mobile ASW Sensor (CMAS)

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

OBJECTIVE: Develop and demonstrate innovative, air-deployable, commandable, mobile sensor technologies that would provide the capability to realistically simulate the full spectrum of Antisubmarine Warfare (ASW) target signals.

DESCRIPTION: The need for Naval Air ASW forces to detect and neutralize shallow water threats has demanded the use of increasingly sophisticated ASW weapon systems. More practical and affordable in-situ targets to improve weapon system training methodology and tactics are therefore needed. The use of air-deployable mobile targets capable of simulating target mission scenarios are an efficient and valuable asset in training. Research in sensor technology, remote flight control systems, battery chemistry and computer-controlled in-buoy decision will be beneficial.
Current Navy technology is sufficient in some scenarios, but falls short of fulfilling all missions. As a result, there is a need for a Commandable Mobile ASW Sensor (CMAS) vehicle to incorporate modular acoustic as well as non-acoustic sensors. It should be remotely commandable from ASW platforms, and expendable or recoverable depending on the mission use. Volume and weight would be affected by aircraft payload limitations and should have the physical characteristics of a standard US NAVY "A" size sonobuoy. Unit cost should be comparable to current expendable sensor systems and mobile targets. Advancements in both acoustic and non-acoustic sensor

technologies have enabled development of smaller and more sensitive signal receivers, but the application of these technologies to active signal emitters has not been investigated for applicability to ASW.

Communication techniques with applicability to underwater vehicles, along with improved vehicle "intelligence," should be investigated to identify opportunities applicable to expendable systems. Modular sensor packages, and the communication protocol necessary to support them, would be an important evaluation factor. Field changeable mission packages could provide grater flexibility and preparedness to adapt to changing missions and requirements.

PHASE I: Demonstrate proof-of-concept of modular payload sensor design to maximize CMAS mission flexibility and utility. Evaluate emerging power source technologies along with innovative low power in-water propulsion systems. Investigate aircraft communication link subsystem concepts. Develop buoy conceptual packaging configurations and demonstrate supporting modeling and simulation results.

PHASE II: Develop, fabricate and demonstrate candidate system components, subsystems and prototype sensor in a graduated iterative development program. Demonstrate working prototype in the ocean environment, with emphasis on over-the-side hardware.

PHASE III: Conduct integrated engineering and operational testing of an air deployed system. Obtain an air carriage and deployment certification, and demonstrate full operational functionality in Navy-supported test scenarios. Transition completed technology to fleet or appropriate Navy platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed in this SBIR could be leveraged for other marine or space based systems that require in-water mobile, lightweight, deployable systems housing a variety of sensor systems / components. This could include air-deployable search and rescue hardware, resource exploration sensor technology, and oceanographic survey instrumentation.

REFERENCES:
1. Safety Testing of Lithium (Sulfur Dioxide) Battery for Expendable, http://stinet.dtic.mil/oai/oai?&verb=getRecord&metadataPrefix=html&identifier=ADA241602

2. Maritime Patrol Aircraft And ASW Training, http://rand.org/pubs/monograph_reports/MR1441/MR1441.appe.pdf

3. Lockheed Martin EMATT, http://www.sippican.com/contentmgr/showdetails.php/id/345

KEYWORDS: mobile target; acoustic sensors; non-acoustic sensors; remote communication; Antisubmarine Warfare; Jammer

N08-009 TITLE: Geomagnetic Reference Sensor System (GRSS) for Air Anti-Submarine Warfare (ASW)

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: PMA-264 - Air ASW Systems; PMA-290 - Maritime Patrol & Reconnaissance

OBJECTIVE: Develop an innovative Geomagnetic Reference Sensor System (GRSS) for reducing the magnetic anomaly detector (MAD) band geomagnetic noise in an airborne magnetic detection system like the ASQ-208, ASW-508, or the ASW-233.

DESCRIPTION: Previous investigations have shown that geomagnetic noise is highly correlated in space. This suggests the probability of using Adaptive Noise Cancellation (ANC) techniques to improve MAD performance by providing a signal free reference. Previous tests have shown that as much as 20 db of noise cancellation can be achieved in the MAD band by ANC thus providing improved performance. A novel approach to providing a geomagnetic reference is to use an air droppable, magnetic sonobuoy(s) which can relay the geomagnetic noise reference to the aircraft to improve the performance of MAD sensor on board the aircraft.

During use, the GRSS will need to be far enough removed from the magnetic detection system so that the target signature does not appear in both data sets simultaneously. The GRSS must be capable of accurately determining the geomagnetic noise without significant contamination by other noise sources like motion, geologic and wave noise. Ancillary sensors for reducing contaminating noises are permitted. Novel approaches are encouraged. Proposed solutions will involve a unique sonobuoy design i.e., no magnetic components, better suspension system and/or unique algorithms which will process the data properly in the aircraft.

The GRSS is intended for use in conjunction with both current and future MAD ASW systems. The innovation must exhibit sufficient sensitivity and internal noise reduction to determine the geomagnetic noise to within 10 pT per root Hz in frequency band of 0.01 to 1 Hz. The data will need to be accurately timed for the coherent noise cancellation between the GRSS and MAD ASW systems. The GRSS cost, weight, power, and ease of deployment are all considerations. Surface and in-water systems may be considered.

PHASE I: Develop the detailed specifications for the proposed GRSS that will achieve the weight, size, power, cost, and performance requirements for an A-size (*) sonobuoy. Evaluate its applicability to the ASW mission. Develop a detailed design to meet the requirements and establish the feasibility of designing and fabricating the GRSS breadboard in Phase II.

PHASE II: Fabricate a GRSS laboratory breadboard based on the Phase I results. Demonstrate the integration of all of the ancillary sensors into the system. Demonstrate the specified noise floor in a laboratory environment and coherent noise reduction of the geomagnetic noise using the GRSS in at least one at sea field test.

PHASE III: Design, fabricate and demonstrate an air deployable A-size (*) GRSS. Deploy the GRSS in conjunction with an ASW MAD mission and demonstrate geomagnetic noise reduction.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A magnetic reference station is required for all high-resolution magnetic survey work.

REFERENCES:
1. R. Wertz and W. H. Campbell, "Integrated Power Spectrum of Geomagnetic Field Variations with Periods of 0.3 to 300 s," Journal of Geophysical Research 81, 5131 (1976).

2. W. H. Campbell, "Geomagnetic Pulsations," Physics of Geomagnetic Phenomena, Vol. II, Academic Press, New York, 821 (1967).

3. J. T. Weaver, "Magnetic variations Associated with Ocean Waves and Swell," Journal of Geophysical Research 70, 1921 (1965).

4. B. D’eniel, “Undersea magnetic noise reduction”, Proceedings of International Conference on Marine Electromagnetics, June 1997.

5. R. Swyers, et al “Analysis of Electromagnetic Noise Characterization and Reduction Flight Test Data” NAWCADWAR-96-41-TR, Nov. 1996.

6. Joseph Czika (Ed), “Electromagnetic Noise Reduction and Characterization Task Final Report” prepared for Naval Air Warfare Center Aircraft Division, Warminster PA by TASC 1101 Wilson Boulevard, Arlington VA 22209, Jan. 1996

7. John J Holmes, “Modeling a Ship’s Femomagnetic Signature”, Morgan & Claypart Puleshire, 2007.

8. Wallace H. Campbell, “Introduction to Geomagnetic Fields Second Edition, Cambridge University Press, 2003.

KEYWORDS: Geomagnetic Noise; Magnetometers; Magnetic Anomaly Detection; Airborne ASW; Sonobuoy; Sensors

N08-010 TITLE: High Dynamic Range Sensor Simulation

TECHNOLOGY AREAS: Information Systems, Sensors, Human Systems

ACQUISITION PROGRAM: PMA-205, Aviation Training Systems

OBJECTIVE: Establish innovative computer algorithms and associated technologies for creating High Dynamic Range (HDR) sensor simulation that leverages advanced database, rendering, and display capabilities at display-limited resolutions.

DESCRIPTION: With the increased requirements of night operations in all aspects of the military, the use of night imaging devices has been amplified. As a result, a greater demand for training systems with an ever-increasing level of accuracy which can no longer be satisfied by the traditional methods of database creation, scene rendering, and display output. Advances have been to increase fidelity, but none have been coordinated in a single effort. For example, the Naval Aviation Simulation Master Plan (NASMP) Portable Source Initiative (NPSI) seeks to standardize archival specifications for high precision, HDR, and physics-based data types. However, traditional simulation processes, formats, and hardware architectures limit the deployment of emerging HDR display technologies. Solutions are to result in generalized ways for the image generator to gracefully transition from stored data resolution to enhanced display-limited resolution beyond the maximum database spatial resolution.

In the hardware and rendering software domain, new technologies for processing, storing, and rendering HDR imagery for real-time use are on the horizon, yet most image generation systems still use the equivalent of the traditional fixed function capabilities, thus limiting dynamic range to 8 bits per component. Physically representative high-fidelity, real-time rendering of environmental components, such as lighting and atmospherics, are just starting to enter the market, yet only a few systems use such technologies. Finally, there are display systems coming to market that produce a far greater range of intensities (16 bits per component), yet few are programs investigating how to bring such technology to bear in the simulation of sensor imagery.

New techniques and algorithms are required for moving sensor simulation from the traditional 8-bit world to support HDR throughout the entire system. Additional requirements are to identify gaps in the traditional work flow, and produce algorithms and techniques that will preserve dynamic range within source data, pipeline computation, and display representation. Emerging technologies that are physically as well as perceptually accurate can be exploited in the areas of displays and graphic architectures for developing advanced sensor systems.

PHASE I: Propose innovative new techniques for creating run-time databases that preserve the dynamic range of a variety of simulated sensor imagery from source data. Demonstrate the feasibility of the proposed approach using a detailed analysis of the frame-rate performance and dynamic range preservation. Consider sensor imagery variables and outline scene inference methods, for different natural (vegetation, rocks, etc) and cultural features (roads, houses, power-line, etc). Propose new mathematical/physics-based modeling algorithm(s), that derive the high dynamic range scene imagery from source data.

PHASE II: Demonstrate an end-to-end HDR sensor simulation that uses all of the algorithms, techniques, and understanding developed in Phase I. Demonstrate with both specific natural and cultural objects being rendered and collect data to compare the simulations with actual sensor imagery, as a validation of the algorithms effectiveness. Show, through measurement and analysis, that dynamic range was preserved. In cases where it was degraded, quantify the degradation and create mitigation suggestions.

PHASE III: Finalize and produce the software as a standalone application, fully capable sensor simulation that can be installed at training sites. Transition the new technology into existing training simulation systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial potential in the defense and commercial sectors, including Homeland Security, Law Enforcement, Public Safety, and Business Intelligence. Industries to benefit would range from geo-specific imagery for land management purposes, to entertainment-gaming.

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5. Olano, Marc and Bob Kuehne, "SGI OpenGL Shader™ Level-of-Detail White Paper", SGI Document 007-4555-001, 2002

6. C. Bloom. “Terrain Texture Compositing by Blending in the Frame-Buffer(aka "Splatting" Textures)”, Nov. 2, 2000

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8. Brawley, Z., and Tatarchuk, N. 2004. Parallax Occlusion Mapping: Self-Shadowing, Perspective-Correct Bump Mapping Using Reverse Height Map Tracing. In ShaderX3: Advanced Rendering with DirectX and OpenGL, Engel, W., Ed., Charles River Media, pp. 135-154.

9. Heidrich, W., and Seidel, H.-P. 1998. Ray-tracing Procedural Displacement Shaders, In Graphics Interface, pp. 8-16.

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KEYWORDS: Sensor; Rendering; Simulation; Training; High Dynamic; Visual

N08-011 TITLE: Ceramic Radome Machining/Tooling Applications

TECHNOLOGY AREAS: Materials/Processes, Sensors, Weapons

ACQUISITION PROGRAM: PMA-242, Advanced Anti-Radiation Guided Missile (AARGM), ACAT-1

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

OBJECTIVE: Develop tooling and machining applications for ceramic radomes that reduce set-up time and dimensional mismatch. This has the benefit of having a more producible ceramic radome for radar applications and more repeatable radio frequency (RF) performance.

DESCRIPTION: The RF performance of a MilliMeter Wave (MMW) missile is highly dependent on the dimensional tolerances of a ceramic radome. Small deviations and variances of extremely tight tolerances on both the inner and outer contours of the radome will impact the insertion loss of the RF performance of the radome and thus will impact the radar performance of the MMW missile. The current method for machining radomes utilizes a combination of custom made and commercial water-cooled diamond grinding tools on a Computer Numerically Controlled (CNC) machine center. The process requires multiple iterations with multiple machine setups for both inner and outer contour machining. Additionally, repetitive dimensional inspections are required to ensure a tightly controlled finished radome wall thickness. The current process is essentially the same approach that has been used for over 20 years on pyroceram radomes.   In many cases it is so difficult to re-align the radome properly back onto the machine that the radome has to be scrapped as its dimensional deviation makes the radome unusable for radar performance. This results in high production costs and inhibits RF performance.

The goal of this innovation is to apply improved tooling and manufacturing techniques to the development of a ceramic machining process to control a radome wall thickness and concentricity to less than .001". With the development of an improved tooling and manufacturing technique, it is the objective to achieve the ability to machine the inner contour and outer contour of the ceramic radome in a two step process. One set up and machining step each for the inner and outer contour machining; allowing the radome to remain in place while all machining is accomplished.   Recent data from researchers show the insertion loss values of properly manufactured radomes is about 1.5dB, In comparison, the conventional machining techniques have produced radomes with an insertion loss of 2.5 dB (at W band), are more time consuming and result in higher costs and lower yield. The new machining technique has the promise to better meet RF performance, reduce production time, and reduce manufacturing costs.

PHASE I: Design and develop an innovative method of tooling and machining for ceramic radomes. Evaluate the improved dimensional control of machining both the inner and outer contours using a reduced number of setups. Develop a machining process definition that will include equipment descriptions, tooling and support fixture concepts, and projected time and labor utilization for the recommended processes. Emphasis should be on determining the RF insertion loss performance of the newly machined ceramic radomes to satisfy missile RF MMW insertion loss requirements. Perform validation to include RF measurements on machined radomes for comparison with the baseline process. Investigate a notional machining approach to machine inner and outer radome contours using the same tools and fixtures.

PHASE II: Construct and demonstrate the operation of the prototype tooling to machine the inner and outer contours of ceramic radomes in a very low rate production setting.   Define test objectives and conduct limited testing of a minimum of ten (10) radomes over a six month period. Each successfully tooled radome should be tested for RF insertion loss at W band to measure if it is within acceptable standards.

PHASE III: Finalize and fabricate tooling to prepare for production run. Successful manufacturing of the tooling and technique, may result in the ability to fabricate 300-400 ceramic radomes per year.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Any application that requires high precision machining of ceramic (aircraft avionics, missiles) could benefit from success of this technology. The use of ceramics has advantages over metal depending upon the application. Ceramics are harder and stronger in compression than most metals. In addition, ceramics can be electrically or thermally insulating or conducting.

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KEYWORDS: machining; ceramic; radomes; high precision; ceramic machining; milli-meter wave

N08-012 TITLE: <u>Dynamic Flight Simulation as a Supplement to In-Flight Pilot Training</u>

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA-205 Aviation Training Systems

OBJECTIVE: Measure the effectiveness of non-motion based simulation versus dynamic flight simulation.

DESCRIPTION: The age of USN/USMC tactical aircraft currently averages 19 years, which is significantly older than in prior combat periods. Due to budget constraints and aircraft development schedules, the average age of aircraft is projected to continue rising and in-service aircraft quantities are projected to fall. Pilot high G tactical maneuver training is wearing out and depleting in-service aircraft. While the use of fixed based flight simulators is increasing, there are no objective data that certify that training without motion cues adequately transfers to actual flight. Providing this verification is critical to ensure that the time spent training in ground-based static or dynamic flight simulators will effectively off-load flight time from in-service aircraft, or will simply be time wasted. Complete training programs that are candidates for ground-based dynamic flight simulation include tactical flight operations, high G training, spatial disorientation, aircraft upsets and recoveries, night vision and night vision goggle operations, and loss of situational awareness. Significant performance variables for training, missions and critical maneuvers applicable to simulation; flight profiles; physiological metrics; skill retention/decay and training measures of effectiveness (MOE), performance (MOP), and value (MOV) must be assessed and defined.

PHASE I: Define and develop effective objective flight training rubric and measurement techniques. Establish a training strategy, requisite fixed and motion base simulator configuration characteristics, simulator performance requirements, a test subject program, training exercises, MOE/MOP/MOV criteria, and comparative training validation methods.

PHASE II: Configure a ground-based fixed and motion based tactical flight simulator applicable to USN/USMC aircraft and demonstrate the effectiveness of the proposed measurement technology.

PHASE III: Apply the results of the Phase II evaluation to enhance the G-tolerance improvement training curriculum at the training facility at NAS Lemoore.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial aviation sector would benefit through the development of ground-based simulator capability to include (a) commercial pilot training and (b) training for space travelers, including sustained G training and Spatial Disorientation familiarization.

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KEYWORDS: Simulation; Training; Pilot; Proficiency; Workload; Fatigue

N08-013 TITLE: Innovative Methods for Modeling and Simulation of Tiltrotor Aircraft

TECHNOLOGY AREAS: Air Platform, Information Systems, Human Systems

ACQUISITION PROGRAM: PMA-275 - V-22 Program, ACAT I

OBJECTIVE: Develop innovative aerodynamic modeling and simulation approaches for rotary wing and tiltrotor aircraft that provides an efficient means of easily updating new and existing simulation math models in order to increase model fidelity and reduce update time.

DESCRIPTION: During aircraft development and testing, the aerodynamic, six degree of freedom simulation math models are continuously adjusted to improve correlation with wind tunnel and flight test data in order to accurately predict and depict aircraft response to varying degrees of success. However, as with all simulations, model complexity and design currently limit our ability to efficiently update the math model. Systemic problems arise from bookkeeping of model correlation adjustments in incorrect or physically improbable locations due to the complexity of the update cycle. Most current rotorcraft/tiltrotor simulation models are cumbersome and onerous to update. Large quantities of manpower and time are required to correlate and update the model with flight and wind tunnel data.

Without high fidelity modeling and simulation tools that allow for efficient methodologies for model updating, the aircraft flight test and training are at a higher risk. An innovative real-time modeling capability is needed, that can be easily updated with flight test and wind tunnel data, to accurately predict aircraft characteristics. By reducing the time and complexity associated with updating the math model, the fidelity of the model should increase as more data can be incorporated into the model. Having a higher fidelity simulation math model would allow for more succinct flight test planning and execution (less flights, less money, more predictive capability), allow for better trainers to be used for training and tactics, techniques, and procedures development; allow for better training to reduce mishap potential; and ultimately allow for more accurate mishap investigation assistance.

While current simulations employ an open architecture design which allows for addition of new modules and capabilities, these do not allow for quick, easy, and accurate simulation update/refinement of the model based on new data. Methods for automated simulation update based on wind tunnel and flight data have been recently employed for fixed wing platforms (Ref 4 and 5); however, as of yet, these methods have not been utilized for rotary platforms due to the increased complexity involved with the inclusion of a rotor. For rotary wing platforms, past experience has shown that component based modeling is required for improved predictive capability. Updating a component based model, however, is time consuming and difficult. Non-component based simulations, while easier to update and validate, are not suited for predictive analysis.

PHASE I: Develop an innovative approach for the aerodynamic modeling and simulation of rotary wing and tiltrotor aircraft that provides the capability for efficiently updating new and existing math models with flight test and wind tunnel data while still increasing model fidelity and predictive capability. Demonstrate the feasibility if the approach through simple modeling examples that demonstrate the ability to perform updates.

PHASE II: Fully develop the approach into a prototype modeling tool. Demonstrate the capability of the tool by performing a simulation on a military tiltrotor or rotorcraft as the case study, and verify the ability to update the model with a limited set of flight test and/or wind tunnel data to improve model fidelity.

PHASE III: Develop a real time, production ready, rotorcraft/tiltrotor simulation tool. Perform verification and validation of the developed technology and demonstrate that the new tool can be easily updated with a wide set of flight test and wind tunnel data and that the model accurately predicts aircraft characteristics. Transition the new capability to tiltrotor and rotorcraft platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The model architecture developed here can be applied to helicopter and tiltrotor platforms via model tailoring. The basic architecture and model methodology can be consistent. Model incorporation in other platforms can result in a potential reduction in development and operation costs.

REFERENCES: Available on the NASA Technical Report Server or from NASA directly:
1. Ferguson, Samuel W. “Development and Validation of a Simulation for a Generic Tilt-Proprotor Aircraft”. NASA-CR-166537. Systems Technology, Inc. Mountain View, CA. April, 1989.

2. Ferguson, Samuel W. “A Mathematical Model for Real Time Flight Simulation of a Generic Tilt-Proprotor Aircraft”. NASA-CR-166536. Systems Technology, Inc. Mountain View, CA. October, 1983.

3. Harendra, P. B., M. J. Joglekar, T. M. Gaffey, R. L. Marr. “V/STOL Tilt Rotor Study – Volume V: A Mathematical Model for Real Time Flight Simulation of the Bell Model 301 Tilt Rotor Research Aircraft”. NASA-CR-114614, 13 April 1973

4. Klein, Vladislav, Eugene A. Morelli. “Aircraft System Identification – Theory and Practice”. AIAA Education Series, Reston Virginia. 2006.

5. Morelli, E., D. Ward. "Automated Simulation Updates based on Flight Data". AIAA 2007-6714. Presented at the AIAA Atmospheric Flight Mechanics Conference in Hilton Head, South Carolina. 20-23 August 2007.3w www.aiaa.org

KEYWORDS: Modeling; Simulation; Tiltrotor; Helicopter; Aerodynamic; Aircraft

N08-014 TITLE: Intelligent Repeatable Release Hold Back (RRHB) Bar

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: PMA-251, Advanced Arresting Gear Program

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

OBJECTIVE: Develop innovative electronic system technology to interface with the RRHB that would count the number of shots on a RRHB, indicate the position of the reset indicators, record the release load pressure, provide the start point (real time) for a catapult launch, and hold a unique identifier (serial number) for each bar that could be read with a PDA. The interface should be adaptable to different hold backs (F-18, S-3, etc.).

DESCRIPTION: Naval aviation depends on catapults to enable aircraft to operate safely on aircraft carriers. An important subsystem of the aircraft launch is the RRHB bar. The RRHB is used to restrain the aircraft until the steam pressure of a launch overcomes the release load of the bar. If the bar releases prematurely (before the catapult is fired), the aircraft will roll down the deck often confusing the pilot. The RRHB is a completely mechanical device without any transducers. An operator visual determines if the bar is reset and he keeps track of the number of shots on a bar manually. No other information (release load pressure, start point of launch, etc.) can be extracted from a fleet issued bar.

Currently, the only time RRHB start time and load pressure can be recorded is during a dead load program. Shots on the bars are manually recorded and tracked by ship's forces. An intelligent bar will keep track of the number of shots on the bar, provide positive reset indication, indicate the start (real time) of a launch, and inform the user when pull test and maintenance are required. In addition, by trending the release load pressure, it may be possible to provide early detection of internal segment failures. The system must be capable of withstanding the shock, vibration, and temperature extremes of the flight deck. Substantial savings will be realized in preventative maintenance, corrective maintenance, and stock system procurement costs.

PHASE I: Determine the feasibility of developing an electronic system to interface with the RRHB that will meet all requirements. Develop a conceptual design based upon the lowest technical risk and highest confidence of completion. Develop a concept of operation and provide defendable estimates for cost and reliability and maintainability (if applicable).

PHASE II: Develop and demonstrate a prototype. Initial testing of the system will be on a sub-scale demonstrator progressing to full scale system testing at the NAVAIR Lakehurst Catapult Test facilities. During a final demonstration, the system should provide system health monitoring and full-scale performance to verify that the system can meet environmental robustness, shipboard shock and vibration, and maintainability requirements.

PHASE III: Manufacture and install, on a candidate USS Nimitz Class Aircraft Carrier, six intelligent RRHB's to function as shipboard evaluation prototypes for a minimum of one year, prior to back-fitting the entire fleet of carrier vessels and ground catapult installations.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be a substitution for any system requiring a high accuracy, harsh environment, intelligent small differential detection system.

REFERENCES: Repeatable Release Holdback Bar (To Be Posted on SITIS)

KEYWORDS: Performance; Environmental Robustness; Maintainability; Hold Back; Real Time; Intelligent

N08-015 TITLE: Jet Blast Deflector (JBD) Operator (JBD Safety) and Weight Board Operator Safety Improvements

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: PMA 251 - Advanced Arresting Gear Program

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

OBJECTIVE: Develop an innovative sensor and display technology that indirectly measures if the JBD panels are fouled and displays aircraft weight (configuration) information to the pilot and the Catapult Officer and Central Charging Panel (CCP) operator.

DESCRIPTION: The JBD panels are raised when launching aircraft to prevent the exhaust from damaging aircraft on deck as well as potentially harming individuals. The JBD Operator (Safety for Waist Catapults) and the Weight Board Operator both perform their duties on deck near the JBD panels. The JBD Operator's function is to determine if aircraft or personnel are fouling the panels' range of motion, which prevents the panels from being raised or lowered. The Weight Board Operator typically negotiates the weight of the aircraft with the pilot behind the JBD while an aircraft is being launched. The Weight Board Operator shows the weight board to the Catapult Officer and relays the negotiated weight and configuration to the JBD Operator so the information can be passed to the CCP Operator. Noise levels associated with the Joint Strike Fighter (JSF) can cause permanent damage to personnel in the area. In order to mitigate the potential harm to the JBD Operator and Weight Board Operator, they must be removed from the area where they presently perform their functions. The goal of this SBIR is to devise a technology to replace these positions. The minimum is to remove the operators from the hazardous area created by the JSF.

PHASE I: Determine the feasibility of replacing personnel or reducing the risk/hazard to personnel taking into consideration such factors as accuracy and safety and develop a conceptual design based upon the lowest technical risk and highest confidence of completion. Develop a concept of operation and provide defendable estimates for cost and reliability and maintainability (if applicable).

PHASE II: Develop and demonstrate a prototype. During a final demonstration, the system should provide system health monitoring, fault detection/isolation, and a fail-safe mode.

PHASE III: Further develop a prototype for robustness and shock, vibration, environmental and electromagnetic interference (EMI) testing (as applicable). Produce units for delivery to carrier Fleet and shore sites.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology used to develop the sensors and display techniques will have potential industrial commercialization in applications that require high precision detection and innovative display techniques (complying with flight deck lighting limitations) in harsh environments.

REFERENCES:
1. Aircraft Weight Confirmation Unit (To be posted on SITIS)

2. Jet Blast Deflector (To be posted on SITIS)

KEYWORDS: Non-Contact; Health Monitoring; Fault Isolation; Catapult; Jet Blast Deflector; Environmentally Robust

N08-016 TITLE: Lightweight Integrally Stiffened Composite Structure

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-275, V-22 Program; PMA-276, USMC Light/Attack Helicopter Program

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OBJECTIVE: Develop and demonstrate design and manufacturing methods applicable to bead-stiffened composite airframe structures as lightweight, affordable alternatives to conventional sandwich construction with enhanced survivability in the Navy shipboard environment.

DESCRIPTION: Current composite airframe construction relies extensively upon use of metallic and nonmetallic honeycomb core. While sandwich construction is structurally efficient, it suffers from durability limitations and very high life cycle costs associated with corrosion, impact damage, maintenance and repair. As a consequence, there is a strong need for alternative materials and construction methods that are structurally efficient, durable and more affordable to manufacture and maintain.

Thin gage airframe structure is frequently limited by stability (buckling) considerations. An alternative means for improving buckling load relies upon geometrical formed part features such as beads, sine wave spars, etc. to create bending stiffness in thin web structures. This approach has long been used in metallic airframes (press formed beads, beaded lightening holes, EB welded sine wave spars, etc). Self-stiffened designs have also been demonstrated in composites, but the low elongation of continuous carbon fiber and planar, non-conformal nature of prepreg material limits the detail geometries that can be formed with high quality due to effects such as wrinkles. Furthermore, forming intricate compound contour geometry on a small scale (i.e. beads) with present material forms is labor intensive, expensive and often requires that fiber and plies be cut and patched for forming purposes, adding weight and introducing discontinuities.

PHASE I: Identify and define realistic rotorcraft airframe designs that can benefit from integrally stiffened designs. Develop realistic requirements such as geometry, tolerances, loads, frequency response, environment, damage tolerance, life-cycle costs, etc based on actual Navy rotorcraft airframe designs. Investigate manufacturing processes for integrally stiffened airframe designs and demonstrate feasibility in a laboratory environment. Demonstrate material and process, as well as their feasibility and scalability for representative rotary wing components.

PHASE II: Using a building block approach develop, demonstrate and test a realistic, full-scale structure using an integrally stiffened design that meets structural integrity, weight, damage tolerance, and other requirements. Identify nonrecurring and recurring costs as a part of a comprehensive Technology Insertion Plan.

PHASE III: Develop production quality, low-cost, low-maintenance airframe designs for military and commercial aircraft programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology (composite manufacturing process, material forms, and designs) has wide-ranging applicability in both the public and private sector. As composite materials continue to displace metals in primary and secondary airframe structure, the focus is on affordability and improving durability in the service environment. This is true from both military and commercial operators. Therefore, this technology, if successful, can lead to greater penetration of the composite airframe market with US-developed technology.

REFERENCES:
1. “Buckling of Open-Section Bead-Stiffened Composite Panels”, Laananen, D. H. and Renze, S. P., Composite Structures (ISSN 0263-8223), vol. 25, no. 1-4, p. 469-476.

2. “Braided Preform Manufacturer for Large Scale, Integrally Stiffened Structures”, Braley, M., SAMPE 2000 - Long Beach, CA May 21 - 25, 2000.

3. “Fiber-Placed Composite Grid-Stiffened Structures”, Van West, B.P., and Wegner, P., 33rd STC - Seattle, WA - November 5 - 8, 2001.

KEYWORDS: Composite Structure; Integrally Stiffened; Bead Stiffened; Buckling; Forming; Automation

N08-017 TITLE: Thermally Stable High Energy Lithium-Ion Batteries for Naval Aviation Applications

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: PMA-273 - T-45 Naval Undergraduate Flight Training System; JSF

OBJECTIVE: Develop thermally stable high energy Lithium-ion battery technology for Navy aircraft in order to meet increasing power and energy demands, satisfy mission operational temperature requirements, and provide increased reliability while reducing weight.

DESCRIPTION: Increasingly demanding 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 and high power Lithium-ion systems have proven themselves in many military, commercial and aerospace applications. However, continued development of this technology is required in order to fully satisfy the broad operational temperature range and high energy density requirements of Navy aircraft batteries. Presently the temperature range of the technology is limited to a maximum temperature of 60 degrees centigrade. Operating temperatures for existing aircraft batteries is 71 degrees centigrade with exposure up to 85 degrees centigrade. Novel approaches are sought to make the electrodes stable in electrolyte at these temperatures. With technology as it is now, the batteries have a short service life and high operating price if used.

The intent of this effort is to focus innovative research on solving the technical challenges associated with adapting Lithium-ion battery technology to satisfy the demands placed upon Navy aircraft. The technical goals include, but are not limited to, (1) enhancing the thermal stability of electrolytes; (2) improving the compatibility of electrolyte/electrode interfaces; (3) improving separator systems; and (4) increasing the battery energy density. Achieving these goals will improve both battery system reliability and mission performance.

The complete battery systems developed under this topic should demonstrate functionality and stability over a wide temperature range (-40°C to +80°C), high energy density (> 200 Wh/kg at the battery level), low self-discharge (<5% per month), good cycle life (>5,000 at 100% depth of discharge cycles), and long calendar life (>5 years service and storage life).

PHASE I: Demonstrate the feasibility of proposed battery system design of meeting Navy aircraft battery requirements. Develop a cell design and cell chemistry that will support these requirements; demonstrate in scaled or full-size test cells.

PHASE II: Develop a prototype battery system for test and evaluation to requirements. Demonstrate manufacturing feasibility and evaluate cost estimates for manufacture of batteries for form, fit and function replacements on Navy aircraft.

PHASE III: Perform functional evaluation of the battery system (including flight demonstration if necessary).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The results of this work can be directly applied to provide high energy Lithium-ion batteries for use in commercial aviation and automotive applications.

REFERENCES:
1. MIL-B-29595. “Batteries and Cells, Lithium, Aircraft, General Specification For.” Military Specification, 29 June 2000.

2. Cohen, S., F. Puglia, J. Hall, and R. Scott. “Design, Thermal Analysis and Testing of Very Large Lithium-Ion Cells.” Proceedings of the 41st Power Sources Conference, (June 14-17, 2004), Session 14.

3. Deroy, C., R. Gitzendanner, F. Puglia, D. Carmen, and E. Jones. “Lithium-Ion Technology for Aerospace Applications.” Proceedings of the 41st Power Sources Conference, (June 14-17, 2004), Session 17.

4. M.C. Smart, S. Hossain, R. Loutfy, and B. V. Katnakumar “Performance Characterization of Lithium Ion Cells Possessing Carbon-Carbon Composite-Based Anodes Capable of Operating over a Wide Temperature Range” 41st Power Sources Conference, (June 14-17, 2004) Session 23

5. B. L. Lucht, C. L. Campion, W. Li, B. Ravdel, J. F. DiCarlo, R. Gitzendanner, K. M. Abraham “Suppression of Decomposition Reactions of Lithium-Ion Battery Electrolytes” 41st Power Sources Conference, (June 14-17, 2004) Session 26

6. T. Guseyno, M. Hurley, B. Deveney, S. Naing, W. Johnson “Development of Prismatic Li-Ion Cells for Unmanned Aircraft” 10th Electrochemical Power Sources R&D Symposium (August 20-23, 2007)

7. D. Britton, T. Miller and W. Bennett “Thermal Characterization of Lithium-Ion Cells” 10th Electrochemical Power Sources R&D Symposium (August 20-23, 2007)

KEYWORDS: Battery Systems; Lithium Ion; Electrical Systems; Energy Storage; Aviation; High-energy Density.

N08-018 TITLE: Cylindrical/Ogive Phased Array Transmitter for Jammers

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA-234, Next Generation Jammer; Joint Strike Fighter Program

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

OBJECTIVE: Determine the feasibility of using non-planar arrays for wide-band, high-power jamming transmitters.

DESCRIPTION: Currently, phased-array transmitters for jamming are generally planar. For high-power airborne use, these planar arrays typically require an aerodynamic radome. The radome design can be complex, requiring aerodynamic consideration as well as the ability to pass wideband high-power jamming signals without depolarizing or distorting the beam as it is steered in angle. The advance of modern digital processing and signal processing may now allow the development of non-planar (i.e., cylindrical or ogive) arrays, possibly conformal, that would provide the wideband high-power jamming required. Note that the difference between prior conformal array designs and this topic is the requirement for wideband (multiple octave) high-power transmission.

PHASE I: Determine the feasibility of using non-planar arrays for wide-band high-power jamming transmitters from ultrahigh frequencies (UHF) to Ka band. Perform analyses and modeling to predict the performance of such arrays, perform comparative analysis with non-planar arrays, and discuss the beamforming methodology for such arrays.

Deliver the analysis tools/files (if an available commercial RF modeling package is used, it need be identified, but not delivered).

PHASE II: Develop and demonstrate a cylindrical and/or ogive array transmitter in a laboratory. Prepare a test plan, conduct the test in a laboratory, and prepare and deliver a test report.

PHASE III: Develop a fully documented, fully flight qualified array for use on Naval tactical jet aircraft. The target form factor is that of a 480-gallon fuel tank.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The non-planar array technology could be applied to make directional antennas that blend into buildings and the surrounding architecture. Non-planar arrays, particularly ogives, could be used to make aircraft weather radars that blend into the aerostructure instead of dealing with reflections behind a radome. The wideband technology required for jammers can be used to support spread-spectrum commercial systems to avoid interference.

REFERENCES:
1. Dinnichert, M. “Full Polarimetric Pattern Synthesis for an Active Conformal Array.” Proceedings of the 2000 IEEE International Conference on Phased Array Systems and Technology, (May 21-25, 2000): 415–419.

2. Hersey. R.K., W.L. Melvin, J.H. McClellan, and E. Culpepper. “Adaptive Conformal Array Radar.” Proceedings of the IEEE Radar Conference, (April 26-29, 2004): 568-572.

3. Skolnik, Merrill. Radar Handbook, 2nd Edition. New York: McGraw-Hill, 1990.

KEYWORDS: Non-Planar; Conformal; Transmitter; Jammer; Array; Wide-band

N08-019 TITLE: Concepts for Pulse Interleaving Radar Modes

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: JSF - Joint Strike Fighter Program

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

OBJECTIVE: Develop innovative pulse interleaving techniques to facilitate the multiple simultaneous mode operation in Naval radar systems in order to improve situational awareness in a littoral environment.

DESCRIPTION: Traditional radar mode interleaving is done by dedicating specific time periods for each mode. However, with the increasing proliferation of very capable Naval radar systems [including those utilizing active electronically steered arrays (AESA)], there is potential for performance gains to be realized by implementing mode interleaving at the radar pulse level. Investigate pulse interleaving of two or more radar modes with differing temporal baselines. Focus on air-to-surface modes (moving target indicator search, tracking and imaging) where ocean and surface craft scattering phenomenology also must be considered. In addition, investigate the pulse interleaving of air-to-air and air-to-surface modes.

PHASE I: Determine the feasibility and potential performance benefits of advanced radar techniques that use pulse interleaving of two or more modes with differing temporal baselines.

PHASE II: Develop specific parameter sets for advanced radar modes that utilize pulse interleaving. Develop the parameter sets to allow demonstration on either an existing, fielded or experimental AESA radar and quantify the expected performance benefits.

PHASE III: Demonstrate the parameter sets on either an existing fielded or experimental AESA radar to validate the predicted performance benefits and provide the basis for technology transition to one or more Navy airborne radar systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The techniques developed under this SBIR could find application in a number of finds application in a wide range of civilian communication systems. The general models developed under this SBIR could be modified to support these civilian applications.

REFERENCES:
1. Miranda, S.L.C., C.J. Baker, K. Woodbridge and H.D. Griffiths. "Phased Array Radar Resource Management: A Comparison of Scheduling Algorithms." Proceedings of the IEEE Radar Conference, 2004, (April 26-29, 2004) 79-84.

2. Hansen, J.P., S. Ghosh, R. Rajkumar and J. Lehoczky. "Resource Management of Highly Configurable Tasks." Proceedings of the 18th International Parallel and Distributed Processing Symposium, (April 26-30, 2004), 116.

3. Watson, R. "Radar Resource Management Modeling." RADAR 2002, (October 15-17, 2002), 562 – 566.

4. Lee, C.-G. "A Novel Framework for Quality-Aware Resource Management in Phased Array Radar Systems." Proceedings of the 11th IEEE Real Time and Embedded Technology and Applications Symposium, (March 7-10, 2005), 322-331.

KEYWORDS: Mode Interleaving; Resource Management; Radar; Operational Scenarios; Temporal Processing; Littoral Environment

N08-020 TITLE: Low-Cost Production of Nanostructured Super-Thermites

TECHNOLOGY AREAS: Chemical/Bio Defense, Materials/Processes, Weapons

ACQUISITION PROGRAM: PEO(W)-ACAT 1C

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

OBJECTIVE: Develop a safe, low-cost, high performance, high production rate method of preparing nanostructured super-thermite materials.

DESCRIPTION: "Super-thermite" is a metal fuel/metal oxide energetic mixture where at least one of the materials has a sub 100 nanometer dimension. Super-thermites with high energy content greater than TNT (4.5 kJ/g) are of interest. Thermite type compositions can have higher densities and energy content by volume than conventional organic explosives. This affords smaller weapon systems or enables the use of higher lethality weapons. A substantial increase in weapons performance is expected. The cost and production rate of super-thermite composites has limited the use of these materials in DoD applications. Currently, the most common approach for the preparation of super-thermites is by ultra sonication of nano metal and nano metal oxide powder. Eliminating the need for nano sized starting materials is preferable for cost minimization.

PHASE I: Determine the technical feasibility of preparing a high performance super-thermite composites in a low-cost but commercially scalable process. The material prepared by the new process should be comparable to that from the ultra sonication method. Capability to determine the performance of the super-thermite material by measuring the reaction rate, time to peak pressure, maximum peak pressure, and energy content is preferred.

PHASE II: Develop a prototype production system capable of producing nano-structured thermite with performance comparable to material from the sonication method. Demonstrate the preparation of several moderate scale batches and measure the performance characteristics as compared to material from the sonication process. Run to run reproducibility is required. Determine the aging and safety characteristics of the prototype prepared super-thermite material.

PHASE III: Develop a production ready system to support the development and integration of the super-thermite material into smaller weapons for the JSF internal weapons carriage, as primers for NAVAIR's medium caliber Gatling gun ammunition, for use in CAD/PAD devices such as ejection seats and flare dispensers, and as flare materials.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Low-cost super thermite has potential applications as lead-free primers for ammunition, igniters, flares, and fireworks, especially indoor displays.

REFERENCES:
1. S. H. Fischer and M. C. Grubelich, "Theoretical Energy Release of Thermites, Intermetallics, and Combustible Metals," 24th International Pyrotechnics Seminar, Monterey, CA, 1998.

2. Son, S. F., Foley, T., Sanders, V. E., Novak, A., Tasker, D., and Asay, B. W., "Overview of Nanoenergetic Research at Los Alamos," Mater. Res. Soc. Symp. Proc., Vol. 896, 2006, pp. 87-98.

3. Puszynski, J. A., Bulian, C. J. andSwiatkiewicz, J. J., "The Effect of Nanopowder Attributes on Reaction Mechanism and Ignition Sensitivity of Nanothermites," Mater. Res. Soc. Symp. Proc., Vol. 896, 2006, pp. 147-158.

4. Schoenitz M., Ward T., and Dreizin E.L. "Preparation of Energetic Metastable Nano-Composite Materials by Arrested Reactive Milling," Materials Research Society Proceedings, V. 800, pp: AA2.6.1-AA2.6.6, 2004

KEYWORDS: energetics; nanostructured; super-thermite; pyrotechnics; ultra sonication; nano metal

N08-021 TITLE: Combined Analytical and Experimental Approaches to Rotor and Dynamic Component Stress Predictions

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

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

OBJECTIVE: Develop an innovative analysis tool which uses combined analytical modeling and experimental measurement to dramatically improve the accuracy of predictions for rotor loads and stresses in dynamic components on in-service rotorcraft.

DESCRIPTION: The accurate prediction of rotor and dynamic component stresses remains an elusive goal. Despite major advancements in computational fluid dynamics techniques, prediction of the unsteady aerodynamic loads acting on the blades continues to be a formidable computational task, and the accuracy of these predictions remains problematic. Since the loading history is not known with sufficient accuracy, fatigue and reliability analyses are difficult to perform, and in all likelihood, the resulting designs are overly conservative. Even if analytical predictions were accurate, the actual flight conditions and resulting loading spectrum are not known with sufficient accuracy to predict stresses in rotor dynamic components.

Innovative, combined analytical modeling and experimental measurement methods are sought to dramatically improve the accuracy of predictions for loads and stresses in dynamic components. These predictions will need to be made in the absence of actual flight conditions and loading spectrums. These methodologies should be applied to develop an analysis tool that receives actual load, strain and/or acceleration data from a limited number of key dynamic components that are instrumented on fleet aircraft. This analysis tool could use this data to constantly improve the fidelity of a predictive model as more data is made available over time so that estimates of loads throughout the rotor system can be made.

PHASE I: Provide proof-of-concept of a combined analytical/experimental rotor loads model based on government-furnished data (rotor system as well as associated measured airloads database). Demonstrate the differences between measured airloads and analytically computed airloads. Propose a method for predicting dynamic component (hub, swashplate, actuators, etc…) loads based on analytical rotor loads. Consider the effect on accuracy when a limited number of on-aircraft sensors provide data to the analytical model. The proof-of-concept should consider minimal data available, such as in the early stages of a rotorcraft program.

PHASE II: Quantify the potential improvement of the Phase I methodology when more accurate, measured airloads are used. Exercise system identification algorithms to create models relating the strains to the input aerodynamic loads for various sensor types and locations within given flight regimes. Evaluate the accuracy of the approach and verify this approach experimentally. Develop a prototype predictive analysis tool and apply it experimentally to actual test aircraft.

PHASE III: Develop a flight test program where an instrumented rotor system will be used to identify airloads. Assess the accuracy of the overall procedure and its ability to improve fatigue predictions and health monitoring of dynamics components. Develop the final analytical software package and the minimum instrumentation system required for use on in-service Navy rotorcraft

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Combined analytical-experimental rotor load predictions will have broad application in both the commercial and military aerospace industry where fatigue prediction of dynamic components is an issue.

REFERENCES:
1. Maley, S., Plets, J., Phan, N.D., "US Navy Roadmap to Structural Health and Usage Monitoring – The Present and Future" Presented at the American Helicopter Society 63rd Annual Forum, Virginia Beach, VA, May 1-3, 2007 (www.vtol.org)

2. Arms, S., Augustin, M., Phan N.D., “Tracking Pitch Link Dynamic Loads with Energy Harvesting Wireless Sensors” Presented at the American Helicopter Society 63rd Annual Forum, Virginia Beach, VA, May 1-3, 2007. (www.vtol.org)

3. Polanco, F., “Estimation of Structural Component Loads in Helicopters: A Review of Current Methodologies” DSTO Aeronautical and Maritime Research Laboratory, Melbourne Australia, 1999

KEYWORDS: Helicopter; Loads; Stress; Aerodynamics; Aeroelasticity; Prediction

N08-022 TITLE: Miniature Ultra-High Capacity Data Storage (MUHCS) in support of Strike and Mission Planning

TECHNOLOGY AREAS: Information Systems, Weapons

ACQUISITION PROGRAM: PMA-281 - Cruise Missiles Command & Control Program, ACAT 1

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OBJECTIVE: Develop novel data storage technologies that would enable forward operating units and Troops-in-Contact to engage and prosecute hostile targets with Precision Guided Munitions (PGMs) to include Tomahawk.

DESCRIPTION: Reference imagery for strike and mission planning, i.e., digital point position data base (DPPDB) and digital terrain elevation data (DTED), are required to generate aim points for precision-guided munitions (PGMs). These peta and terabyte size data files are currently stored on multiple tape cartridges, several DVDs or Redundant Arrays of Independent Drives (RAIDs). The time sensitive targeting (TST) and mission planning require rapid access to this data. These activities can be severely impacted due to inadequate local data storage – especially at the forward operating units where troops are in contact. Depending on the imagery requirement for the area of coverage, insufficient local data or laptop storage severely limits real-time performance.

Innovative, ultra-high capacity, small, lightweight, and low power data storage concepts are sought that capitalize on advances in optical (holographic), carbon nanotube, magnetic recording capability, and others, and enable local and ultimately laptop storage of reference imagery for strike and mission planning at the forward operating Unit level. The combination of reference imagery, digital terrain elevation data and real time imagery data will allow real time generation of geo-referenced imagery, further reducing the kill chain time line. Innovative data storage device solutions to be developed should be highly survivable and reliable, encrypted, require little or no power and be small enough to be able to be installed within a standard laptop computer with no specialized hardware or adapters. Read/write rates should exceed today's highest rates by an order of magnitude. The MUHCS should be operator configurable into partitions and should be able to function singularly or in clusters or groups. It is anticipated that these storage devices will be embedded and operate with all precision weapon systems; Tomahawk Cruise Missiles, Joint Direct Attack Munition (JDAM) and numerous other PGMs. The operational requirements will put critical emphasis not only on size, weight, and power but other characteristics that allow real-time operation within rather hostile conditions. There is considerable progress in commercial research on this topic; however the focus is on magnetic recording devices, not storage of multiple Terabytes within small form factor.

PHASE I: Determine the feasibility of developing a MUHCS for use in high capacity, high data transfer and recording rates, data storage-systems. The emphasis should be directed towards storage of multiple Terabytes within small form factor (no larger then DVD, prefer size of current USB memory sticks) providing real-time performance.

PHASE II: Develop the prototype system and demonstrate mark recording onto the media at desired mark sizes, and subsequently access written marks to determine the media signal-to-noise ratio (SNR), and obtain raw error data from the disk.

PHASE III: Evaluate the MUHCS in a field operation. Transition the developed capabilities to the Tomahawk Command and Control Station (TC2S), Joint Mission Planning System (JMPS), Precision Strike Suite – Special Operations Forces (PSS-SOF) and Digital Precision Strike Suite (DPSS) laptop environments and ultimately precision weapon system. This technology could also be used in other military applications such as new unmanned air vehicles (UAVs) and other surveillance platforms, with size and weight restrictions, that require collection of voluminous amounts of image, radar, and other intelligence data.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would be useful for any commercial application where large volumes of imagery or other critical data must be kept permanently. These applications could include digital cinema, banking, oil exploration, and satellite imagery.

REFERENCES:
1. Bourzac, Katherine. "TR10: A New Focus for Light." Technology Review, posted March 12, 2007. http://www.technologyreview.com/nanotech/18295/.

2. "Nano-Sized Data Storage Devices Carved from Silicon Prove Superior to Current Electromechanical Technology." Nanotechnology News Archive, posted October 5, 2004. http://www.azonano.com/news.asp?newsID=353.

3. Utsumi, Takeo. "Keynote Address – Vacuum Microelectronics: Whats New and Exciting." IEEE Transactions on Electron Devices, Vol 38. No. 10 (October 1991).

KEYWORDS: Imagery; Data recorders; Nanotechnology; Data Storage; Computers

N08-023 TITLE: Precision High Alitude Sonobuoy Emplacement (PHASE)

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

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

OBJECTIVE: Develop a technique for accurate placement of sonobuoy sensors deployed from marine patrol aircraft (MPA) from high altitudes.

DESCRIPTION: Increasing emphasis is being placed on conducting Naval Air Antisubmarine Warfare (ASW) operations, such as sonobuoy deployment and monitoring, from high altitudes. This reduces the stress on the MPA airframe enabling longer service life, improves / maximizes aircraft fuel efficiency and reduces the exposure of the crew and aircraft to hostile surface threats. Sonobuoys, especially tactical sonobuoys, must be accurately placed in the water. At present, an algorithm on board the aircraft calculates the best location to launch a buoy to ensure it will land in the water at the desired splash point. Calculations are based on buoy type, wind conditions and aircraft altitude and speed. Typically operations are conducted at low altitudes to reduce the uncertainty of the actual splash point due to wind drift. Splash point uncertainty becomes a significant problem at the high operational altitudes being discussed by Navy planners.

A technique for precise sonobuoy deployment from high altitudes is sought. Techniques could be (but are not limited to) modification / augmentation of the current sonobuoy parachute assembly, replacing the parachute assembly with another decelerator, active or passive guidance based on local wind conditions, and / or the development of an improved prediction algorithm. Concepts are subject to the following requirements:

Deployment altitude: 20,000 to 30,000 feet above ground level.
Deployment velocity: Per the current sonobuoy deployment envelope.
Splash Point Accuracy: 500 m required / 100 m desired.
Maximum Descent Time: 300 seconds from 30,000 feet
Impact Velocity: Within the shock limits in the Production Sonobuoy Specification.
Sonobuoy Types: All current fleet and developmental sonobuoys.
Wind Characterization: It is assumed that the aircraft will have a prior knowledge of the wind profile through the use of tactical dropsondes or other wind speed measurement technique.
Guidance: GPS can not be utilized.
Added Weight: Less than 10 pounds to current sonobuoys, with total buoy weight not to exceed 39 pounds.
Size: Must be compatible with current sonobuoy and sonobuoy launch container (SLC) dimensions (replacement of the sonobuoy parachute assembly is acceptable).
Added Cost: Less than $100 per unit in production quantities.

PHASE I: Develop concept and evaluate feasibility. Generate hardware design details, and develop aerodynamic numerical model to assess feasibility. Provide the Navy with appropriate design inputs for independent evaluation of placement accuracy. The Navy will provide representative sonobuoy hardware to support hardware design and integration if needed.

PHASE II: Develop prototype and integrate with sonobuoy systems. Develop algorithm to specify launch point, based on predicted trajectory, necessary to achieve desired splash point. Conduct in-air deployment to demonstrate algorithm performance and prototype hardware capability.

PHASE III: Develop production design of Phase II solution. Conduct integrated testing. Transition into the fleet supporting MPA missions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed in this SBIR could be leveraged to assist the Coast Guard or other law enforcement agencies in large search and rescue (SAR) operations where low altitude deployment of SAR equipment is undesirable. Also, sensors to monitor marine mammals or icebergs could be deployed more accurately from a higher altitude.

REFERENCES:
1. Holler, Roger, “High Altitude Launch of ASW Sonobuoys”, NADC-81155-30, June 1981.

2. Submarine Tracking by Means of passive Sonobuoys, Alexander Wahlstedt, Jesper Fredriksson, Karsten Jored and Per Svensson, Div. Of Command and Control Warfare Technology SE-581 11 Linkoping, Sweden http://www.foi.se/infofusion/bilder/FOA-R--96-00386-505--SE.pdf

3. NCAR GPS Dropsonde system
http://www.eol.ucar.edu/rtf/facilities/dropsonde/gpsDropsonde.html

4. Approved Navy Training System Plan for the navy consolidated Sonobuoys N88-NTSP-A-50-8910B/A, Sept 1998
http://www.fas.org/man/dod-101/sys/ship/weaps/docs/ntsp-Sonobuoy.pdf

KEYWORDS: sonobuoy; air deployment; high altitude; precision delivery; accurate placement; splash-point

N08-024 TITLE: Self-Contained, Portable Laser Bonded Mark Application and Data Capture System

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Sensors

ACQUISITION PROGRAM: PMA-275 - V-22 Program, ACAT I

OBJECTIVE: Design and develop an advanced, portable marking system to apply and capture images of laser bonded, machine-readable part identification codes such as DoD standard 2D barcodes. The goal is to miniaturize existing laser marking systems to facilitate the marking and reading of symbols applied to line-of-sight accessible components installed on aircraft.

DESCRIPTION: One of the cornerstones to achieve the Navy's goal of affordable readiness is the Structural Health and Usage Monitoring (SHUM) program, an initiative to leverage existing and emerging technologies to manage and maximize the structural life of the fleet, from aircraft down to the component level. A key element of this program is to further develop means to safely apply machine-readable part identification symbols markings to parts already installed in the aircraft. The proposed laser marking system should be self-contained and incorporate all of the hardware and software elements required to generate, apply, read, and verify the mark. After reading, mark data should be stored for subsequent transfer to remote computer database(s). Focus should be placed on portability and minimizing fixturing so the system could be used in austere maintenance environments. All of the marking system components be miniaturized and integrated into a kit that can be easily carried by the technician and hardened to military standards. The basis components of the system are: A laser marker with mark positioning system, computer with data entry keyboard, system control, mark quality verification and symbol decoding software, high resolution optical reader, and power source.

Current efforts of the marking industry have been focused on developing systems to apply markings to parts during the manufacturing process. This effort is greatly hampered due to characteristics of laser marking systems designed for the manufacturing environment. The problems with implementing current laser marking systems in the field include: Need for latest engineering drawings and specification, approved marking parameters for parts to be marked, appropriate clamping fixtures, size of the laser marking system, quality, safety and engineering personnel on site to certify and monitor marking operations, procedures established to evaluate and disposition improperly applied markings, and procedures established to assess the accumulative effects of multiple marking, removals and re-applications.

This effort should initially focus on rotorcraft dynamic components such as swashplates, rotor hub components, actuators, and rotor blade components. These parts offer the greatest challenge for a marking system. Once the challenge is met for these components, the system should be capable of widespread use on many other line-of-sight accessible airframe structural components.

PHASE I: Develop and propose a conceptual design for development and test in Phase II. The first design considerations for the phase I concept is the capability for reading and laser bonding 2D marks on flat surfaces, tight radii, and compound curvatures. Secondly, the phase I concept should consider capability to read 2D marks via line-of-sight from the greatest distance possible and from oblique angles (i.e. a maintainer standing on the ground, aiming the device to read marks on a rotor hub). Finally, Consider all components that will be required for a complete, stand-alone portable laser marking/reading kit. Define size and portability goals of a final design and support with data showing appropriate technology readiness levels. Proof of concept demonstration may be conducted if time permits. Design of the system should include consideration for the application of custom format 2D marks, such as optical strain gages for Navy flight test use.

PHASE II: Develop, demonstrate and validate a working prototype of the system. Determine a complete range of geometries that require marking and survey the amount of access that is available in areas requiring in-situ marking. Travel may be conducted to the NAVAIR facilities to analyze conditions for rotorcraft maintenance as well as survey part accessibility on actual Navy/Marine Corp helicopters. Systems will be validated under conditions representative of austere maintenance environments and refinements may be made to the system as necessary. The system's marking capabilities should be qualified by applying a selected number of marks, both 2D barcode and optical strain gage, to a test bed rotorcraft. After final validation of the system, develop a final stand alone kit to include everything necessary for laser bonding and reading in the field. This kit should consider all necessary procedures for operating the laser bonding/reading system.

PHASE III: Finalize design and configuration of the production kit. Deliver a production version of the system with appropriate durability and hardening for in service use. Include appropriate training and documentation for end users.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed technology will directly transition to the other military services and commercial rotary and fixed-wing aircraft industry, providing a means to extend UID tracking and a life prediction data gathering tool for aircraft components. This technology can be applied to metal assets that require a very durable mark that doesn't impact the parent materials structural properties.

REFERENCES:
1. Maley, S., Plets, J., Phan, N.D., "US Navy Roadmap to Structural Health and Usage Monitoring – The Present and Future" Presented at the American Helicopter Society 63rd Annual Forum, Virginia Beach, VA, May 1-3, 2007, www.vtol.org

2. DFARS 211.274: Item Identification and Valuation; http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/dfars/dfars211.htm

3. Unique Identification (UID), Capturing Business Intelligence Through Technology; http://www.uniqueid.org

KEYWORDS: barcode; laser; optical; mark; portable; identification

N08-025 TITLE: Innovative Method for Strain Sensor Calibration on Fleet Aircraft

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: JSF - Joint Strike Fighter Program Office ACAT I

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OBJECTIVE: Develop a method to calibrate strain sensors on in-service fleet aircraft to be used in individual aircraft structural life tracking.

DESCRIPTION: In order to obtain a load history for individual fleet aircraft, strain sensors are placed on the aircraft that are monitored and recorded through the flight. This data is downloaded and used in structural fatigue life tracking methods to determine how much structural life has been used up by the aircraft. The readings on these strain sensors can vary by 10% or more from aircraft to aircraft due to manufacturing and installation issues. The variation must be accounted for before using the output of those sensors in the fatigue life tracking method. The ideal way to calibrate a sensor is to place the entire aircraft in a full scale test rig, have known loads put onto the airframe and take a reading of the sensor output. This is too expensive and time-consuming for most aircraft fleets. An alternate method has been developed that use in flight calibration. This method has the aircraft fly a tightly proscribed maneuver where the loads can be fairly well determined, and compares the strain sensor output to the known load. This method is considerably less accurate and maneuvers that can repeat loads on certain portions of the airframe, such as the vertical tail or canopy sill, are difficult to proscribe. We are looking for an innovative way to obtain the strain gage calibration on each aircraft individually that will give us the accuracy of a full scale test rig.

PHASE I: Develop an innovative method that can be used to calibrate a strain sensor that has been installed on a fleet aircraft, so that the aircraft-to-aircraft variation due to installation and manufacturing variation can be captured.

PHASE II: Mature and verify the method developed in phase I through coupon, component and possibly full scale test applications.

PHASE III: Mature the process so that it can be used by maintenance personnel in the fleet to get a calibration factor for any newly delivered aircraft or any strain gage that was replaced in use. This would include developing and maturing any equipment or models necessary to a fleet readiness state.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Civil aircraft are heading toward structural life tracking where strain gages may be installed and would need similar calibration. Civil aviation, commercial airlines as well as private, could benefit.

REFERENCES:
1. Grover, Horace J. "Fatigue of Aircraft Structures." Batelle Memorial Institute, 1966 (NAVAIR 01-1A-13).

2. Molent, L. "A Review of a Strain and Flight Parameter Data Based Aircraft Fatigue Usage Monitoring System." Proceedings of the USAF Aircraft Structural Integrity Conference (Dec 3-5, 1996).

KEYWORDS: Calibration; Strain; Tracking; Fatigue; Sensor; Structures

N08-026 TITLE: Innovative Approaches to the Fabrication of Composite Rotary Wing Main Rotor Blade Spars

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-275, V-22 Program

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OBJECTIVE: Develop and demonstrate low-cost effective fabrication methods for a high performance large composite main rotor blade spar.

DESCRIPTION: Advances in composites have been beneficial to the United States Navy rotary wing community by offering improved fatigue performance and significant weight reductions with equivalent or improved strength capabilities as compared to metallic structure. However, composite aircraft components are expensive to fabricate and difficult to analyze. In particular, blade spars for large helicopters are thick walled, closed section parts with integral attachments that must withstand very high loads. Advanced automated, low cost, defect free fabrication methods are needed. Particularly for spars of increased size and various geometric requirements (taper, twist, etc), like the ones on the H-53 or the V-22 aircraft. Much of this cost is associated with tooling and the lack of automation. These high costs, and a perceived reduction in composite component durability and survivability, often prevent the transition of composite technology particularly for primary structure.

PHASE I: Research and develop innovative, advanced low-cost composite reinforcement fabrication methods of large high performance composite main rotor blade spars requiring increased torque and out-of-plane properties. Demonstrate feasibility and scalability of methods to manufacture representative components as well as the outline of a full-scale production manufacturing plan.

PHASE II: Using the blade geometry, strength and stiffness requirements gathered in Phase I; develop, demonstrate and validate proposed manufacturing methods. Include representative evaluations of building block mechanical testing and a manufacturing demonstration of a spar of representative size and structural configuration to demonstrate quality and scalability. Develop a manufacturing plan and cost benefit analyses with an Original Equipment Manufacturer (OEM), which support transition of the manufacturing process. Perform a risk reduction static and fatigue test with a mid-scale (aprox. 10ft) specimen that demonstrates all critical geometric qualities as well as appropriate strength, fatigue and dynamic requirements.

PHASE III: Demonstrate capability through production, fatigue test and static test of full-size prototype aircraft main rotor blade spar. Transition rotor blade spar to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology (composite manufacturing process, material forms, and designs) has wide-ranging applicability in both the public and private sector. As composite materials continue to displace metals in primary and secondary airframe structure, the focus is on affordability and improving durability in the service environment. This is true from both military and commercial operators. Therefore, this technology, if successful, can lead to greater penetration of the composite airframe market with US-developed technology.

REFERENCES:
1. Ross, A., "Will Stretch-broken Carbon Fiber Become The New Material Of Choice?" Composites World, January 2006: http://www.compositesworld.com/hpc/issues/2006/January/1143

2. Nelson, J., "Aluminum Frame Build Incorporates Carbon Fiber Tubes" Composites World, January 2006: http://compositesworld.com/hpc/issues/2006/January/1159/2

3. Mason, K., "Autoclave Quality Outside the Autoclave?" High-Performance Composites, March 2006: www.compositesworld.com

KEYWORDS: Aircraft; Rotary Wing; High Performance Composite; Structures; Component; Main Rotor Blade Spar

N08-027 TITLE: Wideband Jammer Dynamic Frequency Control for Interference Reduction

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-234, Prowler

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OBJECTIVE: Develop a method for notching out (reducing RF energy within) tunable frequency bands from the output of a high power (kW) wideband (VHF through L band) jammer.

DESCRIPTION: Wideband jamming systems can interfere with blue force communication, navigation, and identification (CNI) systems over great distances. Modern CNI systems can be frequency agile using rapid frequency hopping to reduce susceptibility to narrow band jamming. Applying notch filters to the output of high power wideband jamming systems is not feasible as the reflected power can damage the jammer. Additionally, rapidly tunable notch filters are unavailable for high power application. Inserting conventional tunable filters between the driver and power amplifier (PA) stages of the jammer often does not result in the desired effect because the system is open loop and does not adjust for the effects of the PA (spurious, harmonics, etc.). Conventional filters also are not rapidly adjustable in bandwidth. A method to reduce the energy in defined bands, both static and dynamic (frequency hopping/agile) is required. A reduction of 30dB minimum within the notch is desired. The notch location and width should be rapidly (<1us) tunable to within 1kHz, with a range in width from 15kHz to 10 MHz . A minimum of 8 dynamically tunable notches are required in order to address a normal complement of CNI equipment.

PHASE I: Develop a method to reduce radiation of RF energy within multiple specified frequency bands. The band center frequency and width should be independently and dynamically adjustable. Prepare a demonstration of the method.

PHASE II: Develop a prototype system meeting the defined objectives above and provide a laboratory demonstration at government facility incorporating an actual jamming system and actual CNI systems.

PHASE III: Develop a flightworthy system suitable for use on naval tactical aircraft. Support integration of the system onto the aircraft and subsequent ground and flight test. Support evaluation by interested ground jamming systems programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications include preventing interference to systems using adjacent channels by suppressing spurious signals from nearby transmitting systems. This can benefit many systems employing frequency division multiplexing, a substantial portion of the communications industry. It could be used by the cable TV industry to block unwanted channels or reduce interference from other services using the shared cable.

REFERENCES:
1. Kodali, W.P. "Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies and Computer Models." New York: Wiley-IEEE, 2001.

2. Paul, C.R. "Introduction to Electromagnetic Compatibility." Hoboken: Wiley-Interscience, 2006.

KEYWORDS: Interference Reduction; Notch Filter, Frequency; Agile; High Power; Jamming

N08-028 TITLE: Reactive Shaped Charge Liner

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMA-280 Tomahawk Multi Effects Warhead System (MEWS)

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

OBJECTIVE: Develop a reactive shaped charge warhead liner that will produce more damage in concrete and rock targets than aluminum liners.

DESCRIPTION: Enhanced penetration capability relative to current shaped charge warheads, which utilizes aluminum liners, is desired. Tandem warheads are used to defeat hard targets. First, a shaped charge precursor warhead produces a hole in the target wall. A second, follow-through warhead travels through the hole and then detonates inside the target. If the shaped charge warhead liner material can be made to react inside the target wall, it has the potential to soften the target wall and allow greater penetration by the follow-through warhead.

The development effort should identify candidate reactive liner materials. Consideration should be given to chemistry, thermodynamics, and thermo-physics of various candidate materials. Consideration should also be given to high strain rate mechanical properties of the candidate materials.

PHASE I: Determine the feasibility of developing a reactive shaped charged warhead liner with the ability to produce greater damage to concrete and rock than aluminum liners.

PHASE II: Conduct proof of concept validation testing against concrete targets demonstrating a performance enhancement relative to a baseline warhead design.

PHASE III: Develop a full scale (approximately 20-inch diameter) shaped charge liner.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology may have application to the oil field industry, which uses shaped charges to perforate oil well casings and rock formations.

REFERENCES:

1. Cooper, Paul W. "Explosives Engineering." Wiley-WCH, 1996.

2. Walters, W.P. and J. A. Zukas. "Fundamentals of Shaped Charges." John Wiley & Sons, Inc, 1989.

3. Carleone, Joseph. "Tactical Missile Warheads, Progress in Astronautics and Aeronautics." American Institute of Aeronautics and Astronautics Inc., 1993.

4. Kennedy, D.R. "History of the Shaped Charge Effect – the First 100 Years." U.S. Department of Commerce, AD-A220 095, 1990.

KEYWORDS: Warhead; Shaped Charge; Explosive; Terminal Ballistics; Penetration; Explosively Formed Projectile

N08-029 TITLE: Fabrication of Corrective Optics for Conformal Windows and Domes

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors, Weapons

ACQUISITION PROGRAM: N-UCAS, Joint Strike Fighter

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OBJECTIVE: Create techniques for grinding, polishing, and measuring aspheric, corrective infrared-transmitting optics for use with conformal windows and aerodynamic domes. Corrector elements might not have rotational symmetry.

DESCRIPTION: Future air vehicles will benefit from sensor windows that conform to the shape of the airframe. Conformal and aerodynamic shapes have the potential to reduce drag, increase the field of regard, and decrease signature. One possible scheme for transmissive corrective optics to go with an aerodynamically shaped dome includes a torroidal corrector element. Windows that conform to the shape of a fuselage might not have any elements of symmetry and could require optical correctors without any elements of symmetry. It is envisioned that future domes and windows could require corrective optics with diameters ranging from 100 to 300 mm.

Key technical challenges are to create methods to grind, polish, and measure precision surfaces with arbitrary shapes. There are no established methods in the optics industry to produce such shapes today. The contractor will need to develop new methods of deterministic grinding and polishing to achieve the required shapes with the required precision. The geometric form of a finished window must be precise to a fraction of an optical wavelength, typically on the order of 0.1 micrometer (or less). Ingenuity will be required to apply interferometry to measure conformal shapes with large departures from a spherical surface. Measurements must be fed back to a deterministic polishing process capable of bringing the optic to its required final form.

Proposals will likely be awarded in the areas of machining and metrology and these efforts will need to work together to complete Phase II. It is envisioned that this project will proceed in steps to develop applicable techniques first on inexpensive material such as glass or fused silica. Later, optics will be made from infrared-transmitting materials that could include zinc sulfide, zinc selenide, chalcogenide glasses, and spinel. Spinel will be particularly challenging because it is much harder than the other candidate materials.

PHASE I: Demonstrate techniques of grinding, polishing, and measuring a shape to be selected by the contractor. A material such as glass or fused silica with dimensions on the order of 50 x 50 mm would be suitable for this demonstration. A goal for optical figure is 0.1 wavelength root-mean-square deviation at 633 nm over a 50 mm diameter. Plan a clear path to scale the approach to larger sizes and infrared-transparent materials in Phase II.

PHASE II: Demonstrate grinding, polishing and metrology of toroidal corrector elements and other shapes selected by mutual agreement with the Government. Steps should lead from glass or fused silica to infrared-transparent materials. Steps should lead up in size to dimensions on the order of 200 x 200 mm. The final optical figure should be within 0.1 wavelength root-mean-square deviation at 633 nm over the full clear aperture of the part.

PHASE III: Develop a commercial process capable of making corrective optics for conformal windows with arbitrary shapes and optical figure similar to that of Phase II, but with areas on the order of 750 x 750 mm.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Conformal windows with corrective optics could be used for synthetic vision systems on commercial aircraft. These windows could increase the pilot's field of regard and might be used in locations that would not be suitable for flat windows.

REFERENCES:
1. P.H. Marushin, J. M. Sasian, T. Y. Lin, J. E. Greivenkamp, S. A. Lerner, B. Robinson, J. Askinazi, "Demonstration of a Conformal Window Imaging System: Design, Fabrication, and Testing," Proc. SPIE 2001, 4375, 154.

2. J. P. Schaefer, R. A. Eichholtz, and F. Sulzbach, "Fabrication Challenges Associated with Conformal Optics, Proc. SPIE 2001, 4375, 128.

3. J. E. Greivenkamp and R. O. Gappinger, "Design of a Nonnull Interferometer for Aspheric Wave Fronts," Appl. Opt. 2004, 43, 5143.

KEYWORDS: optical fabrication; metrology; optical finishing; conformal window; aerodynamic dome; infrared imager

N08-030 TITLE: <u>Low Cost, Low Weight Composite Structure using Out-Of-Autoclave (OOA) Technology</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-275 - V-22 Program

OBJECTIVE: Develop and demonstrate design and manufacturing methods applicable to large integrated composite structures using the latest generation of out of autoclave (OOA) processable composite prepregs and resin film infusion technology.

DESCRIPTION: Lightweight composite materials have been widely used in the production of military and other aircraft structures since the 1970's and have displaced metals in large parts of the airframes of manned aircraft such as the F22, F35 and F18. In the case of unmanned aircraft, many of these have been designed almost exclusively from composites from the outset. Unfortunately, the use of advanced materials has resulted in neither structurally efficient designs nor in cost effective aircraft. The F35 is both less structurally efficient and more costly in dollars per pound than older aircraft such as the F15. As indicated in a recent DoD sponsored report on Reducing DoD Fossil-Fuel Dependence (JSR-06-135), significant attention was focused on lightweighting of manned and unmanned ground and air vehicles through advanced materials, such as composite structures. Both DoD and air and ground vehicle contractors are now paying attention to reducing costly fuel demand by employing new designs using composite materials that are being used by private industry.

A key enabling technology is the recent development of new OOA processable materials, which offer the same structural performance as conventional autoclave cured materials and can be readily implemented in a production environment, unlike the older generation OOA materials. These new materials should be supported by extensive material property databases.

PHASE I: Investigate low cost composite parts processing and fabrication characteristics including complementary tooling. Define development of additional property data and scalability up to the component and subcomponent level including fatigue data. Provide a plan for parts qualification for military aircraft through a building block approach.

PHASE II: Using results from Phase I, identify and select realistic rotorcraft airframe designs that can benefit from OOA manufacturing processes. Compile realistic requirements such as geometry, tolerances, loads, environment, damage tolerance, life-cycle costs, etc based on actual Navy rotorcraft airframe designs. Using the latest generation of out-of-autoclave processable composite material systems, develop manufacturing methods and tooling concepts for airframe designs and demonstrate feasibility and scalability of representative components in a laboratory environment.

PHASE III: Using a building block approach, develop, demonstrate and test a realistic, full-scale structure using an OOA manufactured design that meets structural integrity, weight, damage tolerance, and other requirements. Identify nonrecurring and recurring costs as a part of a comprehensive Technology Insertion Plan. Develop production quality, low-cost, low-maintenance airframe designs for military and commercial aircraft programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology (composite manufacturing process, material forms, and designs) has wide-ranging applicability in both the public and private sector. As composite materials continue to displace metals in primary and secondary airframe structure, the focus is on affordability and improving durability in the service environment. This is true from both military and commercial operators. Therefore, this technology, if successful, can lead to greater penetration of the composite airframe market with US-developed technology.

REFERENCES:
1. Player, J., Roylance, M., et al, "UTL CONSOLIDATION AND OUT-OF-AUTOCLAVE CURING OF THICK COMPOSITE STRUCTURES" Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, MA http://web.mit.edu/roylance/www/sampe00.pdf

2. Byrne, C., "Non-Autoclave Materials for Large Composite Structures" Science Research Lab, Somerville, MA November 2000 http://www.stormingmedia.us/89/8974/A897483.html

3. Tatum, S. "LOCKHEED MARTIN DEMONSTRATES LOW-COST METHOD FOR MANUFACTURING LARGE, COMPLEX COMPOSITE STRUCTURES IN ADVANCED FLEET BALLISTIC MISSILE PROJECT" Press Release, Lockheed Martin, March 2001 http://www.lockheedmartin.com/wms/findPage.do?dsp=fec&ci=12144&rsbci=0&fti=0&ti=0&sc=400

4. "GKN Aerospace Develops Manufacturing Processes for Complex Composite Structures" Posted on The A to Z of Materials, July 2006 http://www.azom.com/details.asp?newsID=6054

KEYWORDS: Aircraft; High Performance Composite; Structures; Out-Of-Autoclave

N08-031 TITLE: Biodynamic and Cognitive Impact of Long Duration Wear of the JSF Helmet Mounted Display During Normal Flight Operations

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: JSF Joint Strike Fighter Program

OBJECTIVE: Establish measurement techniques to determine the physical and cognitive effects of long duration wear of the JSF head mounted system in order to optimize pilot performance in the JSF tactical maneuvering environment.

DESCRIPTION: JSF pilot workload and efficiency will potentially be enhanced with the use of visual displays, but the helmet system size and weight will likely increase with its center of gravity shifted forward relative to the current tactical helmet. The expanded male/female pilot population and helmet initiatives raise operational concern regarding pilot neck strength, endurance, muscle fatigue, situational awareness, and behavior under sustained G-loading. The physiological and performance effects induced on the pilot while wearing a relatively heavy, possibly unbalanced, HMD during long missions are not fully understood. Supporting added head weight of the HMD for extended periods in flight could impose muscle fatigue and discomfort leading to distraction, which is related to time worn and how the weight is distributed on the head. The use of pilot-in-the-loop, modern ground-based static and dynamic flight simulation technology will yield a comprehensive assessment of the endurance and physiological effects in an operationally realistic environment. Once assessed, dynamic simulation exercises may yield validated solutions to optimize pilot performance. The measurement technique should assess/define the following: significant dynamic performance variables for long duration missions and critical maneuvers applicable to simulation; measures of effectiveness (MOE), performance (MOP), and value (MOV) applicable to long duration missions; flight profiles; physiological metrics and skill retention/decay for long duration missions.

PHASE I: Define and develop a methodology to determine the physiological limitations and performance effects on the pilot population while supporting an HMD for extended periods of time, including exposures in a high-G tactical flight environment using a ground based dynamic simulator.

PHASE II: Demonstrate the measurement techniques developed in Phase I by configuring a ground-based flight simulator for static and dynamic test modes for JSF HMD endurance tests of physiologic and cognitive performance effects. (Note: JSF cockpit configuration and HMD are required.)

PHASE III: Use the demonstrated measurement techniques to formulate pilot/helmet system requirements addressing endurance and fatigue under long term wear.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial aviation sector would benefit through the development of ground-based simulator capability to include (a) commercial pilot endurance training and (b) endurance training for space travelers including, sustained G training and situation awareness familiarization.

REFERENCES:
1. Thuresson M, Ang B, Linder J, Harms-Ringdahl K. Neck Muscle Activity in Helicopter Pilots: Effects of Position and Helmet-mounted Equipment. Aviat Space Environ Med 2003; 74:527-32

2. Shender BS, Heffner PL. Dynamic Strength Capabilities of Small-stature Females to Eject & Support Added Head Weight. Aviat Space Environ Med 2001; 72:100-9.

3. Alricsson M, Hams-Ringdahl K, Schuldt K, Ekholm J, Linder J. Mobility, Muscular Strength & Endurance in the Cervical Spine in Swedish Air Force Pilots. Aviat Space Environ Med 2001; 72:336-42.

4. Morris CE, Popper SE. Gender and Effects of Impact Acceleration on Neck Motion. Aviat Space Environ Med 1999; 70:851-6.

KEYWORDS: Helmet; Helmet Mounted Display; HMD; Endurance; Proficiency; Fatigue

N08-032 TITLE: Hybrid Lidar-radar Receiver for Underwater Imaging Applications

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMA-264 Air Anti-Submarine Warfare Systems, ACAT IV; PMA-290

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

OBJECTIVE: Develop a hybrid lidar-radar receiver to recover and process the radar subcarrier from a modulated pulsed optical signal.

DESCRIPTION: A gated, demodulating receiver is needed that can efficiently process a modulated return signal after it propagates through a turbid water environment. Although off-the-shelf analogue demodulator components are currently available to coherently process a 0.5-1GHz radar signal, they are lossy (>10dB), sensitive to ambient temperature variations, and have low (<30dB) dynamic range. Optical detectors are also available that have good sensitivity in the blue-green wavelength region (>50mA/W) and >8mm diameter, but they are limited in bandwidth (<0.5GHz) and cannot be gated on/off quickly. Therefore, innovative solutions are sought that maintain the advantages of existing hardware while also improving upon their deficiencies.

The receiver must be gatable to recover the 5 – 30 ns optical pulses and include some form of demodulation scheme to process the modulation within the pulse. This receiver should have good optical sensitivity in the blue-green wavelength region while inducing minimal loss to the recovered 0.5-1GHz radar signal. Thus, high quantum efficiency, large active area (8mm diameter or more) and high dynamic range (>60dB) components are essential, as are high bandwidth, low-loss, high resolution, and coherent radar processing techniques. The receiver should also be compact and integrate well with the modulated optical source. Of particular interest are innovative solutions involving optical and/or digital processing of the modulated optical signal that improved performance over existing analogue approaches.

PHASE I: Determine technical feasibility of developing an efficient hybrid lidar-radar receiver that meet the required specifications and then perform preliminary bench-top tests to explore potential designs.

PHASE II: Based upon the design from Phase I, develop and demonstrate a working bench-top receiver, and then develop and test a fully functioning prototype to ensure stability.

PHASE III: Ruggedize the prototype and package it for use in the field. Transition technology to Navy systems for mine detection and Anti-Submarine Warfare (ASW).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications that would benefit from a hybrid lidar-radar receiver include biomedical optical imaging and imaging through clouds, smoke and flame. First responders would also benefit from this technology as it would give them the ability to “see” through smoke and flames.

REFERENCES:
1. L. Mullen, V. M. Contarino, and P. R. Herczfeld, “Hybrid Lidar-Radar Ocean Experiment,” IEEE Transactions on Microwave Theory and Techniques, Vol. 44, no. 12, December, 1996, pp. 2703-2710.

2. L. Mullen, V. M. Contarino, and P. R. Herczfeld, Modulated Lidar System (U. S. Patent No. 5,822,047, 13 October, 1998.)

KEYWORDS: Lidar; Radar; Underwater; Imaging; Range-gated; High-speed Eelctronics

N08-033 TITLE: Low Profile, Very Wide Bandwidth Aircraft Communications Antenna

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: JSF - Joint Strike Fighter Program; PMA-290

OBJECTIVE: Design and develop an aircraft antenna capable of operation at frequencies from 30 MHz to 2 GHz, without significant impact on aerodynamics, and designed to occupy the smallest practical surface area at the lowest weight practical.

DESCRIPTION: Currently available communications antennas for aircraft have several problems. Blade antennas are inherently resonant structures that are difficult to extend to wider bandwidths, they impact the flight characteristics of faster aircraft, and they may present an ice accumulation problem on some aircraft. Low-profile antennas generally are cavity-backed, requiring significant protrusion into the slipstream outside the aircraft body or significant hull penetration to accommodate the cavity, and the cavity is generally only optimal at one frequency. Additionally, the ever increasing number of antennas on aircraft are impacting the ability to find space for more antennas, requiring simultaneous use of antennas by several radio sets.

The need is for an antenna that does not cause significant aerodynamic drag and does not require structural penetration of the aircraft hull (fasteners and connector penetrations only), and at the same time provides vertically polarized coverage to the horizon at any frequency from 30 MHz to 2 GHz from several radio sets operating simultaneously. It is assumed that isolation of these radio sets will be handled by separate circuitry. The combined power levels from all connected radio sets could approach 100 Watts at 100% duty cycle in some applications. Primary constraints are weight and surface area consumed. Weight allowance is always at a premium on any aircraft. The surface area available is usually minimal at best. An antenna capable of communication with satellites at any azimuth angle and any elevation above the horizon is desired. These would likely benefit from circular polarization toward the sky and would be useful for GPS signals and various communications satellites. The use of advanced materials and concepts is encouraged, particularly the use of controlled impedance surfaces, artificial perfect magnetic conductor (PMC) materials and other meta-materials.

Applications are for communications systems on any aircraft. Current acquisition programs that could benefit from this project include helicopters, Unmanned Aerial Vehicle (UAV) aircraft, tactical fixed-wing aircraft and transport category aircraft.

PHASE I: Determine the technical feasibility of and concepts for candidate approaches likely to be able to satisfy the requirements. Conduct a computational analysis showing limits on performance for candidate approaches. Demonstrate the capability of the selected approach using computational and laboratory models. The use of a standard circular ground plane for all computations and measurements is highly recommended.

PHASE II: Complete the design selected in Phase I, fabricate a technology demonstration model or prototype, and show the performance of this model through laboratory measurements. Conduct demonstration of the prototype.

PHASE III: Finalize the design from Phase II and transition the technology to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology may be useful on commercial aircraft.

REFERENCES:
1. Brewitt-Taylor, C.R., “Limitation On the Bandwidth of Artificial Perfect Magnetic Conductor Surfaces”, Microwaves, Antennas & Propagation, IET, Vol 1 No 1 Feb 2007 pp255-260.

2. Werner, D.H. and Werner, P.L., “The Design Optimization of Miniature Low Profile Antennas Placed In Close Proximity to High-Impedance Surfaces”, Antennas and Propagation Society International Symposium, 2003, June 2003, Vol 1 pp 157-160.

3. Yeo, J.; Mittra, R., “Bandwidth Enhancement of Multiband Antennas Using Frequency Selective Surfaces for Ground Planes”, antennas and Propagation Society International Symposium, 2001, July 2001, Pol 4 pp 366-369.

4. Orton, R.S.; Seddon, N.J., “PMC As An Antenna Structural Component”, Twelfth International Conference on Antennas and Propagation 2003 (ICAP 2003), March 2003, Vol 2 pp 599-602.

KEYWORDS: antennas; wide-bandwidth antennas; low profile antennas; conformal antennas; PMC materials; meta-materials

N08-034 TITLE: Inconel Blisk Repair Technology

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter Program

OBJECTIVE: Develop enabling technology that delivers a practical weld repair solution that will meet or exceed fatigue requirements of Inconel airfoils in an integrally bladed rotor (IBR)/blisk.

DESCRIPTION: State-of-the-art military turbine engines incorporate IBRs, which are one piece components consisting of blades and a disk (blisks), in the compression system. Their purpose is to reduce weight through part count reduction and improve performance and maintainability. However, to maintain affordability, the need for weld repairs of either partial or full blades is warranted to avoid expensive IBR/blisk replacements resulting from foreign object damage (FOD) to the airfoils. No adequate technology exists today to repair fielded engines. For alloys commonly used in fans and compressors, current pre- and/or post-weld heat treatment practices, as part of the repair of airfoils, result in unacceptable micro-structural degradation in the highly stressed disk portion of the IBRs/blisks. Exposing the undamaged airfoils to needless heat treatment at every repair leads to significant reduction in their structural capability. A novel and enabling weld repair technology that will permit independent repair and optimization of airfoil and disk material properties is needed to retain and restore the high cycle fatigue (HCF) characteristics of IBRs/blisks. The technology should be able to meet these requirements in addition to addressing affordability and maintainability requirements of advanced military propulsion power plants.

PHASE I: Conceptualize, evaluate, and determine the feasibility of repair techniques that will restore the airfoils in an IBR/blisk to their original material properties after a FOD event. Demonstrate cost-effectiveness of the proposed technique. Identify hardware and tools needed for the procedure. Evaluate improvements over current repair methodologies.

PHASE II: Demonstrate the technique and subsequent improvement in structural integrity and HCF performance in a rig and engine environment. Address potential adverse affordability issues and identify mitigating solutions.

PHASE III: Integrate the technology into a manufacturing environment at an original equipment manufacturer (OEM) or depot.

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

REFERENCES:
1. Ellison, Keith A., Joseph Liburdi and Jan T. Stover. “Low Cycle Fatigue Properties of LPMTM Wide-Gap Repairs in Inconel 738.” Liburdi Engineering Limited, Hamilton, ON, Canada. http:/doc.tms.org.

KEYWORDS: Inconel; IBR; Integrally Bladed Rotor; Blisk; Foreign Object Damage; Repair Techniques

N08-035 TITLE: Pod Mechanical Power Production

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

ACQUISITION PROGRAM: PMA-234: EA-6B Airborne Electronic Attack, and PMA-265: EA-18G Program

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

OBJECTIVE: Develop innovative technology capable of converting ram air energy into mechanical power

DESCRIPTION: For smaller aircraft, airborne electronic attack (AEA) equipment contained in a wing mounted pod requires supplemental electrical power. Since high power electric cables are heavy and their addition would require extensive airframe modification, a system that produces power at the point of use is preferred. The point of use in this case is within the AEA pod. One form of energy that is readily available to a pod is the ram air flowing past the pod. A system that can convert the kinetic energy of ram air to mechanical power with better size and weight efficiency is required.

Electric power for traditional AEA pod equipment is created by axial flow ram air turbines (RAT) with air foil blades. The RAT is coupled to an electric generator to convert mechanical to electrical power. RATs are limited in available energy conversion. All of their kinetic energy is created by the change in air pressure between the forward and aft ends of the system. Additional energy is available only from increased airspeed or greater turbine diameter. The air pressure differential is not great enough for good size and weight efficiency.

The slow turning wind turbines that drive the generators in modern wind turbine “farms” operate by the same principal as RATs. These wind turbines are optimized for efficiency, and help illustrate the size inefficiency of ram air turbines. In the case of a RAT, the rotational speed is much greater than a wind turbine. Since the linear speed of the blade tip is much greater than the speed near the blade root, only a small portion of the total turbine radius can be used for efficient power conversion.

For a next generation airborne electronic attack (NG-AEA) pod, the expected power requirement is 60 KW. The goal for minimum airspeed at which this power can be produced is 250 knots calibrated airspeed (KCAS). The expected diameter and overall system size for a RAT capable of providing the required power may be too large for NG-AEA pod application. The payoff for a successful technical development effort is an unconventional technical solution that will allow point of use power production with a better ratio of power to size and weight, than is given by traditional RAT technology. Equipment with a cross section perpendicular to the airflow direction that is smaller than that of equipment using existing axial flow RAT technology is required. Compare the capability to the expected overall system weight and component sizes. The overall system may include a gearbox and electric generator. A gearbox and generator are not necessarily part of this technology development, but their respective size and weight depends on the design of the new mechanical power production solution.

One possible example of a suitable solution is the “Tesla Turbine,” also known as a “Bladeless Boundary Layer Turbine.” Instead of traditional airfoil blades, a Tesla Turbine uses many spinning parallel thin disks that are oriented parallel to the airflow. However, a Tesla Turbine has inherent disadvantages, and other solutions may be more practical with lower risk. Another possible solution may be a turbine that operates similar to a water wheel. This may be an unlikely solution, but there is no record of study for applying this turbine type to ram air power production.

PHASE I: Determine the feasibility and technical merit for providing mechanical-rotary power for an aircraft pod at the point of use while using technology other than axial flow ram air turbines with air foil blades. Develop a concept with limited design of critical components and a recommended design approach for the complete system. Show the electric power production capability of the system through engineering simulation or analysis of the conceptual design.

PHASE II: Continue development of the NG-AEA pod mechanical power production (PMPP) system by performing detailed design of all system components. Fabricate a prototype operational mechanical power production unit that can meet all operational requirements.

PHASE III: Integrate the PMPP equipment into the NG-AEA pod, and begin limited production of the PMPP equipment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Other military and commercial aircraft use RATs for emergency power production. The application of this new technology would provide a more space and size efficient emergency power production system. Other commercial use includes power production for aircraft pods that perform any function, such as communication or surveillance.

REFERENCES:
1. NAVAIR 03-500-170 Technical Manual, Intermediate/Depot Maintenance with Illustrated Parts Breakdown for the PU-785/ALQ-99F(V) Ram Air Turbo-Generator, part number 953036-7-1

2. Livingston, Sadie P. and William Gracey. "Tables of Airspeed, Altitude and Mach Number, Based on Latest International Values for Atmospheric Properties and Physical Constants." National Aeronautics and Space Administration (NASA) Langley Research Center, NASA-TN-D-822, 1961.

3. NAVAIR 01-85ADC-1 NATOPS Flight Manual, Navy Model EA-6B Block 89A/89/82 Aircraft, specifically Chapter 4

KEYWORDS: Military Airborne Stores; Power Generation; Electronic Warfare; Ram Air; Airborne Electronic Attack; Pod

N08-036 TITLE: <u>High Speed, Precision Laser-assisted Machining of Silicon Carbide Ceramic Matrix Composites</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter ACAT I

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

OBJECTIVE: Develop and demonstrate high-speed, precision, laser-assisted machining processes and/or tooling for silicon carbide based ceramic matrix composites (CMCs).

DESCRIPTION: Engine and exhaust washed aircraft structures require highly efficient CMC designs to minimize weight and withstand severe environmental conditions. These components are time-consuming and expensive to fabricate and require post-fabrication machining to precise dimensions. The machining process is made difficult due to the low thermal conductivity and hard, brittle, abrasive nature of CMCs. As a result, existing methods of machining and drilling processes are inefficient and expensive. Machining tools are easily damaged and require frequent replacement due to over-heating and repeated contact with the hard and abrasive material. In addition, the CMC components are prone to damage from improper machining. Also, the precision laser focusing, polarizing and reflective surfaces are subject to dust contamination and abuse in a machine shop industrial environment affecting system performance and reliability. A high-speed machining process or method for silicon carbide CMC design is anticipated to eliminate many of the major cost and risk impediments for transitioning these materials into aircraft production.

Innovative, scalable, high-speed, and precise process(es) are sought to fabricate and machine silicon carbide CMC components for engine and exhaust washed aircraft structures. In particular, precision slotting and milling processes should be developed and demonstrated. Possible approaches may explore the use of laser-assisted contact machine tools and/or methods for CMC material removal. Proposed processes should be designed to minimize damage to the substrate and limit replacement of machining tools. It is anticipated that the results of this work will lead to process guidelines and tooling designs that allow a 10 fold reduction in time and cost to machine these components, a significant reduction in part rejection/rework, and decreased maintenance costs of machining tools.

PHASE I: Demonstrate scientific merit and feasibility of the proposed high-speed, laser-assisted machining processes and integrated tooling concepts for precision CMC milling process/material removal operations for typical contours and shapes. Prototype machined samples should be characterized micro-structurally, and mechanically tested for strength and fatigue durability.

PHASE II: Develop the prototype laser-assisted machining process and integrated laser and contact machining tools based on the Phase I work. Fabricate prototype machined samples, and eventually a full-scale component, to be characterized micro-structurally and mechanically tested for strength and fatigue durability.

PHASE III: Generate generic process guidelines and production suitable laser-assisted contact machine tools for use in fabricating high temperature silicon carbide CMC components. Produce and qualify components using the high-speed machining process and transition to current and emerging aircraft production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: More widespread usage of CMC components using high speed machining processes is expected for the aerospace, power generation and automotive industries.

REFERENCES:
1. Lopez de lacalle, L.N. J. Perez, J.I. Liorente, and J.A. Sanchez. "Advanced Cutting Conditions for the Milling of Aeronautical Alloys." J.Matls. Proc. Tech., 100 (2000) 1-11.

2. Ezugwu, E.O. "High Speed Machining of Aero-Engine Alloys." J. of the Braz. Soc. of Mech. Sci & Eng., (January-March 2004), Vol XXVI, No. 1, 1-11.

3. Rozzi, J.C., F.E. Pfefferkorn, Y.C. Shin and F.P. Incropera. “Experimental Evaluation of the Laser-assisted Machining of Silicon Nitride Ceramics.” ASME Journal of Manufacturing Science and Engineering, (2000), Vol 122, 666-670.

4. Lei, S., Y.C. Shin and F.P. Incropera. “Experimental Investigation of Thermo-Mechanical Characteristics in Laser-assisted Machining of Silicon Nitride Ceramics,” Transactions ASME, Journal of Manufacturing Science and Engineering, (Nov 2001), Vol 123, 639-646.

KEYWORDS: Silicon Carbide Matrix Composites; High-Speed Machining; Ceramic Matrix Composites (CMC); Nozzles; Machine Tools; High Temperature Structure

N08-037 TITLE: High Temperature Sensing Parameters

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: Joint Strike Fighter Program Office, Propulsion IPT, ACAT I D Program

OBJECTIVE: Develop high temperature sensing devices that measure parameters other than temperature and pressure, such as heat flux, flow, strain, and gas species.

DESCRIPTION: Previous research and development (R&D) efforts for high temperature sensing have largely focused on temperature and pressure readings. These sensor types are expected to be commercially available in the foreseeable future. Future R&D efforts for high temperature sensing must focus on other sensing parameters, such as heat flux, strain, and gas concentration for advanced engine prognostic and diagnostic monitoring. Industry desires to incorporate such sensors in regions such as the turbine hot section to achieve in-situ, real-time measurements. Sensors that can survive this environment are necessary to advance the state of the art. Sensors must be able to survive beyond 600°C and show merit to meet material expectations of reliability and robustness. The sensor must also include a realistic packaging scheme for the environment and application.

PHASE I: Demonstrate the feasibility of the proposed sensor types and the packaging approach. Describe the manufacturing feasibility of the sensor and packaging necessary for commercialization efforts. Experimentally demonstrate feasibility of the proposed sensor at a laboratory scale.

PHASE II: Fabricate and characterize several full prototype devices in a laboratory environment and in a representative turbine test bed system, such as a burner rig or other applicable device.

PHASE III: Conduct necessary qualification testing of the device to merit further investment and consideration for military turbine engine platforms. Work together with OEM to develop a business plan and necessary IP, and seek necessary investment to support the product/process/service for the OEM military provider.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Both military and commercial turbine engine manufacturers and operators have a need for advanced sensors. The ability to gather real-time data from in-situ sensors will provide enormous benefits and useful information.

REFERENCES:
1. Spetz, A. Lloyd, A. Baranzahi, P. Tobias, and I. Lundström, “High Temperature Sensors Based on Metal-Insulator-Silicon Carbide Devices.” Physica Status Solidi (A), Applied Research, Vol. 162, Issue 1, 493-511.

KEYWORDS: Sensor; Turbine; High Temperature; Harsh Environment; Measurements; Sensing Parameters

N08-038 TITLE: Advanced Analysis Methods for Military Aviation Reliability Data Bases

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

ACQUISITION PROGRAM: PMA 265, Super Hornet, Hornet and Growler

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

OBJECTIVE: Develop and demonstrate a suite of innovate computational tools for reliability data base analysis. This novel toolset would automatically generate timely and actionable intelligence for maintainers, fleet support engineers and design engineers improving propulsion safety, affordability, and readiness of military gas turbine engines.

DESCRIPTION: The F414 Maintenance Data Warehouse (MDW) contains a wealth of data on engine and component reliability and maintenance activities. The data warehouse contains detailed maintenance records for all F414 engines and their serialized modules and components. Such data starts with propulsion system metrics (engine flight hours, cycles and customized life usage indicators) through organizational level engine and line replaceable unit (LRU) removals with reasons for removal and commentary. The data follows the engines, modules and components through maintenance at intermediate level and the depot, including shop findings and changes in component serial number and engine configuration. This affords the opportunity to track removal causes and shop findings to the module and component level, automatically tracking root causes and component reliability against propulsion system, module and component usage.

An added complexity of the F414 MDW is the high levels of lifetime data censoring due to scheduled removals and the staggered introduction of F-18 aircraft into service. Several layers of competing risk (scheduled engine inspections and removals, opportunistic module removals at the inspection level, and opportunistic component replacement and refurbishment at the depot) compounded by the modular maintenance strategy complicate any analysis, particularly given the evolving and non-uniform engine configuration. Extracting representative latent reliability characteristics requires case based reasoning and analysis tailored to the context of individual failures.

The tremendous volume of this data limits most investigations to basic metrics and reactive analysis on a case by case basis. Advanced data mining and statistical analysis techniques are needed to provide in-depth studies to flag trends and anomalies, enabling proactive maintenance, engineering investigations and design modifications. However, the workload to implement such tools in the complex, multi-faceted F414 MDW is prohibitive and the artificial intelligence tools to automate this process have proven unsuccessful. Additionally, multiple data bases (engine, weapons replaceable assembly (WRA), module and components) must be interrogated to adequately characterize system reliability. Analysis to date indicates that novel non-parametric and parametric analysis models will be needed, particularly to validate the multi-variate component life usage indicators [LUI] employed in scheduling engine removals.

Machine aided update of the failure modes, effects and criticality analysis (FMECA) and a representative reliability model for the F414 engine is one anticipated product of the proposed toolset. Another added benefit of such tools would reduce component improvement costs (CIP) by providing better targeted configuration change.

PHASE I: Determine the feasibility of developing a suite of tools that automatically generates timely and actionable intelligence from maintenance and reliability data warehouses. Identify preliminary deliverable specifications and conduct initial trials of promising analytical methods to show the feasibility of the proposed approaches.

PHASE II: Demonstrate the automated data mining and analysis tools developed in Phase I in the MDW information technology environment. The utility of the tools developed is to be demonstrated through trials conducted with the participation of working level GE and US Navy personnel responsible for the management of F414 reliability and maintenance processes.

PHASE III: Full implementation of an integrated F414 automated usage and reliability analysis tool box in the MDW environment through to qualification and release for routine use by maintenance personnel and maintenance, reliability and design engineering. Transition the toolset to other USN platforms as appropriate.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is expected to be extensive cross fertilization of the advanced analysis tools, as commercial aircraft operators and service providers are building similar maintenance and reliability data warehouses.

REFERENCES:
1. Millar, Richard C., 2007, A Survey of Advanced Methods for Analysis and Modeling of Propulsion System Reliability, ASME GT2007027218 (to be published May 2007 in the proceedings of ASME Turbo Expo.)

2. Millar, Richard C., 2007, Application of Reliability Data Base Analysis Tools, to be published in the proceedings of SAE AeroTech, September 2007.

KEYWORDS: Reliability; Analysis; Propulsion; Engine; Module, Component

N08-039 TITLE: <u>Wide Bandgap Amplifier Linearization</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Weapons

ACQUISITION PROGRAM: PMA-265 (EA-18G);PMA-234 (EA-6B) - Next Generation Jammer; JSF

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

OBJECTIVE: Reduce intermodulation distortion in wide bandgap solid state amplifiers that result from multi-tone input signals.

DESCRIPTION: When an amplifier is driven into saturation, frequency components other than the intended signal are created and amplified due to device non-linearity. In addition to robbing power from the fundamental frequency, these spurious frequencies create interoperability problems with devices sharing the frequency spectrum. The problem just described becomes increasingly worse as additional frequencies (multi-tones) are added to the input signal of an amplifier. The combined input signal of multiple frequencies causes potentially high peak-to-average drive level ratios (crest factors). If the input signal is adjusted so that the average power of the combined signal drives the amplifier just into compression, the peak levels will saturate the amplifier causing intermodulation distortions (IMD). IMD can be reduced by decreasing the drive levels of the individual tones, but this reduces the output levels of the desired frequencies and decreases amplifier efficiency.

The Navy is seeking a technology that will allow multiple simultaneous frequencies to be amplified with reduced IMD by means other than input back-off. Such technologies are often referred to as linearization schemes. Currently, linearization is being done in narrow bandwidth commercial communication devices using methods such as pre-distortion, feed-forward, and envelope feedback. The Navy seeks to extend this concept to jamming signals characterized by high power, high duty cycle (up to continuous wave), and wide instantaneous bandwidth. This technology will be used to create a power amplifier module that is capable of being integrated into a high power transmit phased array architecture and flown on a tactical aircraft.

Up to eight simultaneous tones are desired in an input signal with an instantaneous bandwidth of more than 500MHz. IMDs should be reduced as much as possible, with the goal of having all products at least 30dB down from the fundamental frequency levels. Furthermore, a desirable linearizer would have minimal impact on the power added efficiency (PAE) of the amplifier module.

PHASE I: Determine the feasibility of reducing IMD over a wide instantaneous bandwidth in the L-C bands with minimal impact to amplifier efficiency. Provide supporting evidence in the form of analysis, modeling and simulation, calculations and empirical test. Provide a preliminary design or suggested approach.

PHASE II: Develop a prototype of the linearizer technology and demonstrate its performance by dynamically changing the amplitudes and frequencies of the input signals over the instantaneous bandwidth of the linearizer.

PHASE III: Incorporate any design improvements from Phase II and design an amplifier/linearizer module suitable for integration into high power phased array apertures. The target operational environment for such an aperture is the EA-18G tactical aircraft. Conduct reliability testing and analysis with respect to this operational environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology supports effective use of the frequency spectrum. All transmitting devices, both military and commercial, must be concerned with this issue for interoperability and efficiency reasons. By enabling the amplification of multiple frequencies through a single amplifier, total system hardware can be reduced, packaging can become smaller, and system price can be reduced. Cell phones, wireless networks, and point-to-point microwave links could all directly benefit from this technology.

REFERENCES:
1. Pedro, Jose Carlos; Carvalho, Nuno Borges. Intermodulation Distortion in Microwave and Wireless Circuits. Artech House, 2003.

2. Cripps, Steve C. Advanced Techniques in RF Power Amplifier Design. Artech House, 2002.

KEYWORDS: linearization; amplifier; wide bandgap; intermodulation; solid state; crest factor

N08-040 TITLE: <u>Catapult Water Brake Corrosion Inhibition System</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA-251, Aircraft Launch and Recovery Equipment Program Office

OBJECTIVE: Develop and implement an innovative system that will inhibit corrosion in the aircraft carrier catapult water brake system.

DESCRIPTION: The design of the water brake for the catapult launch system on aircraft carriers has not substantially changed for almost four decades. The function of the water brake is to stop the catapult launch pistons at the end of their stroke. The water brake system includes an open-ended cylinder that is filled with water via an array of jets at the mouth of the cylinder. A tapered spear attached to the forward end of the launch piston inserts into the cylinder, stopping the launch pistons. The water used in the system is potable water recirculated from an open storage tank located directly below the water brake cylinders. Sea water and other deck effluent contaminate this water through deck openings just above the system. Corrosion of the low alloy steel of the cylinder has resulted in catastrophic failure of the cylinder. To counter the corrosion, a mixture of sodium nitrite and emulsifier had been added to the water brake storage tank to mitigate corrosion. This mixture was reliably used until the emulsifier manufacturer discontinued production, and could no longer be supplied. Due to the recurring concern that catastrophic failure of the water brake cylinder would occur, NAVAIR investigated replacement of the cylinder with a corrosion resistant material. This effort was abandoned due to the unacceptably high cost of the replacement materials. Emphasis was again placed on finding a new corrosion inhibitor or corrosion inhibition system.

A sodium nitrite-based inhibitor added directly to the water brake storage tank has been used in the past with some success. Testing on board aircraft carriers showed a dramatic reduction in corrosion to the components. An emulsifier was added to the sodium nitrite to increase the crevice protection of the inhibitor, but production of this emulsifier ceased. Further attempts to identify a replacement emulsifier were unsuccessful because the products produced copious foam when the water pumps were activated. The water brake produces an extremely turbulent, high pressure, high velocity flow through the jets located in the cylinder opening. Production of any foam negatively affects the performance of the water brake, and cannot be tolerated.

The Navy will consider proposals for a system that actively inhibits corrosion in the water brake components. This system may consist of the following: 1) a product added to the water storage tank, a monitor or sensor for the active level of that product, and, optimally, automatically replenishment of the level of the product; 2) an active system that monitors and inhibits corrosion through an advanced electrochemical technology and control system. Proposals solely for coatings or alternate materials for the water brake cylinder or components will not be considered.

The cost, volume, weight, environmental impact, and health or safety concerns of any product for addition to the water brake tank must be analyzed with emphasis on minimizing the impact of all these concerns.

PHASE I: Determine the feasibility of developing a system that will inhibit the corrosion to the water brake cylinder and corrosion components. Perform laboratory bench tests to support corrosion inhibition performance and foaming potential for any direct additives to the water. Develop an operational concept for the inhibition system. Assess and mitigate any hazardous material issues for personal safety and environmental hazards of the system. Develop and provide defendable estimates for cost, reliability, and maintainability of the inhibition system.

PHASE II: Develop a prototype system. Design and construct a test stand using a water brake cylinder and pump provided by the Naval Air Warfare Center.

PHASE III: Install operational system aboard an aircraft carrier for operational evaluation and qualification testing. Equipment for delivery to carrier fleet and shore sites will be procured. Establish all logistical elements of the system, including Technical Manuals.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The mitigation of corrosion and repair of corrosion damage throughout the world consumes billions of dollars every year. This system could be applicable to any industry that utilizes water for process equipment to inhibit corrosion in those systems.

REFERENCES:

1. The Warfighters Encylopedia, Catapults, Catapults - In Depth. https://wrc.navair-rdte.navy.mil/warfighter_enc/Carriers/catapult.htm

KEYWORDS: Aircraft Carrier; Catapult; Water Brake; Sodium Nitrite; Corrosion; Corrosion Inhibitor

N08-041 TITLE: Robot for Re-Coating Tall Antenna Towers

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMW 770 Submarine Communications Program ACAT IV

OBJECTIVE: The objective is to develop a small agile robot for re-coating the slender galvanized steel lattice structure of tall slender antenna towers. The cross-sectional shape of these towers is typically a square or triangle, measuring about 12ft on a side. A standard ladder with standard safety rail typically runs the full height of the tower on the inside face of one side. The robot should be able to paint all interior and exterior surfaces of all steel members of the tower, while working from the ladder inside the tower

DESCRIPTION: The typical tower is a collection of millions of structural angles in a very repetitive pattern stretching high into the sky. For a human painter, this repetition is very boring, dangerous and problematic. For a robotic painter, this repetition is very desirable, safe and exploitable. The newest generation paint robots are small and agile. These robots could be modified to use the standard safety rail and ladder on a tall tower as a reliable path to climb and paint the tower. Ideally, the robot should prepare surface to be painted with a high pressure water jet on its way up and then paint the tower with a paint sprayer on its way down. The robot should be able to focus its paint on each and every slender structural angle, thus minimizing paint waste.

PHASE I: Develop a conceptual design for an agile robot that can re-coat tall slender lattice–frame towers of constant cross-section. The robot must have “feet” for traveling up and down the tower ladder/rail, “hands” for reaching/re-coating all interior/exterior surfaces and ”eyes” for verifying quality of the coating. Extension/modification of an existing commercially available robot is encouraged.

PHASE II: Develop a detailed design for the robot. Develop the “intelligence” software for the robot to learn the repetitive pattern of any given tall tower. Build a prototype of the robot, using as many off-the shelf components as possible.

PHASE III: Test the prototype robot on a slender tower with constant cross-section of acceptable height. Assess the efficiency of the robot in its ability to re-coat all surfaces on the tower.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial business for re-coating tall towers is potentially large, given the thousands of telecommunications towers across the world that need regular re-coating for structural corrosion control and/or for general aircraft safety per FAA obstruction marking requirements.

REFERENCES:
1. UFGS-09910, Unified Facilities Guide Specifications, Division 09 – Finishes, Section 09910, Maintenance, Repair, and Coating of Tall Antenna Towers, August 2004

2. MRP-3000, Small-Sized Paint Robot, Mitsubishi Heavy Industries,http://translate.google.com/translate?hl=en&sl=ja&u=http://www.mhi.co.jp/sanki/sanki_j/topix/03/030617.htm&prev=/search%3Fq%3DMitsubishi%2BMRP-3000%26hl%3Den%26lr%3D%26rls%3DGGLD,GGLD:2003-47,GGLD:en.

KEYWORDS: Robotics; Painting; Guyed Tower; Antenna; Coatings

N08-042 TITLE: Low-Permeability Coating for Nitrile Rubber

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PMS 415 - Littoral Warfare Weapon, ACAT III

OBJECTIVE: Develop a low-permeability coating for nitrile rubber and nylon-reinforced nitrile rubber pressurized components. The coating must be pliable enough to conform to the shape of the nitrile rubber component as it expands/contracts due to fluctuations in differential pressure across the rubber. The coating must also withstand exposure to seawater for long periods (up to one year) and survive a minimum of 33 years.

DESCRIPTION: The TOMAHAWK Capsule Launching System (CLS) is being leveraged for integration of the Littoral Warfare Weapon (LWW) on SSGN and SSN 688I/Virginia Class Vertical Launch System capable platforms. The CLS includes a nylon-reinforced nitrile rubber fly-through cover. During stowage of the capsule in the submarine, the fly-through cover can be exposed to seawater. The fly-through cover must seal the capsule interior, which houses a missile, from the external environment. Since the nitrile rubber is permeable, and the humidity inside the capsule must be maintained below a specified threshold, a mylar-tin-mylar low permeability barrier must be installed over the nitrile rubber cover. These mylar-tin-mylar barriers are expensive, easily damaged, and present potential debris concerns after missile launch. A new low-permeability coating applied to the nitrile rubber would allow the fly-through cover to maintain the humidity within the capsule below required limits and eliminate the need for the mylar-tin-mylar barrier.

PHASE I: Identify an existing or develop a new coating for nitrile rubber that significantly decreases its permeability. Laboratory testing to demonstrate and quantify the permeability reduction will be required. Material testing to demonstrate the durability of the coating when the nitrile rubber is expanded/contracted and to quantify the amount of expansion that can be attained without damage to the coating will also be required.

PHASE II: Develop a process for applying the coating identified/developed during Phase I to the TOMAHAWK CLS nylon-reinforced nitrile rubber fly-through cover. Apply the coating to a small number of CLS fly-through covers. Conduct pressure cycling on the fly-through covers to demonstrate coating pliability and durability. Conduct permeability testing on the fly-through cover material with and without the coating to quantify the permeability reduction, both before and after pressure testing. Conduct testing of the coating to determine its longevity in a seawater environment.

PHASE III: Support integration of the developed coating into the TOMAHAWK CLS fly-through cover development for Littoral Warfare Weapon application. This coating, upon meeting Navy requirements, could also be transitioned into various other programs (i.e.: encapsulated UAVs) that require nitrile rubber membranes with low permeability.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The low permeability coating would be available for numerous commercial applications for which nitrile rubber (and potentially other elastomers) are not currently suitable due to their permeability. Examples include packaging materials and pressure vessels.

REFERENCES:
1. Joint Cruise Missiles Project, Capsule Closure Assembly, Rev H, Drawing No. JCM-14051

KEYWORDS: Low permeability; Coating; Pliable; Nitrile rubber; Nylon; Fly-through cover

N08-043 TITLE: Diver Safe Grease

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PMS399 Special Operations Forces Undersea Mobility Programs

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

OBJECTIVE: Develop and test a grease that is safe for divers (i.e. does not off-gas toxic compounds in a pressurized air or mixed gas environment), does not wash out readily in seawater, and provides acceptable lubrication properties.

DESCRIPTION: The submarine force uses Termalene grease, which provides adequate lubrication and does not wash out in seawater. However, it is not acceptable for use in diving applications due to toxic compounds that it releases in a closed atmosphere. Special Operations Forces (SOF) use either polytetrafluoroethylene (PTFE) greases such as DuPont Krytox 240AC per MIL-G-27617, or chlorotrifluoroethylene (CTFE) greases such as Halocarbon Products 25-5S. These provide good lubrication but wash out in seawater. A new, environmentally safe grease is needed that will continue to provide sufficient lubrication while resisting being dissolved or washed out by seawater.

PHASE I: Develop candidate substitute grease formulations that will provide the same level of lubrication as provided by PTFE or CTFE greases at a minimum, but are also seawater resistant. Develop and obtain approval for testing criteria and methods. Conduct laboratory testing to down select potential grease formulations for further testing. If the laboratory testing suggests that different chemistries or additives, or combinations of existing greases may improve the performance, then test these alternatives as well.

PHASE II: Perform testing in a realistic Navy Deep Submergence System environment. Use test results to select the optimum grease. Ensure that the selected grease is independently tested for off-gas characteristics at a laboratory approved by NAVSEA. Ensure the selected grease can be manufactured in sufficient quantities for Navy Deep Submergence System applications. Produce at least one full-scale batch of the product to identify and eliminate potential formulation scale-up issues.

PHASE III: Obtain NAVSEA approval for use of the selected grease. Provide all required procurement information to NAVSEA.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The selected grease could find use in private submersibles, diving chambers, or diving suits in support of the off-shore oil platform industry, or in any other operations within enclosed, recycled atmospheres such as in space operations.

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

2. Submarine Atmosphere Control Manual (S9510-AB-ATM-010(U) REV 2), dated 30 July 1992

KEYWORDS: grease; diver; deep submergence; lubricant; off-gas; closed atmosphere

N08-044 TITLE: Automatic Target Recognition (ATR) Algorithm for Submarine Periscope Systems

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

ACQUISITION PROGRAM: PMS 435 Photonics Mast ACATIII & Integrated Submarine Imaging System ACATIV

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

OBJECTIVE: Develop an algorithm(s) capable of automatically classifying and recognizing marine targets in imagery from submarine imaging systems. The algorithm(s) will also be able to extract target parameters such as length, height, overall configuration (e.g., superstructure, stack, mast locations) from the imagery. This information will be fed to a marine target database to determine the target's identification.

DESCRIPTION: Enhanced situational awareness is driving many new capabilities (e.g. Automatic Range Finding (ARF)). Littoral operations frequently involve a large number of marine targets (fishing fleets, e.g.) that may be intermingled with potentially hostile targets. Imaging systems offer the potential for rapid and accurate target detection and classification. In addition, the large number of contacts may cause operator overload. Automatic target detection and classification can reduce operator workload, allow for less skilled operators and improve classification and detection thresholds. Automatic Target Recognition (ATR) includes the ability to distinguish potentially hostile targets from similarly sized non-hostile targets.   For example, the algorithm should be able to distinguish between a cruiser and a Coast Guard cutter.

This topic seeks to identify innovative approaches to ATR in difficult operating conditions including choppy seas, low visibility, water droplets on the head window, and a variety of weather conditions. The algorithm(s) should be able to operate on data from detection and tracking algorithms including bearing, bearing rate, size, and on imagery from the full spectrum of imaging sensors including visible color and black & white, LWIR, SWIR, and MWIR sensors in multiple formats including SDTV and HDTV. As a goal, it should extract relevant parameters from each target in less than 1 second. ATR capability should not require an operator trained in recognizing the huge variety of marine targets and should provide enough information to a marine target database to facilitate identification. The preferred implementation of this algorithm(s) is in the form of a software program capable of being run on COTS general purpose processors.

PHASE I: Research, evaluate and select Automatic Target Recognition algorithms. Perform design and analysis of Automatic Target Recognition algorithms, define their performance characteristics (including, but not limited to parameters extracted, processor requirements, processing speed and outputs).

PHASE II: Develop an implementation of the ATR algorithm(s) that will operate on stand alone COTS hardware, ready for a land based demonstration using actual unclassified periscope data. Document the design and test results in a final report.

PHASE III: If successfully demonstrated in Phase II, participate in a submarine image processing system subsystem laboratory integration and at sea testing. Fleet implementation may be accomplished through Technology Insertion (TI) upgrade to existing submarine imaging systems.

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

REFERENCES:
1. Automatic Object Recognition: Proceedings, Hatem Nasr, Editor, Society of Photo Optical (1991)

2. Javidi, Bahram; Smart imaging systems, SPIE (2001)

3. Javidi, Bahram; Image Recognition and Classification, CRC (2002)

4. Javidi, Bahram;Optical Information Processing, Proceedings of SPIE (various)

5. The Infrared and Electro-Optical Handbook, Frederick G. Smith, Editor.

KEYWORDS: Automatic Target Classification; Automatic Target Recognition; Electro-Optics; Periscopes; Image Processing; Classification

N08-045 TITLE: Rapid, Distributed Design Change Development for Ship Maintenance and Modernization

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: PMS 392

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

OBJECTIVE: Enable Engineers and planners to collect digital data of the "as is" layout of shipboard spaces using a dimensionally accurate digital 3D imaging system. The captured digital data would accurately depict the color, texture, and configuration of ship equipment (including type and location). These images can be readily converted into engineering drawings or other technical work documents and stored to provide virtual data sharing support for engineers and planners. "As is" data captured would serve as inputs to a feature recognition tool that would aid designers in modeling the shipboard spaces and subsystems therein. Scan data, models, and drawings are managed in a design and technical data management environment which consists of various enabling capabilities for distributed processing, intelligent information management and distribution, program management, and life cycle engineering and support-related activities.

DESCRIPTION: Prior to the execution of submarine maintenance work, extensive engineering and production planning is required. This planning involves one or more manpower-intensive ship checks prior to the submarine entering the depot for repairs or modernization. Ship checks are necessary to obtain accurate ship configuration, since rarely do baseline ship drawings accurately reflect the current configuration of a ship. Typically, ship construction drawings depict a particular system or systems, but do not show all equipment and structures in a particular area. The result is that ship checks normally take a significant amount of time and resources to fully develop engineering changes and production documentation necessary for the depot level work. This effort would use existing technology to build an engineering process for capturing, manipulating, analyzing and sharing the data using digital information.

PHASE I: Develop a system design for distance support shipboard maintenance utility. This system should have a digital 3D scanning device combining images and measurement data, and engineer coded information, an automated analysis process, and automated technical data package generation.

PHASE II: Develop and test the distance support digital information capture System including applications in readiness, logistics and maintenance with performance assessment in actual work environments.

PHASE III: Prepare a user friendly maintenance system for use by shipboard personnel to perform distance support maintenance in civilian and military work environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be applied in any work environment, where structure's change such as complex nuclear and non-nuclear spaces; architectural structures; buildings, factories, and other physical plants; and historical sites where preservation or configuration change is important to document.

REFERENCES:
1. McAllister, David; Woodrow Robins, "True three-dimensional imaging techniques and display technologies" 15-16 January 1987, Los Angles, California, Chairs/Editors: sponsored by SPIE--the International Society for Optical Engineering; in conjunction with the Center for Applied Optics /University of Alabama in Huntsville; v. 761;

2. Sorby, S.A.,K.J. Manner, B.J. Baartmans "3-D visualization for engineering graphics" published in 1998 by Prentice Hall, Upper Saddle River, New Jersey, 07458

KEYWORDS: virtual ship check; product lifecycle management; digital data capture; 3D data analysis

N08-046 TITLE: A Low Noise Tunable Wavelength Laser for Fiber Optic Sensor Systems

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: NAVSEA PMS401, Acoustic Systems Program, Towed Systems, ACAT II

OBJECTIVE: Develop a low noise tunable laser to significantly improve fiber optic acoustic sensor system availability and maintainability.

DESCRIPTION: Current fiber optic towed systems under development require as many as 14 low noise in-board lasers built to a specific frequency ranging from approximately 1520nm to 1560 nm to meet system performance requirements. Further, to meet system reliability and performance requirements, a 100% on-board sparing philosophy is required, which is very expensive and utilizes a high percentage of the available stowage space on a SSN. This effort would leverage existing technology to develop a low noise tunable wavelength laser that would significantly reduce system sparing and maintainability requirements (reduced life-cycle cost).

PHASE I: Develop a system design for a low noise tunable laser for fiber optic acoustic system applications. Conduct an analysis on the reliability and maintainability benefit of this technology over current fixed frequency low noise lasers.

PHASE II: Develop, fabricate, and conduct critical item testing on a prototype laser.

PHASE III: The technology developed under Phase I & II will be transitioned to the TB-33 program for use in the inboard receiver cabinet. The contractor shall design, fabricate and conduct design certification testing (DCT's) on a production ready unit. The contractor shall support all PMS 401 ILS activity, including development of sparing/maintainability plans, etc.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be applied current development efforts on-going in the telecommunication and cable distribution systems.

REFERENCES:
1. TB-33 Performance Specification; 24 June 2004; Laser Relative Intensity Noise (RIN) Trade Study, Chesapeake Sciences Corporation, 7/03.

KEYWORDS: Low Noise, Tunable, Sparing, Maintainability, Reliability, Life-Cycle Cost

N08-047 TITLE: High Power, Compact Compressor for Eye-Safe, Fiber-based, Ultrashort Chirped Pulse Amplification Laser Systems

TECHNOLOGY AREAS: Electronics, Weapons

ACQUISITION PROGRAM: PMS 405 Ultra Short Laser Development. ACAT Level N/A

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

OBJECTIVE: To research and develop a highly efficient, compact compressor for 1 micron and 1.55 micron ultrashort laser amplifier systems capable of withstanding power levels in excess of 200 W average and 5 GW peak power.

DESCRIPTION: High power, ultrashort pulse lasers are versatile tools with a wide range of applications. The combination of high energy and short pulse width found in these lasers make them ideal for applications such as

remote sensing, micromachining, and any process requiring a nonlinear material response. High power, ultrashort laser systems utilize chirped pulse amplification (CPA) to produce high pulse energies while avoiding the problems associated with amplifying an ultrashort pulse. In CPA, an ultrashort pulse is stretched in time, amplified and then recompressed. Current high power, ultrashort laser systems utilize a variety of technologies to compress the stretched, amplified pulse, such as metallic gratings, prisms, and chirped mirrors. While all of these solutions have allowed for the development of high average and high peak power systems, none are sufficient for scaling laser systems to higher power or high peak power in a reasonable form factor and easy alignment. Both prisms and chirped mirrors can not compensate for the large stretch factors required by the higher power laser systems. In addition, prisms can introduce nonlinear phase distortions which are detrimental to a laser system. Volume bragg gratings have demonstrated reasonable pulse compression but are currently limited to small stretch factor and low beam quality. Grating-based compressors can be designed to have a very large compression factor, but thermal effects can limit the average power handling while damage due to optical absorption in the metallic coating limits the peak power handling. More advanced grating technologies are difficult to procure, require difficult alignment, and are typically dedicated to fundamental research experiments.
The goal of this topic is to design and develop novel technologies for pulse compression of deployable high energy, high peak power ultrashort pulse lasers (>5 GW). Solutions based on compact components that minimize the amount of free-space alignment are strongly preferred. Technologies investigated should be robust and highly efficient (>80%) while providing stable, adjustable control of the ultrashort pulse width. Monolithic solutions for pulse width control are preferred. Applicants are expected to have demonstrated expertise in pulse compression for high power CPA systems at both 1 µm and 1.55 µm wavelength. Expertise with compression of pulses stretched to duration longer than 1 ns is also preferred.

PHASE I: Identify technologies and processes required to develop components for a high power, ultrashort laser compressor. The selected technologies and processes will produce components that meet the following criteria:
1. Capable of withstanding average power levels in excess of 200 W
2. Capable of withstanding peak power levels in excess of 5 GW
3. Compact, minimum alignment
4. Excellent output beam quality (M2 < 1.2)
5. High efficiency (>80%)
6. Robust to temperature fluctuations (5-45°C) and vibrations

PHASE II: The technologies and processes identified in Phase I will be implemented to demonstrate a high peak and average power pulse compressor. These components will be tested to verify the component characteristics and performance according to the requirements described in Phase I. Robust packaging, pulse width control methodology, and environment testing will also be performed in Phase II.

PHASE III: A compact, high power compressor is expected to be integrated into high power, ultrashort laser systems for improved remote sensing, material ablation, explosive detonation, and other air and sea platforms. PHASE III efforts will focus on providing a complete CPA system based on the novel compressor technology

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High performance compression techniques enable higher average power for USP lasers. There is a substantial market of USP laser vendors who could seek to enhance their core technology by making use of higher efficiency compression techniques. USP lasers can be utilized in a variety of commercial applications, including surgical, manufacturing, and laser processing.

REFERENCES:
1. L. Vaissié, K. Kim, J.F. Brennan, M.M. Mielke, A. Stadler, T. Yilmaz, T. Saunders, D. Goldman, and M.J. Cumbo, “Autonomous, flexible and reliable ultra-short pulse laser at 1552.5 nm,”, Proc. SPIE Int. Soc. Opt. Eng. 6460, 64600M (2007)

2. W. Kautek and J. Krüger, "Femtosecond pulse laser ablation of metallic, semiconducting, ceramic, and biological materials," SPIE, 2207, 600-611, (1994).

3. M. D. Perry, R. D. Boyd, J. A. Britten, D. Decker, B. W. Shore, C. Shannon and E. Shults, “High-efficiency multilayer dielectric diffraction gratings,” Optics Letters, 20, 940 (1995).

KEYWORDS: optics, lasers, ultra-short pulse, compression, dielectrics, gratings

N08-048 TITLE: Enhanced Riverine and Coastal Sensors for Patrol Craft

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: NECC (Not confirmed)

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

OBJECTIVE: Develop and implement innovative technologies and concepts (radar, thermal imaging, or other sensors) that can be used on riverine and coastal craft to “see through the forest" to provide situational awareness of riverbanks or coastal areas for littoral and riverine operations.

DESCRIPTION: The new Maritime Strategy for the United States being developed includes a global fleet station (GFS) concept wherein small ships and boats may be deployed throughout the world in support of humanitarian missions, diplomatic efforts to influence local governments, developing local contacts and partnerships, and civil issues. The Navy has established riverine squadrons to operate in rivers of the world that are likely to be used in support of GFS. In the GFS concept, riverine and coastal craft would need to be able to operate independent of assets that would provide essential ISR because those assets are not likely to be available. Riverine and coastal operations would be vulnerable to threats that have taken advantage of the growth and underbrush on riverbanks and coastal areas to conceal enemy emplacements and activity. An onboard capability to see what is on the riverbank, where growth is dense, would significantly improve riverine and coastal situational awareness and tactical options.

This topic seeks to identify innovative scientific and engineering solutions to advance imaging capabilities on riverine boats to provide ISR through dense forest growth and underbrush on riverbanks and in coastal areas. Technologies must address the ability to see through dense growth up to a few hundred yards to identify and track adversarial activity. Microwave, magnetic, electro-optical, laser, infrared, automatic tagging and tracking, and other technologies might be needed. The objective is to provide a "see through the forest" capability on boats used in riverine operations so that boat crews can have better situational awareness in the riverine battlespace to improve tactical engagement. An innovative, potentially high-risk solution is required to provide a see through the forest capability.

Proposals should specifically describe the technologies that will be applied to solve the problem, how they will be developed, what the specific benefits will be, and how they might be transitioned to Navy acquisition programs. System life-cyle cost estimates with sufficient detail to determine impact on acquisition and sustainment must be developed as part of the effort. Members of the Naval Advanced Concepts and Technologies (NACT) program are available to provide guidance and assistance in the identification and clarification of common issues and needs. Contact with these resources is encouraged both prior to proposal development and during any subsequent SBIR-related activity.

PHASE I: The contractor is expected to identify and characterize scientific and engineering solutions, which includes technologies that could be enhanced, for use onboard riverine and coastal craft to provide the capability to see into densely covered riverbanks and coastal areas to improve situational awareness and tactical engagement. The contractor will establish performance goals and objectives for key concepts and technologies and provide a plan with technological milestones for further concept development. The development plan must consider transition of technologies into Navy acquisition programs.

PHASE II: The contractor is expected to develop and demonstrate the feasibility of technologies and concepts critical to riverbank and coastal area situational awareness. The contractor will demonstrate, based on the development plan of Phase I, that key concepts and technologies meet performance goals and objectives established during Phase I. The contractor will develop and implement a strategy to transition developed technologies to Navy acquisition programs.

PHASE III: Concepts and technologies will be integrated into a prototype for test and evaluation on a riverine platform. An implementation plan for operational test and evaluation will be developed.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The concepts and technologies developed in this effort could be used on civil patrol craft to protect US waterways.

REFERENCES:
1. Cutler, Thomas J., "Brown Water, Black Berets: Coastal and Riverine Warfare in Vietnam," US Naval Institute Press, Annapolis, MD, ISBN-10: 1557501963 (May 2000).

2. Edward J. Marolda, "By Sea, Air, and Land - An Illustrated History of the U.S. Navy and the War in Southeast Asia," Naval Historical Center, ISBN 0-9452774-10-6

KEYWORDS: Riverine; coastal; squadron; sensor; foliage; imaging

N08-049 TITLE: <u>Modeling and Simulation (M&S) of a Multiple Beam Inductive Output Tube (MB-IOT)</u>

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Electronics

ACQUISITION PROGRAM: Directed Energy Weapons and Radar Systems

OBJECTIVE: Develop an end-to-end, self-consistent, physics-based analysis and design capability and methodology to model high-power multiple beam Inductive Output Tube's (IOTs) and to quantitatively characterize and optimize their performance.

DESCRIPTION: The multiple-beam IOT (MB-IOT) has been identified as a key technology to provide high RF power for emerging applications, such as compact linear accelerators and directed energy weapons on future naval platforms. However, there are no computationally efficient, self-consistent, physics-based design tools available to design and reliably predict the performance of this device. This is due to many factors, including the disparate spatial scales and complex 3D geometry of the RF gridded gun and the complex evolution of emission, acceleration and collective energy extraction that span widely ranging time-scales. For example, the scale of the anode-cathode gap relative to the fine features of the grid can exceed two orders of magnitude, which is a challenge to both RF and particle beam simulation and necessitates use of conformal-mesh codes. Four key issues must be addressed for a full simulation: (1) frequency domain simulation of the RF input circuit, (2) self-consistent time-domain particle emission and tracking in RF and DC fields from the cathode through the beam tunnel, (3) self-consistent non-linear evolution of the multiple-beam phase-space and energy extraction through the output cavity, and (4) collector modeling.

PHASE I: Develop an end-to-end, self-consistent, physics-based methodology to model multiple-beam IOT's, in either fundamental mode or higher-order-mode operation. Operating frequencies of interest are 300 MHz to 1 GHz, at power levels of hundreds of kilowatts to several megawatts (CW). Identify existing codes that can form the basis for the design methodology and the features that must be added, modifications required, etc. Perform a 3D analysis and design of the RF input/gun circuit and develop a procedure for incorporating the results of this design into other software modules, which will be needed to address issues such as dynamic loading of the RF cavity by the multiple beams and collector design.

PHASE II: Complete the additions and modifications to the various design codes and modules, as identified in Phase I. Validate the resulting design tools by modeling an existing single-beam IOT and comparing the results with experimental data. Perform an end-to-end analysis and design of a MB-IOT, with performance parameters selected in collaboration with government technical personnel.

PHASE III: Follow-on activities should include the application of this M&S tool to the engineering design, fabrication, and testing of a high-power MB-IOT.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications of multiple-beam amplifier technology include broadband high-power amplifiers for commercial satellite up-links and high-energy accelerators, where the low operating voltage is attractive due to reduced costs and increased reliability.

REFERENCES:
1. E. Wright, A. Balkcum, H. Bohlen, “Recent advances in MBK technology and their application to a 1-MW CW HOM-IOT for shipboard FEL systems”
Seventh Annual Directed Energy Symposium, Rockville, MD, October 18-21, 2004.

2. J.J. Petillo, E.M. Nelson, J.F. DeFord, N.J. Dionne, B. Levush, “Recent developments to the MICHELLE 2-D/3-D electron gun and collector modeling code,” IEEE Trans. Electron Devices, vol. 52, no. 5, pp. 742–748, May 2005.

3. S.J. Cooke, K.T. Nguyen, A.N. Vlasov, T.M. Antonsen, B. Levush, T.A. Hargreaves, M.F. Kirshner, “Validation of the large-signal klystron simulation code TESLA”, IEEE Trans. Plasma Sci., vol. 32, no. 3, pp. 1136-1146, Jun 2004.

KEYWORDS: modeling; simulation; IOT; MB-IOT; directed energy weapons; radar

N08-050 TITLE: High-Energy Short-Pulse Fiber Amplifier at Eye-Safe Wavelengths

TECHNOLOGY AREAS: Electronics, Weapons

ACQUISITION PROGRAM: PMS 405 Ultra Short Pulse Laser Development. ACAT leve N/A

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

OBJECTIVE: Develop and demonstrate an efficient, all-fiber amplifier capable of amplifying pulses at high repetition rates to the millijoule energy level with high average power and compressible to <500 fs duration. The fiber amplifier output should be single spatial mode at eye-safe wavelengths. The fiber should be bendable to a reasonably tight diameter to enable packaging in a compact form

DESCRIPTION: Ultra-short pulse (USP) lasers offer a variety of potential applications of interest to the Navy in the fields of sensing, diagnostics and distance interrogation as well as with weapons potential. At the pulse energy levels of interest, current state of the art high-power USP laser-amplifier systems are bulky and offer only low efficiency, greatly restricting the deployment of USP lasers for practical applications.

Due to their compactness, suitability for direct diode laser pumping, high efficiency and scalability, the Navy is interested in the development of high peak and average power, high-energy all-fiber amplifiers suitable for chirped-pulse amplification systems at eye-safe wavelengths. High-energy lasers at eye-safe wavelengths present much lower ocular hazards to the military personnel than lasers emitting at other wavelengths. Such systems would enable numerous applications and allow for easier integration into existing sea and air based platforms.

Scaling the pulse energies from chirped-pulse fiber amplifiers to the millijoule level at high average power has been limited by the nonlinear effects in fiber that are detrimental to the amplified pulse quality. These non-linearities, limit the minimum pulse durations achievable by pulse compression following the amplification. Large mode-area (LMA) fibers enable the reduction of nonlinear effects however at the expense of pure single mode operation. As a result, mode field areas in LMA fiber amplifiers have been limited to a few 100 µm2. In order to scale up the pulse energy from fiber amplifiers to useful levels for applications of interest to the Navy, fiber mode area has to be increased by an order of magnitude.

The amplifier fiber should be bendable to a reasonably tight diameter and suitable for integration into compact ultra-short pulse laser-amplifier systems that are diode laser pumped, highly efficient and all-fiber. The fiber amplifier should be capable of delivering millijoule ablative energy at high repetition rates with pulses that are compressible to <500 fs duration near the eye-safe wavelength of 1550 nm in a single spatial mode.

PHASE I: Conduct research, analysis, and studies on the selected high-energy, short-pulse fiber amplifier design and architecture, develop measures of performance and document results in a final report. The phase I effort should include modeling and simulation results supporting performance claims. The effort should also produce a draft testing methodology that can be used to demonstrate performance of the fiber amplifier system proposed for the phase II effort.

PHASE II: Develop the technology advances and methods identified in phase I to demonstrate a proof-of-concept prototype highly efficient, bendable all-fiber amplifier that will deliver single spatial mode pulses at the millijoule energy level with high repetition rates near 1550 nm. Demonstrate pulse compression to <500 fs duration.

PHASE III: Develop a fiber amplifier capable of mass production for a variety of civilian and military uses. The final system may be expected to be "hardened" for field use, depending on mission needs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Highly efficient fiber amplifiers enable higher average power for USP lasers in smaller footprints. There is a substantial market of USP laser vendors who could seek to enhance their core technology by making use of next generation fiber amplifiers. USP lasers can be utilized in a variety of commercial applications, including surgical, manufacturing, and laser processing.

REFERENCES:
1. L. Vaissie, K. Kim, J. F. Brennan, M. M. Mielke, A. Stadler, T. Yilmaz, T. Saunders, D. Goldman and M. J. Cumbo, "Autonomous, flexible and reliable ultra-short pulse laser at 1552.5 nm," Proc. of SPIE, vol. 6460, pp. 64600M1-11, 2007.

2. L. Shah, M. E. Fermann, J. W. Dawson and C. P. J. Barty, "Micromachining with a 50 W, 50 µJ, subpicosecond fiber laser system," Opt. Express, vol. 14, no. 25, pp. 12546-12551, 2006.

3. J. Limpert, N. Deguil-Robin, I. Manek-Hönninger, F. Salin, F. Röser, A. Liem, T. Schreiber, S. Nolte, H. Zellmer, A. Tünnermann, J. Broeng, A. Petersson, C. Jakobsen, "High-power rod-type photonic crystal fiber laser," Opt. Express, vol. 13, no. 4, pp. 1055-1058, 2005.

4. G. P. Agrawal, Nonlinear Fiber Optics, Third Edition, San Diego, CA: Academic Press, 2001.

KEYWORDS: Ultra-short pulses, Millijoule pulses, High-energy amplifiers, High peak power pulses, Compact fiber amplifiers, Eye-safe fiber amplifiers, Direct diode laser pumping.

N08-051 TITLE: Autonomous Self-Repair and Maintenance for Unmanned and Low-Manpower Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

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

OBJECTIVE: Develop and implement innovative technologies that will provide autonomous self-repair and maintenance on unmanned vehicles and reduced-manpower ships.

DESCRIPTION: Congress has mandated that, “It shall be a goal of the Armed Forces to achieve the fielding of unmanned, remotely controlled technology such that by 2010, one-third of the aircraft in the operational deep strike force aircraft fleet are unmanned; and by 2015, one-third of the operational ground combat vehicles are unmanned.” (Section 220 of the FY2001 defense authorization act, H.R. 4205/P.L. 106-398 of October 30, 2000. Similar trends are underway for the provision of naval capabilitities on presently unprecedented levels using unmanned surface and undersea vessels. In parallel, pursuit of reduced life-cycle costs for manned naval platforms has led to a greater and greater call for automation and reduced manning for new designs.

Current limitations on UV operations are largely driven by fuel and battery capacitities, but advances in propulsion and power technologies are coming on line that will mitigate that shortcoming to a considerable degree. As these technologies evolve, the next operationally limiting factor will become maintenance requirements of the vehicle systems. Similarly, a large driver of crew workload on manned vessels is the need to perform scheduled and unscheduled maintenance tasks while underway.

The frequency of routine maintenace tasks such as clearing strainers and changing filters can usually be reduced by clever system design, but seldom eliminated entirely, and usually at increased system acquisiton cost. Similarly, reducing the frequency and necessity of unscheduled maintenance tasks can often be accomplished by adding redundancy to systems, albeit with added system weight and drastically increased cost. In order to maintain sufficiently large payload fractions while minimizing system acquisition cost, approaches to perform scheduled and unscheduled maintenance tasks using robotic technologies combined with autonomous control schema are sought. An example of the sort of unscheduled maintenance or casualty repair task to be performed would be the isolation, removal, replacement, and recharging of a fuel sytem after the identification of a faulty valve component.

This topic seeks to identify innovative scientific and engineering solutions to provide autonomous self-repair and maintenance of UVs and low-manpower ships. Robotics; intelligent autonomous control, failure sensing, identification, and isolation; parts handling; coordination with mission and ship system schedules; and other technologies will likely need to be addressed by proposed solutions. Existing technologies should be leveraged as much as possible to reduce risk, but technologies must be able to operate for long periods (months to years) without human intervention. Technical challenges lie in robotics, intelligent autonomous control and coordination, failure sensing and identification, and long periods of unattended operation.

Approaches to automation of maintenance tasks are considered to be key enablers to the pursuit of economically viable very long endurance unmanned vehicle operation and grossly reduced manning of larger ships. Maintenance is usually conducted by ship's force while deployed, but If UVs are to be deployed for extended periods, some maintenance will have to be done autonomoulsy without the intervention of manpower, particulary as unmanned operation moves to larger vessels. Proposals should specifically describe the technologies that will be applied to solve the problem, how they will be developed, what the specific benefit will be, and how they might be transitioned to Navy acquisition programs. System life-cyle cost estimates with sufficient detail to determine impact on acquisition and sustainment must be developed as part of the effort. Members of the Naval Advanced Concepts and Technologies (NACT) program are available to provide guidance and assistance in the identification and clarification of common issues and needs. Contact with these resources is encouraged both prior to proposal development and during any subsequent SBIR-related activity.

PHASE I: The contractor is expected to identify and characterize innovative scientific and engineering solutions for autonomous self-repair and maintenance that will perform a wide variety or repair and maintenance functions on UVs and low-manpower ships. Concepts and technologies shall permit identification, selection, transport, manipulation, installation, and disposal of physical system components involved in routine maintenance and repair functions. The selected maintenance and repair tasks will be performed while unattended over the full spectrum of expected environmental conditions. The contractor will establish performance goals and objectives for key concepts and technlologies and will provide a plan with milestones for further concept and technology development.

PHASE II: The contractor is expected to develop and demonstrate the feasibility of concepts and technologies critical to an autonomous self-repair and maintenance capability in the shipboard environment. The contractor will demonstrate, based on the development plan of Phase I, that key concepts and technologies meet the goals and objectives established in Phase I. Prototype systems to demonstrate the developing capability will be provided to the Navy for test and evaluation. Life cycle cost estimates for systems and components will be provided by the contractor. The contactor will develop and implement a strategy to transition beneficial technologies to acquisition.

PHASE III: The contractor will finalize development and transition beneficial, affordable, and sustainable (as determined by Phase II testing) technologies into system design and acquisition products, with the end goal of making products available to acquisition programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An autonomous self-repair and maintenance system will benefit the operational maintenance support of any complex system. Man-in-the-loop robotics are already utilized to a limited degree on the external maintenance and inspections of commercial marine and aerospace structures, and are gaining acceptance within the power industry and medical fields for a limited set of internal maintenance tasks as well. Adding autonomy to robotics for internal maintenance tasks on much larger scales and in harsher operating environments opens the door to reduced operational costs and operation in higher risk environments, with direct applicability to a wide range of industries, including oil-gas exploration, manufacturing, and civil infrastructure/utilities.

REFERENCES:
1. Control and driving of a robot for underwater ship hull operation, Roznowski, G.   Kowalczuk, Z.   Raczynski, P., The Experience of Designing and Application of CAD Systems in Microelectronics, 2001. CADSM 2001. Proceedings of the 6th International Conference. Publication Date: 2001, pp. 179-182, ISBN: 966-553-079-8

2. Automated Refurbishment Maintenance Systems - http://www.sti.nasa.gov/tto/spinoff1996/33.html

3. OCTOPUS Automated Hull Maintenance System - http://ec.europa.eu/research/growth/gcc/projects/in-action-octopus.html#01

KEYWORDS: Robotics; Maintenance; Casualty; Manpower Reduction; Autonomous; Machinery Failure

N08-052 TITLE: Riparian Insertion and Extraction System for Expeditionary Combat Craft

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: NECC (Not confirmed)

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

OBJECTIVE: Develop and implement innovative technologies for transport of riverine craft in off-road environments and rapid launch and retrieval of those craft over a broad spectrum of site conditions in a hostile riverside environment.

DESCRIPTION: US riverine units use commercial systems to transport, launch, and retrieve military craft from lakes and rivers in combat zones. These systems are inadequate for the rough, off-road conditions encountered while transporting and deploying military boats weighing up to 11 tons. They become bogged-down in muddy river banks, are often unable to reach water with adequate depth for deployment, and have difficutly with rough terrrain and fluctuating water levels. In addition, prepared launch sites have proved impractical because once discovered, they become potential ambush and Improvised Explosive Device (IEDs) targets. Consequently, tactics require that boats and craft be launched and retrieved at different sites to protect craft and personnel. Commercial systems limit the number of launch and retrieval sites that can be used because site conditions prohibit their use. When unprepared sites are used, site conditions significantly slow launch and retrieval, which endangers boats and personnel. Conventional launch and retrieval systems are incapable of meeting the demands of riverine warfare, therefore and innovative, potentially technologically risky solution is required.

This topic seeks to identify innovative scientific and engineering solutions for boat transportation, launch, and retrieval systems that can meet the demands of off-road transit, overcome site conditions, and reduce launch and retrieval times by at least half to significantly reduce risk to personnel and equipment. Inflation and regulation systems that can automatically adjust tire pressure according to terrain requirements may provide access to more sites and reduce launch and recovery times. Sandia National Laboratory has experimented with automatic tire pressure maintenance systems, and a central tire inflation system is marketed for trucks and military vehicles. These systems, however, keep tires at a set pressure and do not adjust automatically for terrain, which is crucial for rapid launch and recovery. Lightweight composites that could be used in construction of launch and retrieval systems would reduce weight and increase site accessability. Technologies that could automatically and rapidly "extend" launch and recovery beyond muddy, sandy, or rocky shores to where water depths are sufficient are essential to operating over a wide range of site conditions. Variable ground clearance for the launch and retrieval system would would expand access to rugged shorelines and improve transport over rough terrain. Novel technical solutions to improve site access and needed. Launch and retrieval must be accomplished rapidly, with minimal operator intervention, and at minimal system weight. Althought technical risk can be minimized by leveraging existing technologies, there is technical risk in modifying and adapting those technologies to make them suitable for this application.

Proposals should specifically describe the technologies that will be applied to solve the problem, how they will be developed, what the specific benefit will be, and how they might be transitioned to Navy acquisition programs. System life-cyle cost estimates with sufficient detail to determine impact on acquisition and sustainment must be developed as part of the effort. Members of the Naval Advanced Concepts and Technologies (NACT) program are available to provide guidance and assistance in the identification and clarification of common issues and needs. Contact with these resources is encouraged both prior to proposal development and during any subsequent SBIR-related activity.

PHASE I: The contractor is expected to identify and characterize novel launch and retrieval concepts and technologies that would reduce launch and retrieval times of SURCs (22,000 lbs) by a factor of at least two and that permit launch and retrieval over broader range of site conditions. The new launch and retrieval system must be transportable by air (C-130, C-17, C-5, MH-47, MH-53), and the system and boat must fit inside a minimum air transportability envelope of 8’ W x 7.8’ H x 20’ L. The launch and retrieval system must be operable at any time of day, during severe weather conditions, at as many sites as possible. The contractor will establish performance goals and objectives for key concepts and technlologies and provide a plan with milestones for further concept and technology development.

PHASE II: The contractor is expected to develop and demonstrate the feasibility of concepts and technologies critical to an advanced launch and retrieval system. The contractor will demonstrate, based on the development plan of Phase I, that key concepts and technologies meet the goals and objectives established in Phase I. Life cycle cost estimates for the system and its components will be provided by the contractor. The contactor will develop and implement a strategy to transition beneficial technologies to acquisition.

PHASE III: The contractor will finalize development and transition beneficial, affordable, and sustainable (as determined by Phase II testing) technologies into system design and acquisition products, with the end goal being a new launch and recovery system available on GSA schedules. A prototype system will be provided to the Navy for test and evaluation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Development of a launch and retrieval system of this type will improve the rapid response capabilities of relief and rescue craft worldwide. By increasing the suitable areas for launch and retrieval of small boats, maximum use of high speed ground transport can be achieved, bringing the boat as close to the desired work area as possible. In addition to the parallel government applications, private boat owners in areas with poorly developed or nonexistent boat ramps could use such system for launch and retrieval.

REFERENCES:

1. R. B. Rummer, C. Ashmore, D. L. Sirois, and C. L. Rawlins, "Central Tire Inf lation: Demonstration Tests," US Department of Agriculture, Forest Service, Southern Forest Experiment Station, New Orleans, Louisiana, General Technical Report SO-78 (Sept. 1990) (see http://www.treesearch.fs.fed.us/pubs/1752).

2. http://www.sandia.gov/news/resources/releases/2005/elect-semi-sensors/tire-pressure-system.html

3. SAE J2180, SAE J2181, & Federal Motor Vehicle Safety Standard (FMVSS) 121

4. MTMCTEA REFERENCE 99-55-24 Vehicle Preparation handbook for fixed Wing Air Transport

5. NATO Allied Vehicle Testing Publication (AVTP) 03-160W

6. MIL-STD-913A Requirements for the certification of sling loaded military equipment for external transportation by Department of Defense helicopters

KEYWORDS: Boat; Riverine; All-terrain; Lightweight; Launch; Recovery

N08-053 TITLE: Advanced Sabot System Design

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: ACAT II: Gun Weapon Systems Technology program, Naval Surface Fire Support

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

OBJECTIVE: Develop a low-cost, lightweight, high-strength sabot system for use in high acceleration (40kGee) gun launch projectile sabots.

DESCRIPTION: In order to maximize range and lethality of saboted projectiles, the parasitic weight associated with the sabots should be minimized; yet the in high acceleration applications (40-kGee) the sabots must withstand tremendous amounts of mechanical stress. The mass associated with sabots fabricated from traditional materials (aluminum) accounts for too large a percentage of the overall launch package (projectile and sabots). The use of lightweight, high-strength materials should minimize the parasitic mass of the sabots, thus maximizing the projectile weight, lethality and range. In order to be a viable alternative, the sabot system should also be of relatively low cost when compared to other sabot materials.

PHASE I: Develop or demonstrate a sabot system that is inexpensive to produce, launch survivable and of relatively low density. Specifically, the system must survive accelerations of 40 kG in set back and 12.5 kG in both balloting and set forward. The contractor should provide material samples with testing results and structural analysis to support its use.

PHASE II: Fabricate sabot prototypes and demonstrate gun-launch survivability via air- or chemical-gun launches. Projectile design and gun bore dimensions will be provided by the Navy.

PHASE III: In FY04, the Office of Naval Research embarked on an Innovative Naval Prototype for an Electromagnetic Gun System. Concept hypersonic flight demonstrations will occur in which a series of saboted airframes will be both chemically and electromagnetically launched. The contractor will provide sabots throughout the test series. Successful demonstrations will facilitate transition into the follow-on System Development & Demonstration Acquisition Program sponsored by NAVSEA IWS3C.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Low-cost, light-weight, and high-strength components are always in demand by the aerospace and transportation industries.

REFERENCES:
1. http://www.arl.army.mil/aro/aronreview01/materials/materials.htm

2. http://www.its.caltech.edu/%7Evitreloy/development.htm

3. www.llnl.gov/str/pdfs/05_99.1.pdf

KEYWORDS: sabot; light-weight; high-strength; high acceleration; gun launch; lethality

N08-054 TITLE: Marine Assessment, Decision, and Planning Tool for Protected Species (MADPT PS)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS

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

OBJECTIVE: Generate a software-based tool for use by environmental and operation (mission) planners so informed and scientifically based decisions can be made to avoid or decrease interactions with protected marine species (marine mammals, sea turtles, fishes, gastropods, pelagic birds, and coral) for all Navy at-sea activities.

DESCRIPTION: Two necessary components of effective environmental and mission planning are determination of risk to protected species and development of protective measures that avoid or lessen those potential risks. To achieve a valid and defensible result, it is essential that operational risk assessments contain as much information as possible about protected species including their distribution, seasonality of occurrence, density, behavior, habitat usage, key life history parameters (e.g., migration, reproductive timing), anthropogenic threat sources, and responses to those sources. Devising an effective plan of protective measures depends not only upon knowledge of what is operationally feasible and causes the least effect on the mission but also on what is the optimal conservation method(s) to reduce impact on protected species.

Existing Navy databases individually provide some of this information (e.g., Navy OPAREA Density Estimates [NODE], Strategic Environmental Research and Develop Program [SERDP]-funded spatial models of marine mammal density and habitat, Marine Wildlife Behavior Database (MWBD), Protective Measures Assessment and Planning [PMAP], Living Marine Resource Information System [LMRIS], and the NUWC beaked whale database). However, no system integrates these data and information nor provides the needed environmental, behavior, anthropogenic threat sources and information, or life history information in an integratible form. The need for a system to integrate existing databases as well as additional data and information for protected species is essential to the Navy’s continued ability to fulfill its mission at sea.

PHASE I: Demonstrate the proof of concept by selecting one small taxon of protected species, fishes, and develop a data collection plan, database sharing agreements, and determine feasibility of software system development by beginning development of the software interface that is capable of storing, querying, and visualizing the information and data on distribution, density, seasonality, behavior, key life history parameters, known anthropogenic risk sources including sound, habitat usage, and protective measures in a geospatial format.

PHASE II: Fully develop prototype of integrated software system for fish data/information using the lessons learned from Phase I. Demonstrate the usefulness and viability of the resulting software system by selecting a real-time operation scenario, either a sea-test or routine exercise, in a realistic geographic area. The resulting detailed risk information to protected fish as well as the plan of protective measures will be assessed for effectiveness and feasibility.

PHASE III: Develop the software system by fully integrating all existing databases as well as data and information for all other protected species taxon. Transition the software system into the mission and environmental planning communities for use in environmental compliance documentation and planning of tests and exercises with the least risk to protected species.

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. DoN (Department of the Navy). 2007. Navy OPAREA Density estimate for the Gulf of Mexico, Final Report. Contract number N62470-02-D-9997, CTO 46. Naval Facilities Engineering Command, Atlantic, Norfolk, Virginia.

2. MacLeod, C.D. and A. D'Amico. 2006. A review of beaked whale behavior and ecology in relation to assessing and mitigating impacts of anthropogenic noise. Journal of Cetacean Research and Management 7(3): 211-221.

3. Tyack, P.L., J. Gordon, and D. Thompson. 2003/04. Controlled exposure experiments to determine the effects of noise on marine animals. Marine Technology Society Journal 37(4): 41-53.

KEYWORDS: protected species, mission planning, protective measures, risk assessment, anthropogenic sources, environmental planning, databases

N08-055 TITLE: Datagram Segregation Open Systems Service Approach

TECHNOLOGY AREAS: Information Systems, Battlespace, Human Systems

ACQUISITION PROGRAM: Battle Force Tactical Trainer ACAT IV

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

OBJECTIVE: To develop a highly usable data model/process that prepends self-identifying information to a datagram and provides the ability to make intelligent decisions with regard to restrictions, purpose, and applicability of the data content. The key development consideration is to have the "insertable" service available to any application development environment and servers that are development environment insensitive so that regardless of what development tools are used to encode the service into the system, the server can properly administer the appropriate management, administrative, policy and controls.

DESCRIPTION: The problem: There exists no single framework and support software services or applications with processing servers to prepend highly configurable standardized tags to an information message or datagram which allows a system to automatically identify target audience using intelligence based rules.

This becomes a design handicap when attempting to develop widely Open Systems Architecture.
PEO IWS 7C is soliciting proposal for developing a data tagging model, common framework for datagram segregation, programming language independent services that can be applied directly to developing applications and servers capable of directing or restricting information flow based on any compliant application generate datagram.

The following consideration must be directly addressed in the solution space so that an implementation of the framework is highly practice:

Multi Level Security,
Safety Permission to Train,
Secure voice and non-secure voice

Live versus simulated versus virtual versus constructive entities,
Tactical versus, Maintenance versus Engineering versus Navigation versus Damage Control versus locally owned and generated data [Own ship] versus remotely created data [multi-ship].
USN Forces vice Joint and Coalition Forces.

This Open System Architecture approach to datagram segregation must at a minimum comply with OA Navy Standards for hardware, as required, and identify the methodology for software development and be re-usable as an architecture design for other Navy engineering requirements, including NET-CENTRIC and Coalition Warfare paradigms.

The use of self identifying datagrams provides the control information tagging necessary for targeted distribution and filtering of information to a specific recipient, only when appropriate. When applied to the surface training domain, this developed technology will provide the capability to target data information delivery and maintain the necessary restriction and control without using hardware based services such as switches, routers, bridges, guards and gateways. This technology, once developed, will likely not replace the physical security requirements for separation often implemented with Guards or Gateways, however, it may be a complimentary application layer to achieve physical security cooperative identification violation indicator further fortifying the Guard or Gateway.

PHASE I: Develop, using available DoD CADM compliant development tools, a model and architecture that is representative of the necessary data model/structure, service add-in for applications and application independent servers. The deliverable shall clearly identify a control authority programmable taxonomy, such as an XML Namespace, and a programmable hierarchy of restriction, for classification and restriction purposes and how they integrate, interoperate and disseminate information as prescribed. The deliverables must also identify a strategy to practically deliver these developing technologies into a serviceable system component.

Develop a concept of operation for implementation into the TSTS Event Driven Architecture (EDA) and Service Oriented Architecture (SOA) services paradigm. It is highly recommended that CANES be well understood as a potential NAVSEA foundational implementation of SOA.

PHASE II: Develop a non-scripted demonstrable prototype. The prototype shall be able to perform the rudimentary control authority programmable taxonomy configuration and application of tagging to datagrams. The prototype shall also include a non-scripted capability to achieve hierarchy designation as applied to classification restriction indicators. The final component of the prototype shall be a server demonstration showing how information control, restriction and directed delivery was achieved.

Complete the engineering development documentation compliant with industry best practices to be negotiated with IWS 7C and CADM compliant.

Prepare, in collaboration with IWS 7C, a set of acceptance criteria, including parameters for source, purpose, restriction, and constraints for the prototype demonstration.

Complete the necessary documentation, including requirements and specification, to allow for a successful Phase III implementation.

PHASE III: If the contractor successfully passes the acceptance criteria during the Phase II demonstration, it is anticipated that the contractor will be awarded a Phase III contract to perform the full scale development of the technology components, as a System Integrator, for their solution within the TSTS development team under the integration guidance of the PEO IWS 7C.

Private Sector Commercial Potential/Dual-Use Applications
The contractor is free to apply this broad schema to the vast number of commercial application that requires similar data segregation and/or control.

REFERENCE:
HLA IEEE Specification 1516 see section on data distribution management system

KEYWORDS: Multilevel security; datagram; object identifiers; data tagging; data models; data distribution management system;

N08-056 TITLE: Active Sonar Automated Clutter Management

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS5B: The ANSQQ89 A(V)15 program of record.

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

OBJECTIVE: The offeror shall develop innovative methods for characterizing and modeling Mid Frequency Active Sonar return data to encompass the bulk of operating environments anticipated. This model will be used to generate synthetic data for use in a low computation but high fidelity simulation environment as well as an integrated track before detect and classification system for tactical employment.

DESCRIPTION: Mid Frequency Active Sonar (MFAS) systems are a critical resource in the ASW arsenal of the US Navy. MFAS systems currently depend strongly on the individual capabilities of the attendant operators for good performance in terms of probability of detection and false alert rates. Much research has gone into classical characterization of the acoustic data channel (See … below). In support of improving the training to allow proficiency development in operators and for the development of improved detection, tracking, and classification systems, it is anticipated that innovative formal characterization of the expected received data will provide new insights for low cost and effective training as well as improved tactical system exploitation.

PHASE I: Review existing data collected from operational environments, training exercises, and test and evaluation events. Apply alternative concepts for characterization of this data to allow synthetic displays to be rendered from the characterizations. Develop Measures of Performance (MOPs) for the quality of this synthetic data. Develop outline for training system exploitation for Phase II.

PHASE II: Develop a synthetic training application for 3 surrogate environments. Demonstrate similarity of synthetic display and control data to existing data from these environment. Develop and demonstrate a proof concept advanced tracking system against synthetic data and existing data.

PHASE III: Develop and extend the synthetic training system for use as a data generation and handling system feeding the tactical MFAS displays and controls. Develop and demonstrate the same capability in a commercial personal computer or a commercial gaming device such as an XBOX 360 or PS3. Develop and extend the tactical track before detect system to exploit existing active classification information. Deliver and support these products to the production programs and pipeline training community. Extend and adapt as needed the system and team trainer for application with the Battle Force Team Trainer (BFTT) or similar higher level training system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Many high fidelity simulation and training systems are in need of rapid and faithful synthesis of credible sensor data without the expense and time of a full physics model of phenomenology. Methods developed here could potential be of use across the training domain as well as the commercial video gaming industry

REFERENCES:
1. Active Sonar Modelling with Emphasis on Sonar Stimulators, D. McCammon McCammon Acoustical Consulting, Report for Defence Research and Development Canada

2. Statistical characterization of active sonar reverberation using extreme value theory, La Cour, B.R. Appl. Res. Labs., Univ. of Texas, Austin, TX, USA, : Oceanic Engineering, IEEE Journal of;

3. Choosing a non-Rayleigh reverberation model, D. A. Abraham, OCEANS '99 MTS/IEEE. Riding the Crest into the 21st Century

KEYWORDS: Acoustics; Active; ASW; Simulation; Training

N08-057 TITLE: Distributed Multi-Layer Data Fusion

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PEO IWS5E Undersea Warfare-Decision Support System

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

OBJECTIVE: Develop automated data fusion algorithms and associated visualization tools to associate common contacts from distributed sources at multiple layers.

DESCRIPTION: Current limitations for integrating ASW sensors, control systems, and weapons lead to force-on-force engagements that place Navy platforms at risk. Looking forward, the Navy plans to deploy a ‘network-centric’ ASW combat force that supplements conventional assets with unmanned vehicles, standoff weapons, and intelligent command and control (C2) systems. Sensors, weapons, and C2 devices will often reside on different platforms. Information from these distributed assets needs to be fused to provide a Common Tactical Picture that displays friendly and enemy force positions, mission plan overlays, and in-situ environmental measurements from multiple tactical and intelligence sources.

Recent advances in ASW data fusion have focused on platform-level organic sensor capability. In a distributed sensor/compute environment, data fusion can first be performed on an individual platform using its available input sensors; however, this process does not provide the full integration of available cross-platform information needed to generate an effective tactical picture. The aim would be evaluate candidate algorithms and data processing technologies that will extract the maximum information from multiple data fusion engines. Examples of a distributed environment might include (1) a single vessel whose sensor’s detections are fused on-board or (2) a tuned data fusion engine that is specifically designed to accept only a sub-set of the available sensors. These individual data fusion results need to be recombined or fused in an optimal fashion to provide the clearest, most uncluttered picture.

This topic seeks development of an operating concept and technology to provide Distributed Multilayer data fusion across multiple platforms. Automated Data fusion technology components are needed to de-clutter the common tactical picture to provide improved situational awareness, contact evaluation, and threat assessment. USW combat system performance metrics to be improved by Data Fusion technology transition will include reduced time to evaluate/classify new contacts, increased contact handling capacity, and reduced operator workload.

PHASE I: Research and design a distributed data fusion capability that utilizes best-available data fusion information processing techniques. Emphasis will be placed on implementation practicality. The design shall accept contact, track or object inputs, including kinematic and non-kinematic information, from distributed (or stand-alone) data fusion engines and fuse into a single output. Create simulated data to verify system performance. Use evaluated system performance to investigate optimal hierarchical schemes.

PHASE II: Implement the Phase I approach in a prototype software system. Evaluate system performance with data collected from at-sea trials.

PHASE III: Integrate the Phase II implementation into [appropriate Navy system]. Demonstrate and report on performance during at-sea trials.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology has direct application to commercial surveillance and security systems comprised of multiple controllable sensors to improve performance and reduce manpower cost. The Distributed Data Fusion technology could be used to implement security sensor systems to provide optimum surveillance coverage with fewest sensors.

REFERENCES: 1. Mathematical Techniques in Multisensor Data Fusion (Artech House Information Warfare Library) by D. Hall.

2. Handbook of Multisensor Data Fusion (Electrical Engineering & Applied Signal Processing) by David L. Hall (Editor), James Llinas (Editor)

3. Estimation with Applications to Tracking and Navigation: Algorithms and Software for Information Extraction (Wiley, 2001) by Y. Bar-Shalom, X. R. Li and T. Kirubarajan

4. Probabilistic Multi-Hypothesis Tracker: Addressing Some Basic Issues (Proceedings of the IEE – Radar, Sonar and Navigation) by Peter Willett with M. Efe and Y. Ruan.

KEYWORDS: Data Fusion, Automation, Distributed Processing

N08-058 TITLE: <u>Approaches to Directly Measure Heave, Pitch and Roll Onboard Navy Ships</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: DDG 1000 Program - ACAT ID

OBJECTIVE: Develop an innovative, ruggedized sensor that will directly measure the heave of a ship and can be integrated with other ship systems.

DESCRIPTION: The use of advanced hull-form designs, such as the wave-piercing tumblehome hull form for DDG 1000, necessitates the requirement for more accurate measurements of heave than are currently available through existing COTS solutions. This will allow the crew to ensure the hull form is operating within its respective safe operating envelope. Currently available solutions (Ref 2, for example) derive heave measurements by the double integration of heave acceleration, which is measured by a linear accelerometer internal to the ship. This method is tedious and time consuming and is prone to error. Specifically, small offset errors in acceleration can accumulate into large offsets in the reported heave such that the ship can appear to be rising out of the water or sinking deeper in the water with time when it is not. In order to ensure safe operation of these new, advanced hull form designs, crews need to know more about their local environment and ship response than can be currently derived from normal meteorological and oceanographic (METOC) weather reports and currently available heave sensor technology.

The Navy seeks innovative, alternative approaches capable of directly sensing heave. This data is a required input into weapon systems and will be used to ensure the hull form is operating within its respective safe operating envelope in large seas. Concepts proposed should have minimal weight impact and power demands with minimal requirement for shipboard maintenance. All concepts should be based on Open Architecture (OA) principles where practicable to ensure the solutions are able to integrate as needed with existing and future naval sea keeping, navigation and weapons systems. Sensor concepts should address wired solutions; however, extra consideration will be given to concepts capable of providing both a wired and a wireless connectivity. Concepts can be either interior or exterior to the ship. In all cases, the solution should be robust enough for a harsh marine environment and must not contribute to the Radar Cross Section of the ship.

PHASE I: Demonstrate the feasibility of a solution that can directly measure heave onboard Navy ships. Develop an initial concept 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 development for verifying performance and suitability.

PHASE II: Develop and demonstrate the prototypes(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. Develop a cost/benefit analysis and a Phase III testing and validation plan.

PHASE III: The small business will work with the Navy and commercial industry to transition a full-scale system for shipboard installation and testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology can cross over to both future commercial and military ship designs as well as back fit aboard legacy commercial and military systems to increase ship survivability or to counter obsolescence issues. Applications in addition to ship safety include heave compensation for offshore drilling and bathymetry.

REFERENCES:

1. http://www.geology.wmich.edu/Kominz/windwater.html

2. SMC heave motion sensor, http://www.shipmotion.se/products/S-108

KEYWORDS: Heave, Ship Motions, Seakeeping, Survivability, OA, Sensor

N08-059 TITLE: Versatile, Reusable, Lightweight, Deployable, Passive Sensing for Littorals

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS 480: Naval Coastal Warfare ACAT IV & Integrated Swimmer Defense ACAT IV

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

OBJECTIVE: To adapt state of the art acoustic or non-acoustic sensor technologies to develop a versatile, reusable, lightweight, deployable littoral passive sensing system to detect, classify, and track go-fast boats, small craft, commercial craft, swimmers, divers, and swimmer/diver propulsion or delivery vehicles.

DESCRIPTION: The Maritime Expeditionary Security Force (MESF), as a component of the Navy Expeditionary Combat Command (NECC), will fill current warfighting gaps by providing highly trained scaleable and sustainable security teams capable of defending mission critical assets in the near-coast environment. The US Navy Acquisition Program Office for Anti-Terrorism Afloat Programs (PMS 480) in support of MESF, has identified a sensor system is required for the Navy Expeditionary Security System (NESS) Combat System Program to track surface and subsurface contacts as well as the Integrated Swimmer Defense Program to augment detection and queuing of swimmers and divers. The goal of this topic is to develop a passive, littoral sensing system that can be used by both programs and is versatile enough to detect, classify, and track potential threats including swimmers and divers, swimmer propulsion or delivery vehicles, surface craft including go-fast boats, small craft, and commercial craft. In order to support the requirements of the NESS Combat System the sensor system must have a passive acoustic sensing capability. In addition, the sensor system may leverage additional sensors to enhance capability for swimmer detection.

All of these potential threats provide a variety of challenges in the often crowded and noisy littoral environment because of their speed or low observability and/or quietness. While a variety of passive sensors exist, currently none, standalone or in combination, is versatile enough to provide adequate altertment against this wide range of threats. The current sensors include sonobuoys, fiber optics, electro-optics and magnetics. Existing sensors also do not meet the operational needs of the MESF units, e.g. reusable, easily deployed/retrieved, rugged, long life, modular, etc.

The innovative challenge is to provide an integrated sensor package or system comprised of one or a combination of such sensors and their associated processing. The system may be comprised of an array(s) of individual components, such as buoys with one or more sensors, with each unit having the following goals. Each unit should be deployable and retrievable by one person from a 24 to 28 foot surface craft. Compactness and ease of deployment are very important. Each unit should be automated and have the power to operate for at least 72 hours with a modular/replaceable/rechargeable battery components. Each unit should be capable of communicating with a ground-based station either via cables (copper or fiber) or via standard RF communications links such as a US Navy sonobuoy radio or cell phone modem. In addition, the sensor should be able to report geo-location (e.g. GPS), be capable of anchoring at a fixed geo-location, and have a remote-controlled light/beacon for location and retrieval. The system sensor must be able to cover the range of depth settings from 10 feet to 300f feet If the system includes a flotation subsystem, it should be modular/inflatable/replaceable/rechargeable.

The system should have the capability to detect, classify, localize, and track: surface craft at a range of at least two miles; swimmers and divers at a range of at least 200 yards; and swimmer/diver propulsion vehicles at a range of at least 500 yards.

The passive acoustic sensing capability of the sensor should be able to resolve the direction of the source. The goal of the system is to be able to cover five linear miles of shoreline or be able to be deployed as discrete sensors that operate within line-of-sight of the shore station receiver. The system itself does not have to be difficult to detect, so its visibility is not an issue. Since multiple units would be procured, affordability is a key concern. The system is expected to complement radar and electro-optic/infrared (EO/IR) sensing systems; however, such systems are not a part of this topic.

The sensor packages will be placed at remote locations in the field and will be required to be unclassified. It is unforeseeable that the product as a result of Phase II will be classified or access to classified material will be required.

PHASE I: Develop a specific sensing system design including hardware and software. Identify the high risk technical challenges and provide breadboard evidence of the ability to meet them.

PHASE II: Produce a prototype unit and test it in a real-life environment against a full range of targets. Finalize the concept design and make recommendations for Phase III production-oriented designs.

PHASE III: Produce and conduct integrated testing of close-to-production model system. Transition the technology to a PMS480 acquisition program. SECRET clearance may be required for Phase III.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In the ever increasingly complex littoral/harbor environment acoustic sensors will become a vital addition to detect surface and sub-surface contacts and help correlate and segregate contact tracks from other maritime sensors. Much of the technology and its integration, as developed under this effort, will be applicable to homeland defense, law enforcement, and private-security systems.

REFERENCES:

1. Approved Navy Training System Plan for the Navy Consolidated Sonobuoy, Document Number N88-NTSP-A-50-8910B/A (Available at: www.fas.org/man/dod-101/sys/ship/weaps/docs/ntsp-Sonobuoy.pdf)

2. Sonobuoy Technical Manual, NAVAIR 28-SSQ-500-1 (can be obtained via: http://www.tourohio.com/fleetaw/BibResources.html)

3. Ultra Electronics Sonobuoy radio data sheet: (Available at: http://www.flightline-systems.com/pdf/wide_band_brochure_april_2007.pdf)
Basic Introduction to Air ASW Sensors Document, NAVAIR 28-SSQ-500-4 (Available at: www.fas.org/man/dod-101/sys/ship/weaps/docs/ntsp-Sonobuoy.pdf)

4. Feature based passive acoustic detection of underwater threats. Proc. of SPIE Vol. 6204, 620408, (2006) (Available at: http://www.stevens.edu/engineering/ceoe/fileadmin/ceoe/pdf/rustam_publications/DiverDetectionSPIE.pdf)

5. Assessing the Risk in U.S. Ports, Marine Technology Reporter, September 2005 (Available at: http://www.mtronline.net/MTIssues/mt200509o2.pdf)
Antiterrorist Sea Borders and Harbors Protection (Available at: www.haicorp.com/BDD/SOBCAH/presentations/download/15-1520-Henryk%20Chodkiewicz.ppt)

6. Passive Swimmer Detection (Available at: http://www.nrl.navy.mil/content.php?P=04REVIEW97)

KEYWORDS: Acoustic; Sonobuoy; Sensor; Hydrophone; DIFAR; Undersea

N08-060 TITLE: Improved Magnetic Shielding for Electronics

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Radio Frequency Antennas & Topside Program Manager, code PMW 180-D4/E2

OBJECTIVE: Demonstrate an innovative, compact magnetic shield which provides a 1000 fold reduction in feild strength in the interior of the shield due to an externally applied magnetic field. Electronics that must run substantial numbers of leads from the inside to the outside are to be placed in the interior.

DESCRIPTION: Superconducting digital electronics operate by manipulating magnetic flux and must therefore be supplied with a magnetic field environment. This requires cancellation of the field associated with the earth and whatever platform the electronics is located on. Magnetic non-volatile memory (MRAM) can save substantial power but requires protection from intense external fields to operate properly. Hardening methods for conventional electronics to protect from damage from electromagnetic pulses may also involve such shielding. Moreover, satellites may one day use a strong artificial dipole magnetic field to steer ions away from the interior electronics and any human crew. All these applications are more likely if the magnetic shields are compact and light weight. Such shields could make the current >3 year space flight to Mars survivable by people. In current practice, if an electronics assembly is mounted on a disc x inches in diameter, the magnetic shield must extend at least 3x in the direction perpendicular to the disc to achieve the needed shielding factor. Such a long cylinder adds substantially to the volume and weight of the entire system and forces the leads to run large distances to escape the shield. Shields that mimic the form factor of volume they are protecting-- here short and squat to match the disc -- are desirable.

PHASE I: Develop a design concept and prove, at least by simulation, that a shield of the required characteristics can be constructed.

PHASE II: Conduct at least 2 cycles of component design/fabrication/ and test that demonstrates that the design concept is valid, can be integrated with a circuit board with 100 leads, and optimizes the choices of materials and geometry. It is desirable to demonstrate such shields' functionality in both the 1G and 1T applied field domains.

PHASE III: Insert such shields into wide band, superconducting electronics and/or military satellites.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Superconducting electronics has already demonstrated direct reception of SatCom signals. The associated elimination of analog down conversion hardware corresponds to a cost savings of >40% on the system cost, so it is expected this innovation will be picked up by the commercial SatCom market once it is demonstrated by the military. MRAM has potential applications in providing instant-on electronics. The new concept expressed here for how to protect satellites from ionizing radiation will also apply to commercial satellites. Moreover, over half the cost of medical magnetic imaging systems using SQUIDs comes from the need to install the system in a magnetically shielded room. If those shields could be dramatically shrunk in size, their weight and cost would also fall.

REFERENCES:

1. http://www.magnetic-shield.com/faq/index.html

2. http://www.mushield.com/

3. http://www.islandone.org/Settlements/MagShield.html

KEYWORDS: magnetic shielding; 3D EM modeling; high permittivity materials; magnetic sensors

N08-061 TITLE: Materials and Device Modeling to Reduce Cost and Time to Exploit Relaxor Piezoelectric Single Crystals in Navy SONAR Transducers

TECHNOLOGY AREAS: Materials/Processes, Sensors, Weapons

ACQUISITION PROGRAM: PMS 415 Undersea Defensive Warfare Systems

OBJECTIVE: Provide a transducer design methodology to reduce the cost and time for inserting into Navy systems innovative transducers based on relaxor piezoelectric single crystals.

DESCRIPTION: Near the onset of 1997 came the discovery that single crystals of certain relaxor ferroelectric (lead magnesium niobate – lead titanate, and lead zinc niobate – lead titanate) materials exhibit extraordinary piezoelectric properties, namely, strains exceeding 1%, and electromechanical coupling exceeding 90% (compared to 0.1% and 70-75 %, respectively, in state-of-the-art piezoceramics)(References 1 and 2). Concerted efforts to grow these materials in a variety of forms now yield materials in quantities, and at a price, suitable for devices. Three domestic manufacturing firms now supply these materials as well as several more overseas; initial devices have been developed and commercialized (References 3, 4 and 5). This topic aims to reduce the cost and time needed to exploit these enhanced electromechanical properties in practical Navy devices. In broad brush, the piezocrystals' impact is clear, for example in acoustic transducers, the high coupling leads to higher bandwidth (doubled to two octaves or more), while the high strain leads to higher source levels (more than an order of magnitude increase); actuators employing these materials are more efficient and compact; and sensors are smaller and more sensitive. To effectively exploit these "break-through" materials, the transducer design engineer requires a substantial body of materials properties (Reference 6) (dielectric, elastic and piezoelectric tensors), both linear and non-linear responses along with their loss tangents, over a broad range of operating conditions (temperature, electric field and mechanical stress). Moreover, the device modeling must be validated by making exemplar devices and comparing the predictions with detailed measurements over a substantial range of naval operating conditions. A diverse team—materials producers and property measurers, plus device designers, builders and evaluators—must be assembled to carry out this endeavor drawn from industry, academe and government labs (which will be funded from non-SBIR sources beyond the proposed SBIR effort). While a substantial undertaking, the payback will be even more substantial in reducing the cost and time needed to take full advantage of the piezocrystal technology in Navy SONAR systems. This SBIR effort will yield dramatic reductions in the number of design-built-test iterations needed to make an optimal transducer in the short term; moreover, further cost/time savings will emerge in the long term as fielded systems are repaired and upgraded.

PHASE I: Measure selected materials properties (supplementing the published literature) sufficient to produce specific performance predictions for at least one candidate Navy SONAR transducer; build and evaluate an exemplar device. It would be a big plus if the exemplar represents a real Navy SONAR problem.

PHASE II: Expand the properties data base to encompass enough properties to model a broad selection of transducer designs (Reference 6); build and evaluate, over a large range of operating conditions, two or more fundamentally different classes of transducer. It would be a big plus if these demonstration efforts were embedded within a real Navy SONAR development program.

PHASE III: Expand the property data base to include new materials that emerge as the materials community produces compositionally modified piezocrystals to tune specific materials properties to specific device needs. Increase the span of device design to encompass the full range of SONAR transducers. Cement linkages with materials suppliers, transducer manufacturers and system designers by active participation in Navy SONAR systems development.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Once established, this data base and design methodology can be extended readily to a broad range of piezoelectric devices, in the defense sector from Navy SONAR, through Army rotorblade control, to Air Force airfoil shape control—all have analogs in the civilian sector. Other applications will have their primary impact in the civilian arena, including medical ultrasonics, active machine tool control, and vibration suppression in HVAC systems.

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], 1804-1811 (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. Harold C. Robinson, James M. Powers, and Mark B. Moffett, "Development of broadband, high power single crystal transducers," Proceedings of the 2006 SPIE International Symposium on Smart Structures and Materials, in press (2006).

6. Charles H. Sherman and John L. Butler, “Transducers and Arrays for Underwater Sound,” Springer, 2007.

KEYWORDS: Electromechanical Sensors and Actuators; SONAR Transducers; SONAR System Design; Piezoelectrics; Lead Magnesium Niobate–Lead Titanate; Lead Zinc Niobate–Lead Titanate

N08-062 TITLE: Simulation and Visualization for Perceptual Skills Screening, Training and Operations

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Program Manager Marine Expeditionary Squad (PM MERS)

OBJECTIVE: To develop perceptual screening, training and operational tools and metrics to assist Marines, Seals, Allies, and Coalition Forces in USMC – Terrorism operations.

DESCRIPTION: Today’s warfighter is challenged by an opposition that blends into the operational environment while unleashing lethal technology, such as improvised explosive devices (IEDs), in conjunction with insurgent spotters and snipers. These insurgent forces are inflicting most of our causality counts through the utilization of IEDs by concealing these objects and themselves in diversified terrain environments, often in line of site of nearby friendly targets. Gaming, video simulation and high resolution photographic imagery have taken the warfighter into more realistic training, reducing casualties and improving mission success. While today’s training has improved observational abilities, better anomaly detection including during changes in weather and ambient light intensity, would mitigate insurgent efforts to correct and enhance their tactics.

To take perceptual visual training to the next level, the warfighter should possess honed visual skills to help detect insurgents’ and IEDs during immersion in hostile geographical environments. The warfighter should be able to detect changes that signal insurgent threats during changing weather conditions and risk conditions, and at any time of the day. Merging technology, instructional/training tools and human systems is necessary to effectively/efficiently enhance warfighter capabilities to Observe, Orient, Decide, and Act during complex, stressful combat conditions. These capabilities will increase situational awareness in live fire and force on force training evolutions by relying not only on sophisticated devices to distill complex environmental vulnerabilities, but also by the possession of improved warfighter cognitive and visual discrimination skills to discover and expose risks. Warfighter capacity to recognize relevant and potentially dangerous physical and local demographic changes in patrol areas requires keen vigilance and change detection skills.

PHASE I: Establish training tool functionality requirements, operating specifications, interface and simulation design for the unaided (sans digital devices) warfighter. Develop a roadmap to a prototype in which situational awareness is favorably impacted in changing scenarios, including changing light and weather conditions. Create a simulation tool framework for screening and testing that requires only minimal instructor intervention and uses existing training equipment. Develop metrics to identify individuals with high visual change detection acumen. Other metrics will be used to define the individual's baseline for both anomaly and change detection in visually noisy environments using optimized scanning techniques.

PHASE II: Develop individual training modules using the operational metric assessment, baseline performance level identification, and scenario design and validation study established in Phase I. These modules will include temporal observation, change and anomaly detection techniques and enhanced visual skills for the detection of IED devices, and insurgent snipers and spotters in urban and other terrain. These modules should include scene management accounting for changing environments during varying levels of human stress and fatigue. This phase should also provide acquisition of data to be utilized for providing the warfighter with enhanced visualization tools by transferring accumulated data to scalable forms for mobile devices. These tools will optimize human system integration by enhancing and prioritizing information processing and decision making and providing improved team collaboration and communication for distributed operations.

PHASE III: This phase will consist of the development of a scalable interface design component for embedding into devices that augment warfighter observational abilities. These devices will combine assessment/screening and training knowledge and technologies from Phases I and II, establishing a framework for the integration of Augmented Cognition science. This interface will be scalable across complex combat environments and improve operational cognitive performance with no additional weight penalties for the warfighter by incorporating neurophysiological and biometric monitoring such as optometric sensors embedded into shoulder mounted optical sighting systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The applicability of new visualization tools and training for government, defense and industrial entities are at its earliest stages. With the increasing homeland security threats, and with ongoing surveillance required by operators for C4ISR, UxVs, transportation sectors, industrial and corporate complexes, and financial risk management among other operations, the human system integration will continue to evolve along with the complexity of training and the increasing hardware and software capabilities. At the end of each Phase of this SBIR and for the accumulation of all Phases, derivative products and services, should give rise to a myriad of functional technologies.

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KEYWORDS: Perceptual visual skills, visual scanning, training, simulation, augmented cognition, anomaly detection

N08-063 TITLE: User Toolkit for Reducing Cost and Time in the Design of SONAR Systems Using Relaxor Piezoelectric Single Crystals

TECHNOLOGY AREAS: Materials/Processes, Sensors, Weapons

ACQUISITION PROGRAM: PMS 415 Undersea Defensive Warfare Systems

OBJECTIVE: Provide a transducer design methodology to reduce the cost and time for inserting into Navy systems innovative transducers based on relaxor piezoelectric single crystals.

DESCRIPTION: Near the onset of 1997 came the discovery that single crystals of certain relaxor ferroelectric (lead magnesium niobate – lead titanate, and lead zinc niobate – lead titanate) materials exhibit extraordinary piezoelectric properties, namely, strains exceeding 1%, and electromechanical coupling exceeding 90% (compared to 0.1% and 70-75 %, respectively, in state-of-the-art piezoceramics)(References 1 and 2). Concerted efforts to grow these materials in a variety of forms now yield materials in quantities, and at a price, suitable for devices. Three domestic manufacturing firms now supply these materials as well as several more overseas; initial devices have been developed and commercialized (References 3, 4 and 5). This topic aims to reduce the cost and time needed to exploit these enhanced electromechanical properties in practical Navy devices. In broad brush, the piezocrystals' impact is clear. For example in acoustic transducers, the high coupling leads to higher bandwidth (doubled to two octaves or more), while the high strain leads to higher source levels (more than an order of magnitude increase); actuators employing these materials are more efficient and compact; and sensors are smaller and more sensitive. Yet a system designer wanting to use the relaxor piezocrystals needs a grasp of the specific gains and trade-offs amongst them; this is usually achieved by looking at transducers already "on the shelf." Sadly, the relaxor piezocrystal transducer "shelf" is, at this time, sparsely populated. This topic will populate that shelf by providing a "user toolkit" (reference 6) that will allow the system designer to explore options and determine the benefits with reasonable fidelity. This exploration allows the system designer to home in on preliminary system concept that effectively exploits the relaxor piezocrystals. This "toolkit" is likely to consist of separate modules for each class of transducers (Reference 7) that will allow the system designer to vary a number of device parameters and obtain acoustic performance (bandwidth, source level, sensitivity, etc.) and other system characteristics (size, weight, electrical requirements, etc.). This "trial and error" exploration will reduce time and cost in arriving at a good first cut. Next follows a fully detailed, professionally executed transducer design and the conventional build-test-modify design cycle.

PHASE I: Devise a user toolkit module that allows a system designer to explore, with reasonable fidelity, a single class of transducer. Demonstrate its utility with a concrete design example---preferably one chosen from a real Navy SONAR design problem. No hardware is required.

PHASE II: Expand the user toolkit by constructing additional modules to encompass multiple classic piezoelectric transducer designs. Complete at least one real design problem from concept development through the end of one design-build-test-modify cycle. Only transducer hardware, not a full system, need be built.

PHASE III: Expand the span of design modules to encompass the full range of SONAR transducers. Cement linkages with materials suppliers, transducer manufacturers and system designers by active participation in Navy SONAR systems development.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Once established, this design methodology can be extended readily to include modules suitable for a broad range of piezoelectric devices, in the defense sector from Navy SONAR, through Army rotorblade control, to Air Force airfoil shape control—all have analogs in the civilian sector. Other applications will have their primary impact in the civilian arena, including medical ultrasonics, active machine tool control, and vibration suppression in HVAC systems.

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KEYWORDS: Electromechanical Sensors and Actuators; SONAR Transducers; SONAR System Design; Piezoelectrics; Lead Magnesium Niobate–Lead Titanate; Lead Zinc Niobate–Lead Titanate

N08-064 TITLE: Advanced Optics Zoom Hyperspectral Sensor

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PM Intel MCSC ACAT IV

OBJECTIVE: This topic will investigate the integration of advanced optics lens design with a hyperspectral sensor. Advanced processing software to enhance the capabilities of hyperspectral sensors for airborne Intelligence, Surveillance, and Reconnaissance (ISR) missions in cluttered environments will also be investigated. The desired end system will be a hyperspectral sensor with zoom capability that can process and track targets of interest near real time with a form factor that can be housed as an Unmanned Air Vehicle (UAV) payload.

DESCRIPTION: Current UAV sensors are limited in field of view and ability to zoom in on an object or potential threat due to the size and weight constraints levied on the payload. Advanced optic lens designs such as compound zoom and folded optical lens allow for a very compact form factor but are able to provide high magnification with excellent image quality. . The compatibility of this advanced optics with hyperspectral sensors at both long and short focal lengths and the ability to eliminate unwanted scene data through zoom operations will be assessed through analysis and hardware demonstrations. Alternative lens materials such as ceramic lenses which have higher index of refraction and lower weight per lens should be investigated Advanced processing software for optimal hyperspectral channel selection as a function of background and target spectra and for optimizing search routines will be assessed through desktop processing and analysis. Algorithms for automated zoom search routines that can vary with altitude and target parameters are also desired resulting in improvements to tracking reliability and functionality.

PHASE I: Conduct research and experiments to determine the advantages, limitations and feasibility of integrating and operating a hyperspectral sensor with advanced optic lens designs. Research should address visible through long wave infrared systems. Off the shelf visible band advanced optics lens and visible band hyperspectral sensors are to be interfaced and operated in controlled conditions to collect highly registered multi-focal length image data to support the analysis effort. Develop hyperspectral imagery processing algorithms that take advantage of eliminating unwanted scene data through the zoom operations to track targets of interest. Develop algorithms for automating zoom search routines. A report and demonstration of analytical and experimental results shall be provided.

PHASE II: Develop a proof of concept prototype for the Phase I capability that includes a visible or shortwave infrared band advanced optics zoom lens integrated with a visible or shortwave infrared band hyperspectral sensor, ground-based pointing system and data storage devices and displays. The system will be operated in a laboratory environment. Slew and zoom control software will be included to investigate automated search routines and user interfaces. Targets of known spectral will be imaged and geo-registered and analyzed to quantify clutter rejection benefits of zoom operations. The effectiveness of imagery processing algorithms in improving probability of detection and false alarm rate will be assessed. Develop a conceptual design for an airborne version that reflects requirements and features identified through the laboratory investigations and analysis. Demonstrate the proof of concept system. Deliver a final report documenting the performance, capabilities and designs.

PHASE III: Demonstrate that the advanced optics zoom hyperspectral system developed under Phases I and II can be applied to ground-based and airborne ISR missions and perform modifications as needed for initial adoption. Integrate the developed optics into the Marine Corps' Tactical Concealed Video System program's sensor suite. The prototype system will be operated in a mountain top scenario that is representative of ground-based and airborne ISR missions involving imaging in urban clutter and rural, desert terrain. Additionally the Phase II system design will be implemented in a prototype that addresses the needs of existing airborne ISR programs such as the Tier 2 UAV. Testing of the prototype will include airborne evaluations in a standalone configuration.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Topic has direct relevance to ground based force/area protection applications for the other Services, as well as for counter-terrorism surveillance in support of U.S. Navy ships in domestic and foreign ports. A thermal version of this system has direct application to Department of Homeland Security needs including stand-off chemical gas cloud detection. The airborne system is of value to commercial private sector airborne remote sensing companies engaged in environmental monitoring, agricultural assessments and exploration for natural resources due to the system’s compact form factor, flexible flight profiles and precision identification and change/anomaly detection.

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KEYWORDS: Hyperspectral, compound zoom lens, spectral geographic information system, sub-pixel detection, geospatial database, adaptive foreground background analysis.

N08-065 TITLE: Advanced Characterization Techniques that Improve Durability of Fracture Critical DoD Components

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: F135 Joint Strike Fighter Program.

OBJECTIVE: Develop and apply advanced fracture mechanics and thermal-mechanical fatigue (TMF) characterization tools and techniques addressing the variability and mission simulation issues below. This would result in increased fidelity assessments and improved durability management of fracture critical DoD components

DESCRIPTION: Many DoD systems employ fracture critical and/or retirement for cause methodologies for asset deployment, operation and management. They are a key element in the design and certification of turbine engines including the F100, F119, and F135. A key element in this approach is the characterization of structural materials and development of life prediction methodologies and then application of these to component design, validation and assessment. In structural metallic systems fracture mechanics approaches provide the foundation for this assessment, however variability and uncertainty are introduced due to the presence of many factors including residual stresses, material variability, complex damage environments, etc. These factors can influence life assessments by factors of four or more. In addition, mission cycles for hot section components such as turbine airfoils are quite complex and test methodologies such as TMF have not been sufficiently standardized and matured to provide repeatable results across a broad range of facilities and environments. This challenge is exacerbated by the complex loading profiles these components experience. This can lead to loss of durability in key hot section components. The goal of this topic is to develop, demonstrate and validate advanced fatigue and fracture characterization techniques and analytical tools resulting in refined assessments of turbine durability.

PHASE I: Demonstrate in a laboratory environment the feasibility of the test techniques through demonstration of reduced variability and accurate capture of complex cycle damage mechanisms. Develop a business case and development program plan that would support further investment of this approach.

PHASE II: Clearly develop and demonstrate a prototype test system including software, hardware and associated analytical tools to provide more robust characterization of fracture critical DoD components. Validate the performance of the system at several industrial test facilities.

PHASE III: Incorporate improvements and modifications based on the prototype system validated in Phase II into a commercially available product.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Hot section material durability and fracture critical designs play key roles in commercial turbine engine systems. The tools and techniques should be directly applicable to commercial applications.

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KEYWORDS: TMF, fracture mechanics, mechanical behavior, thermo-mechanical fatigue, durability, life prediction modeling

N08-066 TITLE: Advanced Diagnostic Techniques for a Naval Electromagnetic Launcher

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: Office of Naval Research Code 352: Railgun Innovative Naval Prototype (INP)

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

OBJECTIVE: Develop diagnostic techniques for measuring field quantities in a railgun during launch.

DESCRIPTION: The US Navy is pursuing the development of an electromagnetic launcher (also known as a railgun) 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).

The extreme electromagnetic field, current, temperatures and stresses in the rails and armature create a harsh environment within the launcher. This severe environment makes direct measurements of these field quantities during firing difficult with conventional diagnostics. It is desirable that the instrumentation survive repeated exposure to this environment to allow for health monitoring.

In order to create M&S tools to aid in design and predict performance, several different field quantities need to me measured. This effort would develop diagnostics to measure one or more quantities such as temperature, strain, magnetic field, electric field, and current density in the armature and rails. Other measurements of interest are spectroscopy and multi-axis acceleration of the armature. Fields within the rails evolve over timescales of approximately 10 microseconds, and so a frequency response of at least 1MHz is desired. Fields within the armature evolve over a much longer timescale, approximately 1 millisecond, and so a frequency response of 10 kHz for armature diagnostics may be adequate. While small access holes in the rails and armatures may be allowable, it is not desired.

Two classes of diagnostics are envisioned. First, diagnostics suitable for laboratory use and second, diagnostics that can be used as a health monitoring tool. It is hoped that this will allow a tradeoff between performance and robustness. The awardee is encouraged to explore innovative transducer technologies that are insensitive to EMI especially, but are also immune to high temperatures, strains, and temperature and strain rates.

PHASE I: Investigate transducer technologies that will provide one, some, or all the necessary data to characterize the behavior of the launcher. Conduct bench-top tests of promising technologies that demonstrate the proposed transducer(s) will survive static magnetic fields of 10 Tesla and temperatures of 300 deg. C. The outcome should be two transducers that show promise for further study.

PHASE II: Design and fabricate prototype transducers, signal cable, and data acquisition and test in a transient environment similar to the railgun. Magnetic fields should be 30 Tesla and temperatures of 300 deg. C. The outcome should be at least one transducer that show promise for testing in a railgun. Also in phase II, a design study should be performed to show the robustness of the concept against all environments expected in the railgun, particularly strain and strain rate. Perform a trade study to show the tradeoff between a diagnostics system suitable for laboratory use vs. one suitable for shipboard installation for health monitoring.

PHASE III: Incorporate the instrumentation into an existing launcher. Perform measurements in an EM gun during firing. The EM gun may be available as a gov't furnished test asset or as a teaming relationship with other EM gun test sites. Potential test sites include various scale railguns operated by Universities and Defense contractors. If successful, work with Navy contractors to incorporate the instrumentation into advanced launcher concepts being developed by industry. If necessary, modify design to allow for use in an at-sea environment to enable 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.

The results of testing may be classified. The Phase III product may become classified.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The measurement techniques that are developed could have application for large scale, high power electric motors for electric ships or UAV's, switch diagnostics, and high current electric transportation (cars, trains, etc.). The measurement techniques developed may also be used in the automotive and aviation industry for safety monitoring and non-destructive evaluation as well as for any structural diagnostic requiring high frequency response such as magneforming operations.

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KEYWORDS: Electromagnetic launcher; railgun; measurement; diagnostic; stress; temperature

N08-067 TITLE: Live Fire Virtual Sniper/Counter Sniper Training System

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Brad Valdyke, PM, Training Systems (PM TRASYS), MARCORPSYSCOM, 407-380-4914

OBJECTIVE: Develop a modular, containerized counter-sniper virtual environment that enables both live and simulated infantry weapons systems to interact during training in the virtual environment. The technology product is intended for equipping live training ranges and home station training.

DESCRIPTION: At present, Marines and Seals have the capability to train marksmanship and shoot/don't shoot skills in fully simulated virtual environments such as Instrumented Simulated Marksmanship Trainer Enhanced (ISMT-E). Although the ISMT-E system is useful as a tool for initial and sustainment marksmanship training, it lacks the flexibility, advanced graphics, and robust scenarios required to provide realistic training in dynamic situations. Additionally, urban live fire training exercises are currently conducted in a "Shoot House" that does not incorporate advanced technology solutions to augment the training. Neither ISMT-E training, nor "Shoot House" training provide the immersive, robust and seamless training that is required to prepare Marines and Seals for urban combat. Therefore, the desired virutal environment must provide high levels of immersion and seamless training using actual and simulated weapons. The system should use or develop Government Off The Shelf (GOTS) protocols and GOTS or Open Source software that integrates live and simulated fire of organic infantry weapons. Additionally, to maximize transitionability of this effort, maximum use of ISO containers that have become the defacto standard building in many training ranges should be considered for housing the various modules of the system. Finally, robust representation of virtual Opposition Forces (OPFOR) and scenarios that can be readily modified by Marines is highly desirable.

PHASE I: Research the current virtual environments and technologies that have the capability to track weapons as they interact with virtual environments. Based upon these results, design an architecture for the development of the modular, containerized virtual environment system.

PHASE II: Based upon the architecture specified in Phase I, develop a prototype of the modular, containerized counter-sniper virtual environment training system. The prototype should incorporate the capability to interact with a limited set of actual and simulated weapons. Additionally, a limited set of scenarios should be developed.

PHASE III: Phase III will result in fully functional, validated system that can be operated, maintained, and expanded by infantry marines. The system should have the capability to be installed at training ranges for interacting with live weapons and at the home station training site for interacting with simulated weapons to fully provide seamless training.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology will be directly applicable to law enforcement as they train for urban patrolling. Additionally, sports equipment manufacturers will benefit from the developed technologies as a test environment for future sports equipment.

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December 10, 2001) http://www.neguard.com/TAG/MarinesTurnedSoldiers.htm)

KEYWORDS: Modeling, Simulation, Human Performance, Human Factors, Ergonomics, Training

N08-068 TITLE: Reference Template Generation for Cross-Correlation Based Receivers

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Radio Frequency Antennas & Topside Program Manager, code PMW 180-D4/E2

OBJECTIVE: Develop methods usable in real-time to generate multi-bit reference templates for initially unidentified signals to allow them to be more accurately identified and searched for in subsequent signals.

DESCRIPTION: Cross-correlation is an especially effective method for doing digital matched filtering in wideband systems in complex signal environments. Doing this filtering by using matching of a table of ~20 parameters that describe the signals' external characteristics is becoming increasingly ineffective as frequency and waveform agile transmitters become the norm. More information is required. Fortunately, the maturation of high speed digital technologies allows this correlation process to begin while the signal is still represented at the carrier frequency and doing so harvests additional processing gain not available if the signals are reduced to the base-band information before beginning. Because correlation involves mixing, it is very desirable that the reference templates contain little noise, be it of environmental, system, or quantization origin. Thus the templates should contain more bits than the quantized representation of the current signal. Moreover, in the most desirable wide band, software defined systems, the reference template must potentially have the same band width as the widest band signal expected, tho more normally it will be narrower. In principle, templates for known signals may be stored in a large, rapidly read-out memory, waiting for recall and utilization. However, in practice, channel distortions such as multi-path effects may alter the details of the perfect template. Moreover, not all signals are known a priori and for uncooperative sources, the latency involved in deciding which templates to invoke may be unacceptable in real-time systems. Thus it is desirable to develop a technique for defining new templates as the signals are first encountered, storing them in an indexed fashion, and making them available to functional cross-correlators in both the current and future moments.

PHASE I: Analyze cooperative communications signals in the HF, UHF, S, X, and Ka bands and determine the range of template lengths and word widths that it is desirable to implement. Design a hardware realization of a system to create the templates and calculate the cross-correlation of these templates with an ADC representation of a complex total waveform composed of more than 10 in-band signals having different modulation and arising from incoherent transmitters. The ideal hardware should not be limited to operation in a single band or for a specific modulation class, but instead be generic. Proposals should indicate the kinds of digital technologies that would be considered for the receiver system.

PHASE II: Implement and demonstrate the designed hardware chain operating on two or more simultaneous cooperative communications signals and yielding an increased effective signal to noise ratio of the system. Develop concepts for the modifications required to address non-cooperative signal sources.

PHASE III: Such units will find application in both communications and ISR systems. In particular, comms systems will be able to trade off lower bit error rate, lower transmit power, and smaller receive arrays.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The same hardware could be used in settings where the signal is badly corrupted by multipath such as wireless and UWB comms in urban environments. Indeed, by making the template longer and more accurate, the functionality of few tap rake receivers may be exceeded, simplifying the system architecture.

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KEYWORDS: cross-correlation; matched filtering; digital reception; templates; digital signal processing; high speed processing

N08-069 TITLE: Real-Time Effluent Quality Sensor Technologies for Organics and Bacteria in Shipboard Wastewater Treatment Systems

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: NAVSEA (SEA 05P25); Ship R&D Program

OBJECTIVE: Develop sensors to measure or provide accurate predictive capabilities for five-day Biochemical Oxygen Demand (BOD5) and/or Fecal Coliform (FC) values of effluent from blackwater and graywater marine sanitation devices (MSDs) in real time.

DESCRIPTION: The need for shipboard wastewater treatment for military vessels is driven by existing and anticipated future regulations. Without treatment, military operations in littoral waters will be restricted by the limited holding volume of the ship. In order to meet regulations, the Navy is beginning to install U.S. Coast Guard (USCG) certified Type II marine sanitation devices (MSDs) onboard its vessels, such as US Navy future carriers and littoral combat ships (CVN 77, CVN 78, LCS 1 and LCS 2), and Military Sealift Command vessels (T-AKR 303, T-AKE 1 and T-AKE 2).

Currently, the performance of MSDs cannot be confirmed by the ship on a real-time basis while underway or in-port. Specifically, the regulations set effluent discharge values for BOD5 and FC levels. The standard laboratory methods to measure BOD5 and FC require a minimum 5 days and 24 hours, respectively, to complete. The delayed reporting of effluent quality prevents the crew from reacting to the results and adjusting the treatment system operation and maintenance to prevent discharge of insufficiently treated wastewater.

Sensors are desired that are capable of quantitatively and accurately measuring or predict BOD5 and FC in real time (preferably on the order of minutes) or within a few hours. Regulations require values of BOD5 and FC in shipboard MSD effluent of 25 to 50 milligrams per liter (mg/L) or less, and 20 to 250 colony forming units per 100 milliliters (cfu/100ml), respectively. Minimum detectable limits required are less than 5 mg/L for BOD5 and 3 cfu/100ml for FC. Other considerations for eventual sensor design and package include the following attributes: robust, simple, compact, fully automated, low cost/maintenance and preferably not requiring any consumables.

PHASE I:
• Perform laboratory studies to confirm the feasibility of proposed technologies and approaches to accurately measure or predict BOD5 and FC at realistic levels with representative effluent samples.
• Obtain data that can be used to model/propose a sensor package design for Phase II consideration that addresses the attributes discussed above.

PHASE II:
• Further refine the approach to measure minimum and maximum BOD5 and FC levels and obtain maximum precision and accuracy.
• Design prototype sensors and construct sensors for testing both in-house and at Navy facilities.
• Work with the Navy to test and evaluate the sensors in a laboratory with simulated MSD effluent and measure performance (accuracy, precision, time required to measure parameters).
• Work with the Navy to test and evaluate the sensors shipboard with MSD effluent and measure performance (accuracy, precision, time required to measure parameters), durability, ease of use and maintenance.
• Any testing and evaluation costs at Naval facilities will be paid for by non-SBIR sources and provided directly to the facility

PHASE III:
• The final sensors will transition to the Naval Sea Systems Command for implementation and further advanced development and integration. Based on the evaluations completed under Phase II, the contractor will make further modifications, improvements, and optimizations to the sensors, as required, and conduct full scale shipboard evaluations on Navy/marine vessels with operating MSDs in conjunction with the Navy customer.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of sensors to measure effluent BOD5 and FC in real time would be of significant interest to the commercial and military industries. For example, the cruise ship industry is currently under very strict regulations in specific ports of states, such as Alaska and California. Quick detection of high effluent concentrations of BOD5 and FC would help them minimize the discharge and rectify the issue to reduce risk to the environment and reduce financial risk due to fines or business loss. As with the Navy, some military vessels have MSDs installed, such as US Army tugboats (LT 800 series), and USCG buoy tenders (WLB214, WLB216).

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KEYWORDS: biochemical oxygen demand; fecal coliform; blackwater; wastewater; sensors; marine sanitation device

N08-070 TITLE: Collaborative Technology Testbed for Quick Response Teams

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: Naval Special Warfare Command (NAVSPECWARCOM)

OBJECTIVE: Develop a collaboration technology proof of concept, prototype demonstration and validation testbed for team decision making research tools designed for use in quick response scenarios for special operations teams with a focus on teams dealing with coalition operations and composed of both joint and multicultural team members.

DESCRIPTION: Collaboration tools have proliferated across both commercial and military enterprises with the intuitive assumption that improved visualization and more rapid transfer and larger volumes of data to more participants can only help decision making. Further, many commercial and research collaboration tool prototypes have been employed by operational forces with no hard metrics regarding improved team collaborative proficiency or team performance. A tested is an essential component for validation of claims of improved team performance. Current research has developed a set of cognitive principles that are often ignored or overlooked in the rush to employ new IT technology and agent support without ensuring that the basic knowledge transfer required for actionable decisions has been effected. The proposed testbed would investigate these principles to include: team knowledge building, knowledge interoperability, state of situational awareness and metrics for team consensus development in addition to technical issues such as speed of decision cycle, required bandwidth and data source connectivity.

PHASE I: Develop a preliminary design of a collaboration testbed for empirical evaluation of collaborative problem solving both for strategic and tactical decision-making with a focus on Special Operations Forces (SOF). The testbed should be designed to capture the cognitive processes used during collaborative team problem solving in quick response scenarios such as Non-Combatant Evacuation, Intelligence Analysis and Mission Planning scenarios. A representative scenario description will be made available in the form of a Naval Air (NAVAIR) Collaborative Operational and Research Environment (CORE) architecture.

PHASE II: Develop and demonstrate the collaboration testbed for supporting empirical assessment of collaborative problem solving. Conduct one or more empirical experiments to validate the testbed using representative mission scenario vignettes and quantifiably demonstrate its benefit in improving team collaborative problem solving. Results from the empirical experiments should provide a better understanding of the cognitive processes used by quick response teams during collaborative problem solving. Based on empirical findings, prepare documentation that describes the types of collaboration tools required to support the representative cognitive processes and how these tools should be effectively integrated.

PHASE III: Based on Phase II results, select and integrate the representative collaboration tools into an integrated collaboration tool suite that can be demonstrated to various operational communities (such as SOF Mission Support Center, San Diego). The integrated tool suite shall include a module intuitive graphical user interface (GUI) to permit not only effective integration of existing collaboration tools but enable incorporation of future tools. Field test the integrated tool suite in an operational setting to demonstrate improved collaborative problem solving in quick response teams.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private-sector applications would include any team collaboration systems engaged in information analysis situations that involve high data volume and quick response requirements. This would include state and local emergency support teams for crisis action planning and humanitarian aid response.

REFERENCES:
1. Jensen, J.A. (2002) Joint Tactics, Techniques and Procedures for Virtual Teams. Assistant Deputy for Crisis Operations, USCINCPAC (J30-OPT), Camp H.M.Smith

2. Naval Special Warfare Web Site, http://www.sealchallenge.navy.mil/

3. Chief of Naval Operations Strategic Studies Group XXVI, Cyberspace and Maritime Operations in 2030, January 9, 2007.

KEYWORDS: Collaboration, team decision making, knowledge interoperability, Special Operations Forces

N08-071 TITLE: Lightweight, High Temperature, Low Cost Materials for Mach 4-5 Cruise Missiles

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PEO(W)

OBJECTIVE: Develop materials and manufacturing methods for materials that can withstand high temperatures while maintaining sufficient strength properties to be utilized on high supersonic cruise missiles at reasonable cost.

DESCRIPTION: Although there are high temperature metals available, often these materials are expensive and difficult to use in fabrication (difficult to machine, difficult to maintain the processes, etc.) and often result in a relatively heavy airframe structure. Composites and ceramics are beginning to make their way into high-speed designs; however, these materials have drawbacks and typically are only utilized in very specialized areas of a vehicle (i.e., leading edges). Development of materials and manufacturing methods is needed to allow manufacture of affordable high speed vehicles. In order for this to be accomplished several aspects regarding the design and manufacture of high speed vehicles should be considered:

- Materials capable of withstanding high temperatures (~800o - 1100o F for 30 minutes) without ablation in order to maintain an efficient aerodynamic outer mold line (OML).
- Methods and processes for joining different materials with different physical properties and different thermal expansion rates.
- Materials that can efficiently transfer heat to cooler areas of the structure to minimize high thermal gradients.
- Alternatives to high temperature structures for certain applications, such as affordable and maintainable thermal protections systems (TPS), including coatings and materials that can be used to thermally protect antennas and other sensitive equipment that must be mounted near a high temperature environment (~ 1100o F).

All developments must consider the manufacturing processes and costs in order to understand the compromises between material properties, manufacturability, and durability.

PHASE I: Develop a concept for high temperature materials applied to a high-supersonic missile sized structure and demonstrate the feasibility of the concept with respect to its use in the high speed environment. In addition to performance, address its manufacturability, and durability aspects in the phase I option.

PHASE II: Develop and demonstrate a concept prototype at the component level (i.e. a wing/fin system including high temperature leading edge joined to a lower heat tolerant material for the remaining wing area) showing the performance capabilities of the system. Also demonstrate examples of manufacturability and durability of the system through testing.

PHASE III: Insert the product into a candidate high speed missile airframe and test as part of joint (Air Force and Navy) demonstrator activities currently being planned.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be applied to any air vehicle which must fly at high supersonic to hypersonic speeds (space access and recoverable vehicles). In addition, any low-cost high-temperature materials capable of surviving in a high-supersonic flight environment would have diverse application in other industries that have components exposed to high temperatures, such as automotive engines, industrial processes, aircraft engines, and confined electronics.

REFERENCES:
1. Fleeman, E.L., Licata W. H., Berglund, E., "Technologies for future precision strike missile systems,", NATO Research and Technology Organization Lecture Series, RTO-EN-018, June 18-29, 2001. (ADA394520)

2. Douglas, Mitchell; Lindgren, John, “Hypersonic weapons technology for the time critical mobile ground threat”, DMSTTIAC-SOAR-99-01, January 1999. (ADA361137)

3. MDA / DEP, NDIA Manufacturing Division Meeting, Mr. Doug Schaefer, Director, Producibility and Manufacturing Technology, Missile Defense Agency, 5 October 2006

KEYWORDS: Hypersonics;Thermal Protection Materials (TPM);Thermal Protection Systems (TPS);hot structures;high-temperature materials;missiles

N08-072 TITLE: Optimized Coding and Protocols for Free-Space Optical Communications Links

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Automated Digital Network Systems

OBJECTIVE: Optimized coding, e.g., Forward Error Correction (FEC), and protocols will be developed for robust and reliable free-space optical communications that link to Transport Control Protocol /Internet Protocol (TCP/IP) maritime and expeditionary networks.

DESCRIPTION: Future service oriented networks will require high bandwidth for efficient C2 and ISR reachback from the tactical theater. Due to their high bit rate capability (Gbps and beyond) in addition to reduced SWaP (size, weight and power) and spectrum alleviation, free-space optical links will be attractive over RF for these maritime and expeditionary environments (ship-to-ship, ship-to-shore, ship-to-air, and air-to-shore).

However, optical communications in these environments experience data loss from: (1) atmospheric attenuation (fog, heavy rain, snow, dust) resulting in total loss for minutes to hours and, (2) atmospheric turbulence (scintillation) with short milliseconds burst errors. It is the atmospheric turbulence errors that are targeted in this work. The most common techniques to mitigate atmospheric turbulence are to (i) increase power, i.e., provide extra link margin to fill the fade depth, (ii) provide aperture averaging or use adaptive optics, (iii) provide diversity (multi-wavelength) as well as (iv) channel coding (block coding/interleaving) and protocols. It is the channel coding and protocols that are targeted in this work.

The atmospheric optical fading channels are not well characterized, nor are the efficacy of FEC for such models well understood. Therefore, related coding and error correction technologies, techniques, and mechanisms are very much hard problems for research. The characterization and mitigation of atmospheric properties causing slow fading are still academic topics as indicated in reference 2 of this SBIR proposal.

Specifically, this SBIR intends to investigate and characterize, interaction and impact of these coding schemes and interleaving on memory requirements, latency, retransmission strategies for both TCP/IP unicast and multicast services will need to be well understood to develop the optimized codes and protocols for high bit rate free-space optical communications. The appropriate combination of physical layer FEC, link layer packet/frame coding and/or retransmission strategies, and end-to-end network reliability mechanisms will be identified and a solution developed.

PHASE I: Utilize/Characterize maritime and expeditionary free-space optical communications channel statistics and provide tradeoff studies on channel codes/protocols, receiver hardware/firmware and Quality-of-Service impact. Provide a technical approach and supporting selection rational to migrate and mature an optimized FEC/protocol system for Phase II.

PHASE II: Develop optimized FEC/protocol system for connection to TCP/IP networks. Test integrated FEC and adaptive error correction and TCP/IP using actual full duplex maritime and expeditionary laser communications links.

PHASE III: This technology would be employed to support reliable high bandwidth links in both maritime and expeditionary environments to provide video, C2, and ISR information. Potential Acquisition Programs for transition include Automated Digital Network Systems (ADNS), Consolidated Afloat Network Enterprise Services (CANES), and Control on-the-move Digital Over the Horizon Relay (CoNDOR).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Variants of this technology could be employed in maritime ship to ship and ship to air communications and by emergency services during disasters recovery operations and when SATCOM is unavailable.

REFERENCES:
1. “Evaluation of FEC for the Atmospheric Optical IM/DD Channel,” by H. Henniger, F. David and D. Giggenbach, Free-Space Laser Communication Technologies XV, Proceedings of the SPIE, 2003.

2. “Evaluation of the scintillation loss for optical communication systems with direct detection,” by N. Perlot, in Optical Engineering, Feb. 2007.

3. “A digital fountain approach to asynchronous reliable multicast”, by Byers, Luby and Mitzenmacher, IEEE Sel areas in Comms Oct. 2002

KEYWORDS: Atmospheric Turbulence; FEC; Laser Communications; Network Reliability Mechanisms Protocol; TCP/IP

N08-073 TITLE: High Mach, High Altitude Navigational Sensor

TECHNOLOGY AREAS: Air Platform, Sensors, Weapons

ACQUISITION PROGRAM: PEO(W)

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

OBJECTIVE: This solicitation is seeking viable concepts for a low-cost, high-precision navigational sensor system for air vehicles flying at high altitudes and Mach number speeds that do not rely on satellite navigational systems, and which can be demonstrated in a representative environment.

DESCRIPTION: Future weapon systems with sustained high supersonic (Mach 3 to Mach 5) cruise capability fly at altitudes in excess of 70,000 feet above ground level. At low, terrain-following altitudes, precision navigational sensors such as a high quality inertial navigation system (INS) coupled with a position update sensor (radar altimeter, radar sensor, optical imaging sensor or Doppler navigation sensor) are used by long-range cruise missiles and combat aircraft to maintain accurate flight trajectories from launch to target approach and even target impact. Advanced manned and unmanned air vehicles, however, will operate for long duration (tens of minutes to hours) at high supersonic speeds and high altitudes. Active RF or optical sensors are susceptible to detection by enemy defensive sensors at these altitudes, and high-altitude weapon systems cannot rely on terrain masking to mitigate this susceptibility. Likewise, flying at these high altitudes, optical imaging of terrain features for navigational updating cannot be relied upon given the presence of cloud cover prevalent over long ranges. There is the strong possibility that such vehicles will not be able to rely upon satellite-based navigational systems for the entirety of the vehicle’s flight path.
What is needed is a navigational sensor system that can maintain an accurate position estimate while not dependent upon systems such as GPS, Galileo or Glonass. For anticipated applications to expendable weapon systems, an affordable navigational sensor system will be required, implying a low-cost inertial system coupled with a low-cost sensor.
Use of a passive, radiometric imaging receiver operating in the RF spectrum that exploits the thermal radiation from the earth’s surface offers such a sensor. Prior art for radiometric imaging from an aircraft platform has been demonstrated some 20+ years ago under a technology titled MICRAD (short for Microwave Radiometry).
Today’s RF technology is such that this type of sensor hardware could be made more compact, lightweight and more affordable, thus making such a sensor an excellent candidate sensor to complement a low-cost, advanced Inertial Measurement Unit (IMU) for the desired navigational sensor system.

PHASE I: Develop a concept for a suitable high Mach, high altitude air vehicle navigational sensor suite and show its feasibility in a laboratory environment. A tradeoff between sensor resolution, observation frequency and duration will be needed to ascertain the level of navigational improvement to a given navigational system.

PHASE II: Design and prototype the conceptual sensor suite and demonstrate system functionality.

PHASE III: Mature the sensor suite design and demonstrate it in a relevant environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial high-altitude transport envisioned for the future will need a backup system to GPS, to mitigate the effects of solar flare disruptions.

REFERENCES:
1. H. Buell and A.J. Hunton, "Synergistic effects of Doppler radar/ GPS navigation integration and the development of an advanced navigation system for helicopter applications," Navigating the earth and beyond; Proceedings of the 1994 National Technical Meeting, San Diego, CA; United States; 24-26 Jan. 1994, pp. 821-830.

2. R.P. Moore, C.A. Hawthorne, M.C. Hoover, and E.S. Gravlin, "Position updating with microwave radiometric sensors (for all- weather inertial navigation)," NAECON '76, Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, United States; 18-20 May 1976; pp. 13-19.

KEYWORDS: navigational sensor;high-altitude;cruise missile;high Mach;air vehicle;control

N08-074 TITLE: Bore Insulator Protection Layer for a Naval Electromagnetic Launcher

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: Office of Naval Research Code 352, Railgun Innovative Naval Prototype (INP)

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

OBJECTIVE: Develop toughened electrically insulative and high temperature layer to protect the bore insulator that is used to separate 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 railgun) 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 up the other rail. This causes strong magnetic fields, high temperatures, and strong lateral forces on the rails and armature in the launcher bore.

A pair of electrical insulators maintains the separation between the rails. These insulators also provide lateral guidance to the armature. The bore face of the insulator 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 contact of 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 face of the bore insulator must possess adequate toughness, have high strength and stiffness, high shear strength for sliding contact, all at high transient temperatures, a low CTE and be electrically and thermally insulating,. The material is required to resist thermal breakdown in the presence of plasma due to high current electrical arcing and shocked gas. A notional insulating bore material might have dimensions such as .25m x .05m x 10m. The material must be manufacturable as well as affordable for these dimensions. Potential protective layers may be bonded claddings, jackets, etc.

PHASE I: Develop a process approach to manufacture tough electrically insulating bore materials of significant lengths (7 – 12 meters). Conduct any necessary subscale tests needed to show that the proposed process is suitable for Phase II demonstration.

PHASE II: Produce sample electrically insulating bore materials of significant 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 process for fabricating long pieces. Produce a prototype set of bore insulators layers for testing in a large scale EM Launcher. EM Gun may be provided as government furnished test asset, or as teaming relationship with other EM gun 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: 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 bore insulator 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 and high stress requiring both the beneficial thermal and high compression strength aspects of materials such as ceramics combined with the need for higher toughness and relatively long sections. Example applications could be high-speed mag-lev applications, possibly very large bore MRI applications, and sections for re-entry protection of space-craft.

REFERENCES:
1. Stevenson, R.D.; Rosenwasser, S.N.; Washburn, R.M., "Development of Advanced Ceramic Matrix Composite Insulators for Electromagnetic Railguns", Magnetics, IEEE Transactions on , Volume: 27 Issue: 1 , January 1991, Page(s): 538 -543.

2. Noel, A.P.; Bauer, D.P., "Laminated Barrel Axial Stiffness Assessment [of railguns] ", Magnetics, IEEE Transactions on , Volume: 37 Issue: 1 , Jan 2001, Page(s): 454 -456.

3. Newman, D.C.; Bauer, D.P.; Wahrer, D.; Knoth, E., "A Maintainable Large Bore, High Performance Railgun Barrel", Magnetics, IEEE Transactions on , Volume: 31 Issue: 1 , January 1995, Page(s): 344 -347.

4. Hurn, T.W.; D'Aoust, J.; Sevier, L.; Johnson, R.; Wesley, J., "Development of an Advanced Electromagnetic Gun Barrel", Magnetics, IEEE Transactions on , Volume: 29 Issue: 1 , Jan. 1993, Page(s): 837 -842.

KEYWORDS: Electromagnetic launcher; railgun; toughened ceramics; polymers; composites; insulator

N08-075 TITLE: Radio Frequency (RF) Modeling of Layered Composite Dielectric Building Materials

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: Infantry Weapons ACAT IV

OBJECTIVE: Development of algorithms which enable imaging through layered composite dielectric building materials. This effort should result in modeling of layered composite building materials and develop methods for mitigating the distorting properties to enable see-through-wall imaging. The effort will enhance the clarity of sense through structures radar images, increasing the utility of this capability for force protection and intelligence applications.

DESCRIPTION: Many branches of the federal government including the DOD, DOJ, DHS, DOA, and INS, as well as local and state law enforcement agencies are keenly interested in developing technologies which enable remote, standoff surveillance of man-made structures. Low frequency RF radar systems are demonstrating great promise in their ability to penetrate various wall materials and image objects such as furniture, construction features, and humans within. However, certain building materials, such as hollow cinder block common in both North America as well in the Middle East, results in poor imaging performance. In particular, hollow cinder block walls contain an air-gap void within the cinder block with disparate dielectric constants establishing a periodic structure resonance cavity that traps electromagnetic modes. The consequence of this layered composite structure on radar target imaging is to induce long time constant relaxations on target detections in radar range profiles. Electromagnetic simulations have suggested that walls composed of hollow cinder block obscure the imaging of humans and other objects located as far as five feet from the wall. More generally, layered walls composed of a high dielectric constant outer layer, plywood/wood stud framing and plasterboard, common in residential construction, may potentially cause similar imaging distortions.

PHASE I: Conduct research to model this property of building materials and confirm measurements by performing simulations/tests on layered composite dielectric walls. Investigate algorithms to mitigate these effects on imaging such as applying pre-distortion to the transmitted radar signature to compensate for the long time constant phenomena. Develop approaches to perform imaging through layered composite wall types without prior knowledge of the wall material. Submit a report covering the approach, design and results.

PHASE II: Develop a working prototype for the Phase I capability and demonstrate its capability against a relevant man-made layered structure. Deliver and demonstrate the working prototype. Deliver a final report documenting the performance and capability.

PHASE III: Demonstrate that the products developed under Phase I and II can be applied to civilian scenario and be transitioned to through the wall sensor programs managed by Infantry Weapons at MARCORSYSCOM, including airborne impulse synthetic aperature radars. Provide documents and prototypes to many DOD and contractor test facilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Topic has direct relevance to civilian law enforcement in that it will develop a more agile sense-through-wall capability. Topic is also relevant to medical applications such as ultrasound imaging.

REFERENCES:
1. Yasumoto, K., Jia, H., Toyama, H., “Analysis of Two-Dimensional Electromagnetic Crystals Consisting of Multilayered Periodic Arrays of Circular Cylinders”, Electronic and Communications in Japan, Part 2, pp 19-28, Vol. 88, No. 9, 2005.

2. Fante, R., “Scattering of Electromagnetic Waves from Random Media with Multiple Scattering Included”, Journal of Mathematical Physics,, pp 1213-1222, Vol. 23, No. 6, June 1982.

3. Evans, D., Levitin, M., Vassiliev, D., “Existence Theorems for Trapped Modes”, Journal of Fluid Mechanics, pp 21-31, Vol. 261, 1994.

KEYWORDS: See-through-walls, radar imaging, dielectric constants, layered composite structure, reflection and transmission from boundaries, resonance trapping, trapped electromagnetic waves in periodic structures, trapping and detrapping of electromagnetic modes

N08-076 TITLE: <u>Development of Dielectric Films for Wound Capacitors</u>

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

ACQUISITION PROGRAM: PEO(S), PMS-500, PMS-405, DD(X) Program Office, EMALS program

OBJECTIVE: Develop and demonstrate processed dielectric films with 10 J/cc capacitive energy storage capability and low dielectric loss.

DESCRIPTION: The Navy plans to develop the all electric ship. One motivation for this development is the realization that the power requirements of future Naval vessels will not be as dominated by propulsion as current ships and that it may be desirable to be able to transfer energy between uses. This will require storage and conditioning of vast amounts of power. Additionally, weapons, catapult systems and other military technologies that require pulses of power would require very large banks of dielectric capacitors. The goal of this effort is to develop dielectric materials appropriate for large pulsed power capacitors (wound metalized film) that have film level storage capability of greater than 10 J/cc to enable fully packaged capacitors that deliver >4 J/cc.

Current state-of-the-art dielectric capacitors that deliver 1 J/cc are based on polypropylene (PP), which derives its high energy density from a high breakdown strength. Other scalable thin film dielectric materials approaches, including PVdF and composites, have not yet shown the needed combination of processability, breakdown strength, and low loss for high energy density large scale capacitor manufacturing. Optimization of materials composition and processing conditions is required to mature these and other approaches to viable thin film dielectrics.

PHASE I: Develop a processable dielectric film with the capability to achieve 10 J/cc capacitive energy storage with discharge times of 10 milliseconds or less, less than 1% loss, thermal performance to 120°C, and a potential to incorporate a graceful failure mechanism. Throughout Phase I, the offerer will be able to submit a reasonable number of samples to the Navy for evaluation of the permittivity and dielectric strength. This is to aid the offer in the development of the dilelectric films and to allow the offerer to see how the Navy performs this characterization (breakdown results vary significantly with measurement techniques). The deliverables for Phase I will be 1 square foot of film for final performance testing, instructions for how to electrode the film, and a report on the potential scalability, cost, and performance and of this technology. Suggested approaches include but are not limited to polymer films, oriented polymer films, and composite films.

PHASE II: Work will include further development of the dielectric film, scaling of the material to lab scale film processing levels (> 2 to 5 kg of material) and incorporation of the dielectric film into a packaged capacitor that represents a subunit of a potential military capacitor. The fabrication issues will depend on the specific type of capacitor but may include synthesis scale-up, film processing for optimal breakdown properties, electroding procedures, design of the capacitor element, approaches to graceful failure, and packaging procedures. Several capacitors of appropriate size will be delivered to the Navy for full characterization. Cost estimates of the technology will be developed.

PHASE III: The goal of the phase II work is to mature the technology to a point in which an acquisition program (all electric ship particularly for the rail gun and electromagnetic launch applications) would be interested in transitioning to phase III development. Dielectric materials development was completed in phase II and film processing procedures should be well developed. Focus here is on designing and fabricating larger and larger capacitor subsections to demonstrate the manufacturability and performance of the technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Whereas large pulsed power capacitor banks and the strong emphasis on energy density are critical military needs, improved dielectric capacitors could find commercial applicability in power conditioning and back-up applications, hybrid vehicles, and other applications.

REFERENCES:
1. “A Dielectric Polymer with High Electric Energy Density and Fast Discharge Speed,” B. Chu, et al., Science 313, 334 (2006)

2. “Phosphonic Acid-Modified Barium Titanate Polymer Nanocomposites with High Permittivity and Dielectric Strength,” P. Kim, et al, Adv. Mater. 2007, 19, 1001-1005.

KEYWORDS: biaxially oriented polypropylene; polyvinylidene fluoride; polymer films; graceful failure; dielectric films; capacitors

N08-077 TITLE: Automated Entity Classification in Video Using Soft Biometrics

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PM Intel, Marine Corps Systems Command, ACAT IV

OBJECTIVE: Develop technologies for an automated capability to recognize and classify entities in video imagery using soft biometrics. Advance understanding of which soft biometrics features/ metadata from entities in video imagery is most useful for subsequent entity identification. Video can include imagery from wide area surveillance cameras both in indoor and outdoor settings. Resultant system should have capability to translate an image to soft biometric metadata about the observed entities. The metadata, once forwarded, should allow a second imager to infer with confidence a second sighting of the same entity. The developed algorithms should also allow for the translation of a description of a person to a similar soft biometric metadata representation, allowing distributed imagers to infer matches. It should be noted that using soft biometrics does not provide absolute identification and verification but is intended to reduce the number of subjects to be investigated.

DESCRIPTION: Soft biometrics are the human characteristics that provide information about the individual but is insufficient to differentiate any two individuals and thus identify an individual reliably and uniquely due to its lack of distinctiveness and permanence. Soft biometrics include information such as gender, eye color, ethnicity, age, height, weight, length of arms/leg, gait and gestures. In order to perform identification or verification, a system totally based on soft biometrics information cannot provide results with a satisfactory matching rate. However they are usually easier to capture from a distance and do not require cooperation from the subject. These soft biometrics traits are descriptors that can be present in human intelligence reports. Soft biometrics can complement and improve the performance of common biometric systems (e.g., signature verification system, face recognition system, fingerprint identification system, iris). The capability sought will allow individual people to be rapidly associated with groups of people having similar soft biometric features. This filter will allow the warfighter to more efficiently process individuals that may be of interest as opposed to individuals with no soft biometric matches to entities of interest.

PHASE I: Conduct research to evaluate the viability of extracting soft biometrics from video imagery. Identify good data sets that can be used for algorithm verification. Develop algorithms that can extract soft biometrics from imagery and record these as metadata in a database. Develop algorithms that can take in soft biometrics descriptors and find matching entities in video imagery. It is expected that performance predictions will be developed during Phase I for all algorithms proposed by the offeror. Submit a report covering the approach, design and results.

PHASE II: Develop a working prototype for the phase I capability and demonstrate its capability against a relevant data set. Deliver and demonstrate the working prototype. Deliver a final report documenting the performance and capability.

PHASE III: Demonstrate that the products developed under phase I and II can be integrated into the Tactical Exploitation Group, the Marine Corps senior Imagery Intelligence (IMINT) system. Provide documents and prototypes to many DoD and contractor test facilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Topic has direct relevance to military operations and civilian law enforcement in that it will develop capability to filter video imagery based on soft biometrics. The topic would enable law enforcement to send descriptions of people of interest to camera networks and be returned possible matches.

REFERENCES:
1. Anil K. Jain, Sarat C. Dass, Karthik Nandakumar , "Soft Biometric Traits for Personal Recognition Systems" Pro. Of the Int. Conf on Biometric Authentication, LNCS 3072, pp 731-738, Hong Kong, July 2004

2. J. Phillips, "Human Identification Technical Challenges", IEEE Int Conf On Image Processing, 2002

3. http://sphericalcube.com/biometrics/biometrics.php

KEYWORDS: Biometrics, soft biometrics, recognition, identification, verification, video analysis

N08-078 TITLE: Compact Cryogenic High Temperature Superconducting Cable Junction Box

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO SHIPS PMS 500 CG(X) DDG-1000

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

OBJECTIVE: Develop a high temperature superconducting (HTS) cable junction box to provide coolant circulation and electrical feed through for a low voltage DC HTS cable.

DESCRIPTION: Superconductivity has become of interest in recent years to the Department of Energy (DoE) and the Department of Defense (DoD) for its characteristic of power density. The DoE has led a significant effort to develop high temperature superconducting (HTS) wire for use in power cable demonstrations. The cable projects are typically maintained by sub cooled liquid nitrogen which also provided the benefit of electrical insulation. Nitrogen is usually pumped down the HTS cable and circulated back to the refrigeration site through a return cryostat. The Navy has leveraged off of the DoE investment in wire development through various motor and generator programs demonstrating the benefits of HTS in propulsion applications. The Office of Naval Research (ONR) has also funded the feasibility study and subsequent land based demonstration of concept of a gaseous helium cooled HTS degaussing system.

The HTS degaussing system consists primarily of three components: a cryogenic refrigeration system, current supply, and HTS cable. The HTS cable consists of the HTS wire surrounded by a cryostat to reduce heat leak into the system. The cable consists of 20-40 superconducting tapes and both the electrical current and gas cooling needs to enter and exit the cryostat at cryogenic electrical junction boxes.

Different types of compact, very low heat leak junction boxes would be desired depending on the ship class and installation techniques planned. An integrated cable termination junction both with the cryocooler and circulation fan would be one option. Another option would be a cable termination junction box that accepts input for both cooling flow and electrical power to the HTS cable from a remote location. Both types of junction boxes need to send coolant down the cryostat and return from the opposite side while allowing electrical continuity between each individual turn of superconductor.

The use of standard vacuum components will not meet the Navy needs for this program. This is a complex problem and innovative approaches to reduce heat loads on the cryogenic system and overall size of the junction boxes are required.

PHASE I: Identify concepts to achieve gas flow through the degaussing loop while enabling multiple turns of superconductor to pass through the junction box. Determine the feasibility of incorporation of a helium fan and cryocooler cold in a single junction box while minimizing parasitic heat leaks. Complete preliminary designs of shipboard cryogenic HTS cable junction box.

PHASE II: Develop and demonstrate full scale prototypes of the compact HTS junction boxes. The prototype should successfully demonstrate proper operation and be verified compliant to military shock and vibration standards.

PHASE III: Transition this technology to commercial and military market. The DDG-1000 and CG(X) platforms will receive Advance Degaussing systems (ADS) to improve the capability of these platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The resulting compact cryogenic high temperature superconducting junction box will have application in the expanding markets of cryogenics and superconductivity. This junction box will benefit superconducting projects as the transition from the research environment to field use through simplification of electrical and cooling incorporation. Markets for this junction box include research laboratories, electrical utility cables, and Navy ship HTS degaussing systems.

REFERENCES:
1. Fitzpatrick, B. “High Temperature Superconducting Degaussing System Assessment,” ASNE Day 2007, June 2007.

2. Fitzpatrick, B. “High Temperature Superconducting Degaussing System Assessment,” ASNE Day 2005, April 2005.

3. Snitchler G., Gamble B., Kalsi S.S., “The performance of a 5 MW high temperature superconductor ship propulsion motor” Applied Superconductivity, IEEE Transactions on Volume 15, Issue 2, Part 2, June 2005 Page(s):2206 – 2209

4. Fitzpatrick, Kephart, Golda. “High Temperature Superconducting Degaussing - Cooling two HTS coils with one cryocooler for the Littoral Combat Ship.” Advances in Cryogenic Engineering, July 2007

5. Fitzpatrick, Kephart, Golda. “Characterization of Gaseous Helium Flow Cryogen in a Flexible Cryostat for Naval Applications of High Temperature Superconductors.” IEEE Transactions on Applied Superconductivity. (Applied Superconductivity Conference AUG 2006).

KEYWORDS: high temperature superconductor, cryogenic, superconductivity, HTS, power cables, degaussing, DC, junction box, cryocooler, current feed through

N08-079 TITLE: Autonomous Guidance for small UAV Safe Flight Operations in the National Airspace System (NAS)

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Space Platforms

ACQUISITION PROGRAM: PMA-263

OBJECTIVE: Develop and demonstrate autonomous collision avoidance and auto-pilot guidance algorithms for small unmanned aircraft systems (UAS), in the teir I/II classes, enabling safe flight operations in airspace shared with manned aircraft or other UAS. The autonomy capability shall include the ability to evaluate situations and determine best maneuvers to enable mission accomplishment and safety of flight/compliance with FARs regarding rules of the road..

DESCRIPTION: Federal Agency stakeholders recently agreed that a lack of critical mass of small business involvement and innovation impedes the future of UAS industry[1] in the United States. As such, the cost of small UAVs remains high due to a lack of commercialization. The U.S. Navy and Marine Corps need to be able to safely operate UAVs in the National Airspace System (NAS) for a variety of missions. These include, but are not limited to: training and certification of operators, test and development of advanced UAV components, transport of UAS between facilities, and support of USCG/DHS homeland security missions. Currently, these operations a limited to restricted airspace only or under very limited COAs. Furthermore, the Navy and Marine Corps are continually expanding their use of UAVs to supplement manned systems capabilities. As such, in many cases it is desirable to operate small, tactical-class UAVs in common airspace with manned aircraft safely. Additionally, other non-DoD government agencies have potential UAS missions: NASA – for performing aeronautics and atmospheric science research; NOAA – for environmental monitoring, hurricane watch and research; DOE – for monitoring and security of remote and/or potentially dangerous installations; and DHS – in support of Coast Guard, Border Patrol, and federal law enforcement operations. Furthermore, state and local agencies such as police, search and rescue, and fire fighting units are potential users of UAS technologies.
ONR wishes to apply the SBIR program to facilitate commercial applications of small UAS. This will increase the utility of the technology area, accelerate its development and drive down the cost of this technology for DoD. Commercial and civil government applications are currently very limited as an unlimited airworthiness certificate is not possible due to safety of flight concerns (in airspace shared with manned aircraft). Other consumer applications could include, but are not limited to, agricultural surveillance and mapping, oil pipeline and powerline surveillance, and news gathering. These industries could benefit from routinely employing small UAS in support of their operations.
A number of technology milestones must still be achieved before UAVs can be seamlessly integrated into the NAS. One of these is the development of a reliable guidance system that will autonomously provide both separation assurance and collision avoidance with other aircraft, while complying with federally regulations governing operations in both controlled and uncontrolled airspace.

The emphasis in this topic is the development of the autonomy algorithms and interface to UAV autopilot systems. This is not focused on individual supporting technologies such as or sensors or autopilots. Autopilot technologies were developed/matured through the SBIR/STTR programs investment from 2001-2004. Sense and avoid sensor technologies are under development in in ongoing FY07 STTR program.

Avoidance strategies can be classified in two major groups: 1) separation assurance, which deals with scenarios involving larger separation distances and time to minimum separation on the order of at least several minutes; and 2) collision avoidance, which involves scenarios where separation distances and the time to minimum separation are much smaller. In both scenarios, the autonomous behavior of the overall system should be compliant with applicable federally mandated regulations and currently evolving UAS-specific regulations. Additionally, in case 1), the system should optimize for a return to mission profile or accomplishment.

PHASE I: Develop an autonomous collision avoidance system, consisting of algorithms and processing, with the appropriate SWaP (size, weight and power) and cost for USN/USMC tier I and tier II levels of UAS. As inputs, the system will utilize detect/sense system data from collision avoidance sense system, flight dynamics information from the UAS auto-pilot, and mission profile/priorities information from a planning/control segment. Demonstrate the proposed system's potential performance through a series of high-fidelity multi-aircraft/UAS simulations of collision avoidance and HITL-based testing. Use of typical small UAV autopilots and airframe performance (such as a piccolo family autopilot and silver fox UAV) is required. Simulation should be adaptable for multiple platforms/flight dynamics. Sensing modes available should be any or all of the following: radar, EO-IR, or acoustic on-board sensors and/or participation in the ADS-B datalink. Simulated inputs of appropriate temporal and spatial fidelity will be used. Determination of performance of combinations of sensing modalities for best results in terms of safety of flight, SWaP, cost and mission accomplishment is an expected outcome of the effort.

PHASE II: Design and build a prototype system and demonstrate with an operational UAS equipped with a collision avoidance sensor capability. Perform initial flight test experiments for system evaluation. Provide assessment of performance.

PHASE III: This effort will transition to Navy/USMC tier I and tier II programs with operational requirements for beyond line of sight or over the horizon surveillance and targeting (surface action groups that do not have organic air assets and Navy/USMC expeditionary or riverine forces).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An ultimate aim of this effort is to enable small UAS airworthiness certification for autonomous flight in the National Aerospace System. These systems are much less costly than Predator/Global Hawk class UAS and are not intended to be operated/flown by rated aircrew. The certification of small UAS for autonomous flight for commercial work (mapping, pipeline/powerline patrol, etc.) work enable support a business model which would commercialize these assets and greatly reduce the cost to DoD. The algorithms and approaches developed and validated under this program will lead to safe operation of small UAS in the National Airspace System. Additionally, by meeting Swap/cost for tier I and II type UAS, it also would bring autonomous collision avoidance sensing into affordability for general aviation civil aircraft also.

REFERENCES:
1. AIAA Infotech@Aerospace 2007 Conference at Rohnert Park CA.

2. Topic Writers Keith Krapels, Harold Szu ONR Code 312, 703-696-5787,keith_krapels@onr.navy.mil.

KEYWORDS: Autonomous; Guidance; Collision avoidance; tier I, tier II; small UAV; Safety of flight

N08-080 TITLE: Process Research and Development for High Density Metal-Metal Composites

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: Integrated Warfare Systems (IWS-3); Advanced Gun Systems; ACAT III

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

OBJECTIVE: Enable the manufacture of metal-metal high-density composite materials, which have strength to survive severe shock loading conditions.

DESCRIPTION: Metal/polymer and metal/metal reactive material billets have shown remarkable promise in the development of new warhead concepts and effectiveness, however, low strengths, moderate densities and availability of material sizes, densities, and compositions has been a problem in advancing this promising technology. These weaknesses place limits on their use. This SBIR suggests a composition and process modification, which should increase density and strength while not adversely affecting performance. It is suggested that novel metal/metal composite materials with pre-selected densities and compositions could be constructed out of a heavy metal/light metal powder mixtures to predefined densities. Subsequent compression, sintering and/or polymer cured could provide materials with sufficient strength and resilience to provide excellent candidate compositions for advanced reactive material assessment. Metal-Metal compositions (or molding powders) with high densities (5-8 gm/cc) and reactivity (calculated output energies in the 1000 to 2000 cal/gm) when oxidized are sought. Materials produced must be fully characterized using standard chemical methods to verify composition, coating layer thickness, poly-dispersity particle size, shape, surface properties and composition stability/compatibility (DSC/TGA analysis) with standard processing and ordnance materials. Examples of metal-metal combinations sought include, but are not limited to; Hafnium/Aluminum, Tungsten/Aluminum, Hafnium/Zinc, Zirconium/Zinc and Zirconium/Aluminum among others. The process should be sufficiently adaptable so that tri or tetra components systems can also be synthesized and evaluated. The proposed processes should be scaleable and offer scales of economy for eventual production lots of well characterized compositions.

PHASE I: Identify, with process chemistry support, high density compositions that have high potential energy release. Synthesize coated compositions with final densities in the range of 5 to 7 gm/cc using materials suggested above. Provide samples which reverse the core material yet achieve the same densities. Provide one pound samples of mutually agreed upon compositions to government laboratories for evaluation and assessment. The Phase II product may become classified.

PHASE II: Demonstrate that candidate metal-metal compositions can be scaled to the multi-pound level with appropriate characterization and evaluation. Provide material samples to various research and development establishments for continued development and evaluation. Develop and provide a process research and development plan that will allow for the generation of specifications and quality controls for material manufacture. The Phase II product may become classified.

PHASE III: Provide specifications for large scale production of selected metal-metal materials. Develop manufacturing data package describing cost factors, material characterization, processing and quality control aspects. It is anticipated that this technology will be used for several systems, including the Kinetic Energy--Electronic Time Fuze (KE-ET) gun round (PEO-IWS), the advanced high blast bomb family (PEO(W) PMA-280), as well as any number of PIP air-to-air and ground-to-air missile systems HARM, AMRAM, Sidewinder, Standard Missile, RAM, etc.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This material has application in any product which has high energy output where plastic parts could be replaced by higher density reinforced reactive material to increase energy output, strength and density. Safety flares may be one application.

REFERENCES:
1. “Impact Initiation of Rods of Pressed Polytetrafluoroethylene (PTFE) and Aluminum Powders”, W. Mock, Jr, W. H. Holt, 14th APS Topical Conference on Shock Compression of Condensed Matter, 31 July – 5 August, 2005, Baltimore, MD

2. “Reaction Efficiencies for Impact-Initiated Energetic Materials”, R.G. Ames, S.S. Waggener, 32nd International Pyrotechnics Seminar, June 2005, Karlsruhe, Germany

3. “Vented Chamber Calorimetry for Impact-Initiated Energetic Materials”, R.G. Ames, AIAA Aerospace Sciences Meeting, January 2005

4. “Measurements of Energy Release of Impacting Reactive Spheres”; Waggener S.S.; Warheads and Ballistics Classified Symposium, August 2004 5. “Energy Release of Impacting Reactive Spheres”; Waggener, S.S., Naval Surface Warfare Center; Dahlgren Division Technical Report TR-04/9; September, 2004

KEYWORDS: High Density Reactive Materials, Reactive, Energetic, Metal-Metal, Composite, Manufacture

N08-081 TITLE: Exploitation of Network-Based Information

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: No acquisition program is specifically supporting this topic.

OBJECTIVE: To develop algorithms, methodologies and tools for encoding and analyzing network-based data and information that arises in a Global Information Grid (GIG) and Net-centric Enterprise Services (NCES) environment (e.g., sensor networks, computer networks, communications networks, intelligence networks, etc.).

DESCRIPTION: The GIG-NCES framework relies heavily on networks of all types: communications networks, information networks, computer networks, intelligence networks, sensor networks, and others. The ability to understand the complex behavior of networks is important for their protection and for risk management. Additionally, networks can be looked at as a type of sensor. Thus, information about the networks can be exploited for warfighting operations (offensive and defensive) and decision making. We seek innovative methods for encoding network-based data with the goal of understanding its current state and predicting its future state in the presence of noise or uncertainty. Some issues that might be addressed include dynamic and evolving networks, spatio-temporal aspects of network-based data, anomaly detection, estimating uncertainties associated with networks, metadata analysis, integration/fusion of network data, and others.

PHASE I: Investigate and develop algorithms, methodologies, and tools for gathering, encoding, processing, analyzing and displaying network-based data.

PHASE II: Develop and demonstrate a prototype for testing and demonstrating the capabilities and limitations of the approach and system developed in Phase I. The enhancement and/or improvement using this approach should be quantitatively evaluated.

PHASE III: Further develop and validate a productized tool suite for delivery to the Navy or DoD. This toolkit might include graphical aids and interfaces for easier understanding of the network-based data and how it affects decisions and performance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The research results are applicable to most commercial businesses and enterprise decision-making operations. Network-based data and information are ubiquitous in both commercial and military venues, so the results from this effort would have commercial sector potential.

REFERENCES:
1. S. Strogatz, “Exploring complex networks,” Nature, Vol 410, 8 March, 2001, 269–276.

2. M. E. J. Newman, “The structure and function of complex networks,” SIAM Review, vol. 45, no. 2, 2003, 167–256.

3. C. Chong and S. Kumar, “Sensor networks: Evolution, opportunities, and challenges,” Proceedings of the IEEE, vol. 91, no. 8, 2003, 1247-1256.

4. R. Albert and A. Barabasi, “Statistical mechanics of complex networks,” Reviews of Modern Physics, vol 74, Jan. 2002, 47-97.

KEYWORDS: Dynamic networks, information integration, random graphs, network visualization, sensor networks, social networks, network science

N08-082 TITLE: Team Knowledge Interoperability in Maritime Interdiction Operations

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: None - product is technology development with broad application

OBJECTIVE: Develop a collaborative ability for spatially separated, networked warfighters to maintain tightly coupled shared awareness during fluid, quick-response maritime interdiction operations.

DESCRIPTION: The majority of military and business tasks today are performed by teams who collaborate to share information and task perspectives in order to reach a decision. As Network Centric Warfare (NCW) policy has been effected military forces are beginning to operate as a networked force, which requires them to plan, decide, and act collaboratively and concurrently to accomplish many tasks simultaneously. Rapid access to current, accurate, and relevant information, and the ability to engage in real-time collaboration with other decisionmakers who are geographically distributed, have become indispensable elements of the command and control planning and decision-making process. Recent incidents such as the attack on the Cole and illicit transport of weapons and destructive materials have made Maritime Interdiction Operations (MIO), a key responsibility of the Navy, Homeland Security and many geo-political entities. Many of these scenarios require team collaboration to solve complex problems. The objective of this solicitation is to better understand the cognitive processes employed when teams collaborate to solve problems.

A representative scenario might involve the development of a global Maritime Domain Security testbed using a wireless network for data sharing during a MIO scenario to facilitate expert reachback for radiation source analysis and biometric data analysis. Subject matter experts at geographically distributed command centers collaborated with a boarding party in near-real time to facilitate situational understanding and course of action selection. The objective of the scenario would be to evaluate the use of networks, advanced sensors, and collaborative technology for conducting rapid MIOs. Specifically, the ability of a boarding party to rapidly set up ship-to-ship communications which permit them to search for radiation and explosive sources while maintaining contact with the mother ship, command and control organizations, and to collaborate with remotely located experts. Analysis of data captured from teams performing their tasks in a collaborative environment could provide valuable insight into what constitutes effective collaborative performance. This understanding could then be used to develop technology to support this cognitive activity, develop tools to reduce cognitive workload, and techniques and processes to improve information exchange among collaborating members.

PHASE I: Develop a preliminary design of a collaboration system for distributed multidisciplinary search teams to rapidly evaluate uncertain data, integrate reachback communications and reach a consensus on a course of action in high-stakes, quick response scenarios. Propose a prototype concept for application in quick-reaction distributed team situations.

PHASE II: Develop and demonstrate the prototype tool or model for supporting consensus development. Conduct one or more lab or controlled experiments to validate the tool and quantifiably demonstrate its benefit in improved team decision-making performance. Develop a usability-qualified interface for the tool and validate performance in an experimental or simulated operational environment. Prepare guidelines and documentation for tool transition to an operational setting. Validate, standardize and document underlying software for application purposes and implement in a field experiment venues.

PHASE III: Coordinate with user subject matter experts to instantiate a working model with actual data, get user (such as Special Operations Mission Planning Environment at the Marine Corps) commitment for training and maintenance of the application.   Field test tool in an operational setting and produce improved performance measures. Implement the tool in a comprehensive package that would include an intuitive graphical user interlace (GUI).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private-sector applications would include any information analysis situation that involves high data volume and quick response requirements. This would include state and local emergency support teams for crisis action planning and humanitarian aid response.

REFERENCES:
1. McKinsey, (2002). Improving NYPD Emergency Preparedness and Response, McKinsey & Company, August 19, 2002. Available: http://www.nyc.gov/html/nypd/pdf/nypdemergency.pdf.

2. Warner, N., Letsky, M., and Cowen, M. (2004). Cognitive Model of Team Collaboration: Macro-Cognitive Focus. In Proceedings of the 49th Human Factors and Ergonomics Society Annual Meeting, September 26-30, 2005. Orlando

3. Klein, G. A. (1993). A Recognition-Primed Decision (RPD) Model of Rapid Decision Making. In G. A. Klein, J. Orasano, R. Calderwood, & C.E. Zsambok (Eds.) Decision Making in Action: Models and Methods (pp. 138-147). Ablex Publishing Corporation, New Jersey.

KEYWORDS: Collaboration; teams; decision making; knowledge; interoperability; shared awareness

N08-083 TITLE: Fast Tuning, Analog Notch Filters

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Radio Frequency Antennas & Topside Program Manager, code PMW 180-D4/E2

OBJECTIVE: Develop analog filters capable, in response to software control, of protecting high sensitivity receivers from high power, in-band, fast hopping signals.

DESCRIPTION: On military platforms and in battle groups where many RF systems are collocated and share the same spectrum, co-site interference is often a severe problem. The arrival of in-band energy from some of our own transmitters effectively jams our receivers. Co-site interference will be an even worse problem in the future if wide band receivers are deployed to harvest the inherently more useful and affordable features of software radio. Such self-jamming is the RF equivalent of fratricide -- the victim systems usually turns off until the problematic signal goes away for self-protection, although in mild cases, they can continue to operate in a less sensitive mode by strongly reducing the signal gain in the receiver. It is highly desirable to have available a tunable filter that can reproducibly tune in less than 3 microseconds, center tune over relatively wide band (>20% of band center frequency), introduce <0.5 dB insertion loss at the upper end of the band (assume 2 GHz center), and provide >60 dB of rejection at the band center in narrowest BW tuning configuration. Small physical size, band width selectable in the range 20% to 5%, and smooth phase gradients at the band edges may also be desirable.

PHASE I: Develop a design concept and prove, at least by simulation, that a filter of the required characteristics can be constructed.

PHASE II: Conduct at least 2 cycles of component design/fabrication/ and test that demonstrates that the design concept is valid and can be integrated with band pass filters. It is desirable to demonstrate both reproducibility of tuning and independent operation of multiple such filters in the same band and to measure their power handling characteristics.

PHASE III: Insert such filters into the analog sections of wide band military receivers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Such filters should have applicability in digital transmitters at the point where digital to analog signal conversion happens, assuming they have sufficient power handling characteristics to be low loss. They may also have applicability in commercial comms systems where spectral density is high so that active suppression of adjacent channels is critical to a given channel's utility.

REFERENCES:
1. http://jjap.ipap.jp/link?JJAP/40/L1148/

2. http://www.eecs.umich.edu/rebeiz/Current_Research.html#anchor335476

3. http://horology.jpl.nasa.gov/quantum/pub/ElectronicsLetters1.pdf

KEYWORDS: tunable filters; analog filters; rapid tuning; equal phase filters; high Q filters

N08-084 TITLE: Rapid Identification of Asymmetric Threat Networks from Large Amounts of Unstructured Data

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: PMA 480 AT/FP(Anti Terrorism/ Force Protection); ACAT II

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

OBJECTIVE: Develop algorithms and technologies that will rapidly process massive amounts of unstructured data in order to expose at risk populations and determine the likelihood of threat activity in time to warn or intervene. It is most desirable that the large volumes of data be processed on laptop computers forward deployed as opposed to reach back nodes. The technical objective is to develop neural networks that are able to understand how word, entity and theme occurrence can be used as a predictor of risk. Developed neural network based analysis tools need to be able to model a new domain quickly, requiring only months of past data. Once trained, the analysis tool should be capable of monitoring a large number of processed open sources in real time, monitoring trends and threats. Warnings and intervention shall consist of determining impending threats in order to quickly generate the actionable intelligence needed to accelerate the friendly strategic communications and/or force planning decision-making and execution cycle. This faster cycle will increase friendly operational tempo, depriving asymmetric and irregular foes of the initiative and forcing them into reactive modes, thus rendering them susceptible to disruption, manipulation, and defeat. Databases to be considered are open source intelligence (OSINT) including BLOGs and other available unstructured data sources.

DESCRIPTION: Most unstructured inputs are currently analyzed using manual or automatic extraction technologies in order to identify entities of interest and link them in relation to times, places and events. Unstructured data is numerically reduced and inputted to graph analysis systems. This SBIR will explore automatic analysis of reduced unstructured data using artificial neural networks in order to enable trend analysis of at risk populations and the measurement of threat levels. The inputs to the neural net can be themes, specific words or bundles of words, mentions of entities, or entity relationships found in open source references pertaining to an area of interest.

Anticipated asymmetric and irregular adversaries are ever-changing entities, often seeking to hide among indigenous populations and exhibiting decentralized, yet self-synchronizing, network structures, as well as the ability to quickly adjust their techniques, tactics, and procedures (TTP) in response to U.S. actions. Future threats will most assuredly be more adaptive, deadly, complicated, and harder to discern than those the US currently faces.

It is understood that blind extraction of relevant predictive information (as actionable intelligence) from such a large set of data is an inherently complex computational problem. However, the potential for approximate but fast and robust computational algorithms exists. Neural networks are generally relevant to this class of problem.

PHASE I: Develop an approach that will support the processing of large streams of unstructured data using artificial neural networks. The approach should be efficient and timely to minimize processing power requirements to enable real-time or near real-time operation. The offeror may use as is or improve existing open source word, entity and theme tools to create the structured input needed by the analysis tool

PHASE II: Develop a prototype system that uses artificial neural networks to predict trends in at risk populations and threat levels by processing large unstructured data streams in near real time. The offeror may use a mixture of existing tools and new tools to rapidly create structure out of large amounts of unstructured text.

PHASE III: Demonstrate the products developed under Phases I and II can perform in operational systems via real field or simulated demonstrations. Provide software and hardware packages for field use as appropriate.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Homeland Security initiatives are driving municipal, county, state, and federal agencies to obtain an interoperable communications capability. The technology developed from this topic is directly applicable to these non-DOD threat-warning applications.

REFERENCES:

1. Abdi, Herve (1994). A Neural Network Primer, School of Human Development: The University of Texas at Dallas, Richardson, TX http://www.utdallas.edu/~herve/abdi.primer.pdf

2. Bar-Yam, Yaneer (2003). Dynamics of Complex Systems, Chapter 2. http://necsi.org/publications/dcs/Bar-YamChap2.pdf

3. Bar-Yam, Yaneer (2003). Dynamics of Complex Systems, Chapter 3. http://necsi.org/publications/dcs/Bar-YamChap3.pdf

4. Bar-Yam, Yaneer (2005). Making Things Work. http://necsi.org/publications/mtw/

5. A close view to Artificial Neural Networks Algorithms (2007). http://www.learnartificialneuralnetworks.com/

KEYWORDS: fast, robust, artificial neural network algorithms

N08-085 TITLE: Shock and Vibration Tolerant High Temperature Superconducting Shipboard Degaussing Cable

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO SHIPS PMS 500 CG(X), DDG-1000 ACAT I

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

OBJECTIVE: Develop a low weight, shock and vibration tolerant cable to support the application of shipboard degaussing that allows for quick installation in a Navy Shipboard environment.

DESCRIPTION: Advanced degaussing systems use long lengths of copper cable wound around the ship to reduce the ships magnetic signature. This copper based system is heavy and is expensive to install. High Temperature Superconductivity (HTS) has shown possible advantages in size, weight, power conversion efficiency when applied to motors, generators, power cables and fault current limiters. In a HTS Degaussing system the copper can be replaced with HTS for significant weight savings through reduced amount of conductor while achieving the required current carrying capacity. The Office of Naval Research has funded development of a land based HTS Degaussing system and has identified components that may provide significant challenges in meeting Navy shock and vibration standards.

HTS degaussing presents additional challenges over copper based systems. The superconducting cable requires continuous cryogen flow while maintaining electrical continuity of multiple turns of conductor. Each conductor must be individually isolated from another so multiple turns exist through the cable to develop required amp-turns of field while being powered from low current, 100–200 amp, power supply. The degaussing cable will require between 20-40 conductors with cable lengths up to 200m. Since this cable will be used shipboard, sailor safety must be considered and a gaseous cryogen, typically helium could be used as the cooling fluid. While the cable itself should not require any routine maintenance, proper monitoring of the cable parameters would be desired to ensure adequate operation. Cable maintenance should be condition based stemming from parameters of the superconductor such as voltage, temperature, or magnetic field. Effective means to measure these parameters could be established without significant burden to the system through excessive instrumentation wiring or equipment. Cable design, technique, and instrumentation will need to meet shock and vibration requirements.

Novel and innovative ideas or approaches for superconducting cable designs are desired. The proposed approaches should address a need to meet Navy qualification and condition based maintenance requirements for a HTS degaussing cable.

PHASE I: Investigate novel cabling techniques for tape based superconductor to support a low voltage DC HTS degaussing cable. Consideration to condition base maintenance parameters should be identified, investigated, and demonstrated as required in a laboratory demonstration. A preliminary cable design and small prototype should be developed by the conclusion of the phase I effort.

PHASE II: Develop and demonstrate a scale prototype of the HTS degaussing cable and demonstrate condition based maintenance sensor performance. A full scale prototype should be developed and subjected to shock and vibration testing.

PHASE III: Transition this technology to commercial and military market. The DDG-1000 and CG(X) platforms will receive Advanced Degaussing Systems (ADS) to improve the capability of these platforms

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This work has application in the private sector though advanced development of cabling techniques and condition based maintenance monitoring. These advancements can be applied to commercial HTS power distribution systems.

REFERENCES:
1. Fitzpatrick, B. “High Temperature Superconducting Degaussing System Assessment,” ASNE Day 2007, June 2007.

2. Fitzpatrick, B. “High Temperature Superconducting Degaussing System Assessment,” ASNE Day 2005, April 2005.

3. Snitchler G., Gamble B., Kalsi S.S., “The performance of a 5 MW high temperature superconductor ship propulsion motor” Applied Superconductivity, IEEE Transactions on Volume 15, Issue 2, Part 2, June 2005 Page(s):2206 – 2209

4. Fitzpatrick, Kephart, Golda. “High Temperature Superconducting Degaussing - Cooling two HTS coils with one cryocooler for the Littoral Combat Ship.” Advances in Cryogenic Engineering, July 2007

5. Fitzpatrick, Kephart, Golda. “Characterization of Gaseous Helium Flow Cryogen in a Flexible Cryostat for Naval Applications of High Temperature Superconductors.” IEEE Transactions on Applied Superconductivity. (Applied Superconductivity Conference AUG
2006).

KEYWORDS: high temperature superconductor, cryogenic, superconductivity, HTS, power cables, degaussing, DC

N08-086 TITLE: Dynamic characterization of polymer composite materials

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

OBJECTIVE: To develop a clear understanding of the material response (all the way to failure) under conditions of high strain rate loading (equivalent to those experienced during wave slamming) with the ultimate goal of developing a standardized testing protocol that includes rigorous mechanics principles and affordable laboratory instrumentation.

DESCRIPTION: Current test standards used by industry for determining material mechanical properties of composite materials can be difficult and sometimes complex. Most methods that are used to characterize material properties are provided by the ASTM International or the former Suppliers of Advanced Composite Materials Association standards. These procedures are based on quasi-static loading and do not provide a complete characterization of the candidate materials, especially in the medium to high strain rate regimes that are now common to high performance military and recreational marine craft. Composite materials react differently to dynamic loading and can not be characterized quasi-static extension. Additionally, for large parts using heavy fabrics, the American Society for Testing & Materials (ASTM) testing protocol is inappropriate. A new procedure is needed to accurately characterize the response of materials in wave slamming and impact loads allowing optimization of marine craft design and fabrication.

This effort seeks to investigate the relationship of operational loading to structural and material response relative to the design and performance of high-speed marine vessels. The objective of this effort is to investigate and understand the principals of materials responses in the medium to high strain rate load regimes leading to the development of a standardized testing protocol. Special emphasis will be placed on vessels constructed of advanced composite materials utilizing glass, carbon, aramid, and hybrid reinforcements, in vinyl ester and epoxy resins. Vacuum assisted resin transfer molding is the process of choice, as it applies to the U.S. Navy and the commercial boat building industries.

An expected outcome is improved panel or coupon testing that supports the design and construction of high-speed marine craft subjected to slamming loads. The development of a test procedure and apparatus shall simulate “real life” operational conditions and allows the evaluation of various reinforcements, cores, resins and processing methods common to the marine vessel design.

PHASE I: Study, analyze, simulate and model the response of structurally significant composites components (reinforced composite sandwich component) to high strain rate loading environments equivalent to wave slamming rates. Define and characterize typical dynamic loading events. Produce a design intended for an affordable computer controlled laboratory instrumentation device that will allow the characterization of composite materials against high rate dynamic loading.

PHASE II: Evaluate the design in Phase I, introduce the necessary modification to the design and fabricate the high rate dynamic loading device which will be used as part of a standard test procedure. Complete the high strain rate dynamic loading models to simulate dynamic wave slamming events. Develop a material characterization test procedure for high rate dynamic loading that will validate the test procedure, mechanical models and the instrumentation by using standard Navy coupons.

PHASE III: Demonstrate this technology in a larger scale. Develop a modeling correlation between slamming / impact loading of composite panels to fatigue life. Establish a larger standard coupon that is appropriate to characterize large parts made with heavy fabrics. Initiate an addition to the ASTM testing protocol. Establish flaw criticality criteria and identify cost-effective Non-Destructive Evaluation (NDE) technology to quickly locate flaws in complex laminate structures. The Naval Sea Systems Command (SEA 05) and commercial shipbuilding entities would likely be very interested in a successful demonstration of this enhanced realistic composite material testing protocol.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This phase is not funded by the SBIR program office. The PI will seek Navy program funding geared at demonstrating this technology in a larger scale.

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4. Garme K., Rosén A., "Experimental Pressure Investigation on High-Speed Craft in Waves", Proc. International Conference on Hydrodynamics of High-Speed Craft, RINA, UK, 2000.

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KEYWORDS: structural composites, dynamic loading, wave slamming, mechanical behavior, modeling and testing

N08-087 TITLE: <u>Next-Generation Mobile Software Defined Radio</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Tatical Radio Systems - Network Enterprise Services ACAT I

OBJECTIVE: Design and development of a software-defined radio platform that achieves wide frequency coverage and reprogrammability with low size, weight, and power consumption.

DESCRIPTION: Software Defined Radios (SDRs), when deployed in the field, can be reprogrammed with new waveforms, applications, and other functionality with a software upgrade. To achieve the impact of this concept, innovative component technologies and system engineering is needed to produce wideband and completely reprogrammable radio platforms. In general, implementations of radios with wide bandwidth, high-performance RF selectivity, and true reprogrammability of waveform processing do not have the long battery life required of mobile handsets. The goal of this project is to define, design, and develop a high-performance mobile/handheld SDR radio platform that incorporates innovative components and architectural approaches to meet requirements.

PHASE I: Develop an architecture and approach for the Next-Generation Mobile Software Defined Radio. RF frequency coverage should be 2 MHz to 2 GHz continuous, with programmable bandwidths to at least 40 MHz where applicable. Micro-Electro-Mechanical Systems (MEMS) filters should be considered to achieve the low power consumption of equal importance to RF performance. The usage of very low power consumption digital devices, used in novel configurations, should be considered when defining the system architecture and design. Develop a preliminary system design that models the RF, signal processing, and general purpose processing. Estimate the power, size, and weight of the product and explain superiority compared to present-day commercial products. Use the public release JTRS Software Communications Architecture (SCA) and Application Program Interfaces (APIs) as a reference for defining the radio infrastructure. Consider the Software Defined Radio Forum's Future Multiband Multiwaveform Modular Tactical Radio (FM3TR) waveform as an example application. Produce a conceptual design for a development environment, including signal flow diagrams, and scheduling partitions, to demonstrate how the development environment can emulate the FM3TR waveform and permit waveform development.

PHASE II: Develop and demonstrate the Next-Generation Mobile Software Defined Radio designed in Phase I. Where costs preclude full implementation of all component technologies, provide analysis to extrapolate the performance of a complete design. Waveform design will be performed in parallel to hardware design using a development environment. Reprogrammability of the radio shall be demonstrated with a second waveform provided by the government. RF performance and power consumption will be demonstrated.

PHASE III: Expand the implemented component technologies and the radio infrastructure to complete a radio platform compatible with commercial and Homeland Security markets. Port a civil defense waveform such as the Association of Public Safety Communications Officials (APCO) 25 into the Next-Generation Mobile Software Defined Radio.

PRIVATE SECTOR COMMERCIAL POTENTIAL: SDRs offer the potential for significant cost savings to many commercial markets including telecommunications, broadcasting, and consumer electronics. SDRs also provide for enhanced interoperability and spectrum reuse for International and Homeland Security applications. New component technologies and radio infrastructures are needed to extend the programmable capabilities into long battery life handsets.

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KEYWORDS: software defined radio; SCA; communications; waveform; virtual radio; JTRS; MEMS

N08-088 TITLE: Universal Air-to-Ground Broadband Networking Communications Waveform

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

ACQUISITION PROGRAM: Joint Tactical Radio System (JTRS) Network Enterprise Domain (NED) ACAT I

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

OBJECTIVE: Develop a broadband, networking communications waveform that enables robust high-speed communications among air, maritime, ground, and disadvantaged users.

DESCRIPTION: Current military communications “waveforms,” which is defined here as all aspects of a radio communications implementation from the user’s data to the radio frequency spectrum, have historically been designed by a single service for a specific operational need. Until recently, there has not been a Joint focus upon in-theater tactical communications among all service platforms; consequently, no communications waveform has been designed for this purpose. Partner foreign services are also important players in current and future warfare, and therefore this waveform would be shared with our international partners.

In emergency services, communications links specifically designed for aircraft-to-ground use have not been developed; conventional terrestrial waveforms are used. As a consequence, the bandwidth capabilities and robustness of these communications links is not adequate to support the high bandwidth connectivity needed to leverage the full capabilities of the aircraft platforms such as high-resolution surveillance and reliable IP connectivity.

There is a significant technical challenge to developing such a waveforms, because the dynamics of an air platform impose a certain set of requirements upon the waveform while the multipath and fading environment of ground communications imposes others. The characteristics of each are well understood, but there has not been a 21st Century effort to develop an optimal universal waveform that achieves high performance capabilities using high power DSP and Software Defined Radios. Our international partners are also developing SDR products, which will enable the distribution of this new waveform as a software upgrade to their fielded systems.

PHASE I: Document the performance requirements for this new waveform. Perform basic modeling and simulation to validate that the proposed waveform could feasibly meet the requirements when fully developed.

PHASE II: Create a highly accurate software simulation of the approach derived in Phase I that is capable of stressing key performance requirements in the required environments. Demonstrate performance capabilities and validate that the required digital processing requirements are feasible using available Software Defined Radios (SDRs). Create a partial implementation of the waveform that can be loaded into available SDRs to enable field-testing. The Government’s repository of communications software source code and available modeling and simulation resources will be made available to the vendor.

PHASE III: Refine the waveform based upon Phase II results. Complete the implementation of the waveform and support porting to Joint Tactical Radio System (JTRS) radio sets. Support formal Development testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Homeland Security is working towards the use of Unmanned Air Vehicles (UAVs) and other airborne assets to monitor the border and other high priority locations such as harbors and the coastline. There is a need for reliable communication of information such as real-time video and real-time control between these airborne assets and border patrol or other homeland security personnel. In addition law enforcement often uses airborne assets for surveillance and fire fighters for coordinating efforts against large wildfires. The technology developed from this topic is directly applicable to these non-DOD air-to-ground communications applications.

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3. Software Communications Architecture, JTRS Standards, JPEO JTRS, http://jtrs.spawar.navy.mil/sca/home.asp

KEYWORDS: Air-to-ground; waveform; communications; software defined radio; JTRS; data link

N08-089 TITLE: Many-to-Many Real-Time Collaboration Environment

TECHNOLOGY AREAS: Information Systems, Sensors, Human Systems

ACQUISITION PROGRAM: ACAT III, IV; PEOs Space, C4I, IWS; PMWs 160, 150, 790, 760; SPAWAR 056

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OBJECTIVE: Develop a tactical, self-organizing, self-healing, low-bandwidth Mobile Ad Hoc Mesh Network (MANET) that can provide voice, video, data and application-sharing in a many-to-many collaborative environment. Use a model-driven, simulation-based, architectural framework (simulation architecture framework) to integrate the routing and video transmission protocols. Integrate state-of-the-art simulation languages with the simulation architecture framework to allow operational views to be fully articulated and boundary conditions fully described, so that the views can be derived and applied to all phases of integration through test and evaluation in system design and development. Application of the simulation architecture framework results to test and evaluation and exercises will provide a validation mechanism for the entire model.

DESCRIPTION: Every node must be able to both add information to and search for information from the network. No special nodes (such as servers) are required that operate in a substantially different manner from other nodes in the network. The solution must be able to run on extremely low bandwidth networks that have the potential for high packet loss, such as very-high-frequency (VHF) radio, long range/mesh WiFi/WiMax and VSAT. The solution must also be able to link people on Internet and MANET (where the two networks are segmented except a bridging node). The combined routing and video transmission protocol solution will be iteratively designed and simulated (for eventual inclusion in a Battlegroup Experiment) with architecture processes and tools (discrete event simulation languages, such as: EXTEND, SIMPROCESS, and SIMSCRIPT III.

PHASE I: Demonstrate/evaluate the feasability of the conceptual framework for a scalable, self-organizing, collaborative, distributed, MANET database that can push and pull video, voice, text and application sharing to a large number of nodes (MANET video network). Provide a scenario to be used for Phase II in conjunction with Navy operational personnel participation. Develop a scenario environment that consists of: afloat and ashore receivers and control units; a large number of low and high bandwidth nodes; and the communication of situational awareness data consisting of voice, acoustic, radar, video, text and/or a desk-top applications that can be shared among mobile units/nodes that self-organize and self-heal. Deliver a network, capability specification that describes the components that must be brought together to provide this combined functionality. This will include a simulation that mimics the operational environment with fixed and mobile nodes with varying bandwidth. The proposed solution must define the approach, processes, and tools required to complete the development. An initial demonstration of components of the design will be required.

PHASE II: Prototype the self-organizing database and develop a simulation that mimics the operational environment as closely as possible. Evaluate the composability of the network. Composability should consider layers or different routing equations that are parameterized in terms of security, latency, speed, capacity, and user priority. Develop the architecture framework, products and the visual templates that present the simulation environment. The interactions should result in the Architecture Framework becoming the Human Machine Interface (HMI) to the simulation.

PHASE III: Deploy the prototype for experimental verification and validation in an operational experiment or demonstration. Instrument the experiment to test the dynamics of the network. Instrumentation will measure, at a minimum, dropped packets, latency, information assurance, maximum load and the ability to respond to disruption of the network. Instrumentation will test the recoverability of the data, text, voice, video and applications shared. The experiment and scenario will cause deliberate disruptions to the network. Develop and test the ability to pass control seamlessly. Test the recoverability of compressed data (text, voice, video and application sharing). Measure the scalability of the system as a function of available bandwidth, network topology, and number of participants. Demonstrate the composability and robustness of the network to information assurance (red teams to include jamming) and intrusion detection capability. Build integration and production templates from the simulation architecture framework so that it can be applied commercially, especially where there is potential of providing a large reuse opportunity in design, test and training.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: If the collaborative environment remains successful under stress, it will be applicable to tactical edge battlegroup circumstances, emergency response (hastily formed networks) and all mobile networks, wireless networks, wired and wireless networks and training/mentoring/apprentice circumstances, including remote medicine. Remaining successful under stress means that the collaborative environment can: self-organize and self-heal with a large number of nodes; preserve video Quality of Service (QoS) over several hops in the network; and preserve application-sharing over several hops in the network. If the model-driven, simulation-based approach can be proven by its application to the synthesis of the routing and video transmission protocols, it will have applicability to all enterprise architectures that are based upon the Services Oriented Architecture (SOA) paradigm. For example, it would be used in any enterprise such as homeland security/defense, emergency response finance, banking, airline scheduling and reservations and education networks. The approach will also significantly shorten the development time of all enterprise architectures.

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2. Averill M. Law and W. David Kelton, McGraw-Hill Higher Education - December 30, 1999, ISBN: 0-07-059292-6

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KEYWORDS: High throughput; low-bandwidth; self-organizing; self-healing; application sharing; video transmission; ad hoc mesh network

N08-090 TITLE: Miniaturized Modular Fiber Optic/Copper Hybrid Circular Connector

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

ACQUISITION PROGRAM: Submarine Antenna Modernization and Sustainment (SAMS)

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

OBJECTIVE: The objective of this SBIR topic is to identify and develop technologies to miniaturize hybrid fiber optic/copper circular connectors. The ultimate goal of this SBIR topic is to field a dual use military/commercial grade miniature hybrid connector in the next generation Buoyant Cable Antenna system as well as in any other communications system that could benefit from this technology.

DESCRIPTION: There are many problems associated with waveguide and coaxial cabling. The shortfalls of these two power transmission methods can be minimized or even eliminated by using optical energy transmitted with fiber optics. In this scheme, Radio Frequency (RF) energy is converted into optical energy before entering the transmission line- the fiber optic cable. At the end of the transmission line the optical energy is modulated back into

RF energy where it continues on to a termination. This type of communication system relies upon active outboard components to convert the optical energy to RF so that it may be used.

A hybrid connector is required so that optical and electrical signals may pass through a single connector somewhere inboard of the transmission line termination. The problem with hybrid connectors available right now is the packaging size. An industry survey reveals no truly miniature hybrid connectors that are suitable for subsurface, tightly packaged communications systems. The available connectors are either not rated for subsurface operations or are too bulky to be efficiently used. Miniaturization of existing designs poses new problems in the form of tighter tolerances. Current fiber optic connectors rely heavily on concentric tolerances and mating tolerances in the microns to maintain low connector loss.

Ultimately, this hybrid connector would possess the following characteristics:
rigid section size to be no larger than .625 in. in diameter and 1.25 in. in length when mated (strain relief does not count as rigid body length), minimum of six electrical and one fiber optic contact, minimal assembly, minimum of 50 assembly/disassembly cycles, pressure sealed and rated for deep sea submergence, minimum mated tensile strength of several hundred pounds. Ideally, the connector would have a modular insert which would allow the designer of the system the ability to choose any combination of electrical or fiber contacts with a maximum of seven slots available while using a common connector shell.

PHASE I: Asses the feasibility of designing a miniaturized hybrid connector with the minimum properties outlined in the description portion of this topic. Approaches should consider Finite Element Analysis (FEA), solid modeling, simulations, or any other applicable means.

PHASE II: Design and develop a prototype to be delivered to the US Government. Final design work, development of the materials and methods for production, demonstration of a proof-of-concept prototype, and validation tests are to be completed. Additionally, Military robustness and functionality such as shock, vibration, and connector characteristics are to be assessed during this phase.

PHASE III: There are applications that exist already in the military and civilian markets. Civilian applications would include the telecommunications industry, offshore oil industry, underwater vehicles, and in general, any other uses where subsurface hybrid operation is desired. Military applications include submarine communications systems, electronic warfare systems, and intelligence systems.
The communications industry is increasingly moving away from copper conductors as a primary means of transmission medium and towards a fiber optic infrastructure for increased connectivity and bandwidth. While the transition from copper to fiber is occurring, there is a specific need for hybrid connectors that allow one connection to be made for both fiber optic and copper conductors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology that would be developed as a result of this SBIR topic could be used in the telecommunications industry and off-shore oil industry as a way to ruggedize and miniaturize existing hybrid connections. The telecommunications industry, in recent years, has been moving from copper conductors as a primary transmission medium to a fiber optic based communications platforms. This industry would primarily benefit from the smaller size and reduced number of connections that have to be made. The off-shore oil industry could potentially benefit in the same manner as the telecommunications industry with the addition of a pressure sealed connector capable of being submerged up to several thousand feet.

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Environment Fiber Optic Connectors”, Online Paper, Ocean Development Inc., 4pgs, 19JUN07 <http://odi.com/ODI_Documents/Articles_and_Papers/pdf/Oceans-MTS2003-JenkinsPaper.pdf>

KEYWORDS: Fiber Optic; Hybrid; Electrical; Connector; Miniature; Subsurface; Circular; Modular; Optical;

N08-091 TITLE: Middleware Specification for Low-Power Distributed Processing Devices

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Tactical Radio System (JTRS) Network Enterprise ACAT I

OBJECTIVE: Develop a middleware specification and corresponding development tools that enable software-defined, hardware-independent high-speed communications among distributed processors in an environment in which size and power consumption must be minimized.

DESCRIPTION: Increasingly, military and commercial devices utilize a distributed processing approach that maximizes the usage of existing chipsets and software/firmware to implement complex systems. In addition, the scale of these complex systems is being reduced down to battery-powered small form-factor devices utilizing embedded processing such as smart phones, PDAs, Software Defined Radios (SDRs), and expendable sensors. Currently, software for these devices is strongly hardware dependent; this minimizes the potential for software reusability among similar hardware platforms produced by different manufacturers. Middleware used commercially in devices such as smart phones and low-end networking devices is very limited in scope and not applicable to military systems. Legacy open-standard middleware currently used in military systems, such as the Common Object Request Broker Architecture (CORBA), provide adequate capabilities but are too complex for economical use in the small form-factor devices that commercial and military customers demand.

A scalable, expandable, middleware architecture is needed that can meet the current and future needs for high-speed data interface, extensive control functionality, isolation among processing segments, and hardware-independent reusable software while optimally utilizing the next-generation of low-power microprocessors. Core functionality must be implemented using a very low overhead approach and developers need to be able to utilize additional functionality as needed to optimize the usage of available hardware capabilities.

PHASE I: Beginning with existing open-standards, develop an enhanced specification that addresses the anticipated next-generation requirements of military and commercial distributed processing systems. Define the software interfaces and middleware functions that will be required to implement the capability. Perform a simulation experiment to demonstrate that the approach when implemented will result in a significantly reduced overhead load compared with legacy middleware.

PHASE II: Implement and test the performance of the proposed standard when integrated into a reference Software Defined Radio intended for emergency services and commercial applications (i.e., no Type I encryption). Using an actual embedded hardware/software system or a high-fidelity simulation, demonstrate that the middleware meets the Phase I requirements.

PHASE III: Complete development of the standard functionality and development tools. Work with a prime vendor of a Joint Tactical Communication System (JTRS) radio set to integrate the capability into a production model. Promote the new standard for use in commercial, foreign, and other military applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial, international and Homeland Security embedded distributed-processing products utilize middleware. This new specification will result in improved performance and enable smaller form-factor products to be developed. This vendor would sell, maintain, and support middleware to the product manufacturers.

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KEYWORDS: software defined radio; CORBA; embedded computing; security; JTRS

N08-092 TITLE: Low-Overhead Software Communications Architecture (SCA) Core Framework (CF) for Small Form Factor (SFF),Low-Power Software Defined Radios (SDRs)

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Tactical Radio System, Network Enterprise Domain (NED) ACAT I

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

OBJECTIVE: Develop a scalable Software Communications Architecture (SCA) suitable for implementing Software Defined Radios (SDRs) in personal-mobile packaging that can be configured to meet DOD waveform and Type 1 high-assurance encryption requirements but can also be optimized to implement unencrypted non-DOD specific waveforms at minimal production cost.

DESCRIPTION: The Software Communications Architecture (SCA) utilized by the Joint Tactical Radio System (JTRS) provides a common architecture for Software Defined Radios (SDRs) that can host current and planned military and commercial radio communications waveforms; this enables fielded radio systems to maintain capabilities and interoperability by loading software updates rather than replacing the complete radio systems. However, the available SCA Core Framework (CF) implementations have been optimized for multi-channel, DoD radios. The resulting size and complexity may be incompatible with the size, weight, power, and production cost constraints for small form factor, personal-mobile, and inexpensive public service/consumer radios. Additionally, improvements in the SCA could possibly enhance the performance of waveform software applications or alternatively reduce the cost of the processing components used. ”Lightweight” SCAs have been described in literature since 2002 [Ref 2], and approaches have been proposed by different organizations. New technologies are available and it should be possible to improve the current specification.

PHASE I: Conduct design trade studies and perform a proof-of-concept demonstration for a lightweight, scalable, high assurance SCA for small form factor SDR transceivers. The study shall identify performance criteria, any changes needed to the baseline JTRS SCA, and applicable test tools needed to implement the approach.

PHASE II: Develop and demonstrate a lightweight, scalable, high assurance SCA “reference implementation” on a small form factor SDR transceiver. Document as a stand-alone architecture and also as a change proposal package to the current JTRS SCA.. Demonstrate the implementation in accordance with performance criteria developed in Phase I.

PHASE III: Transition the “lightweight” SCA technology to applicable small form factor JTRS developments and other low-cost or non-DOD applications, including the Department of Homeland Security Project SAFECOM and potential first responder transceivers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is currently a significant market demand for an affordable SDR in certain DoD/Government Agency, emergency services, Homeland Security, and high-end consumer/hobbyist applications. The product of this project will provide an industry standard that can be leveraged to create new products for these markets.

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Source: (http://enterprise.spawar.navy.mil/UploadedFiles/JTRS_OVERVVIEW_MILCOM06_v12.pdf)

2. SDR Forum Security Working Group, "High-Level SDR Security Requirements", document SDRF-06-A-0002-V0.00, 19 January 2006. Source: (http://sdrforum.org/uploads/pub_37308206_a_0002_v0_00.pdf)

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KEYWORDS: Joint Tactical Radio System (JTRS), Software Communication Architecture (SCA), Information Assurance (IA), software defined radio (SDR), software tools, lightweight SCA.

N08-093 TITLE: Co-site Interference Mitigation for VHF/UHF Communications

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

ACQUISITION PROGRAM: Joint Tactical Radio System (JTRS), Ground Mobile Radio (GMR), ACAT I

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

OBJECTIVE: Develop and demonstrate techniques to mitigate the impact of unintentional interference in the VHF and UHF communications bands caused by high-power transmitters located in close proximity to the communicator.

DESCRIPTION: As military operations increasingly rely upon communications and surveillance equipment, these systems are ever more prone to cause mutual interference. Cellular telephone operators frequently combat service-degrading interference to their network induced by nearby commercial, amateur, and military transmitters. Procedural solutions have been used historically to mitigate this issue with a modest degree of success, but the continuing proliferation of transmitter devices is overwhelming this approach. Rather, the communications equipment requires a defense mechanism to enable communication in the presence of high-level interferers.

In the presence of an in-band strong interferer, the Radio Frequency (RF) Front End of many radios will overload and become effectively disabled. As a first level of defense, the amplitude of a high-level in-band interferer must be reduced to a level low enough to ensure normal RF operation of the radio. The operation of such a device must be transparent to the user; it must be able to support the presence of multiple simultaneous interferers, and it must be implemented using hardware technology that can be implemented in a small form factor. It is also acceptable to utilize a systems level approach that includes networked communications and negotiations with a friendly interfering device in order to achieve performance objectives.

PHASE I: Conduct a Preliminary Design Review for a device capable of reducing the levels of high-level interferers in accordance with the following requirements: (1) Frequency Range - VHF and UHF bands; (2) Minimum number of interferers to cancel simultaneously – Three; (3) Required Operator Input – Frequency range of operation; (4) Minimum attenuation of interferer – 40 dB. Use a hardware prototype or simulations to validate the potential of the proposed technique.

PHASE II: Utilize Modeling and Simulation (M&S) or build hardware/software prototypes to test and validate proposed technical approaches. Determine applicability of approach for a net-centric mobile, shipboard, and terrestrial non-mobile installation scenarios. If approach is validated, design a limited-capability prototype system using representative hardware. Support the Government in performing field testing with the device.

PHASE III: Complete implementation of system. Fabricate Engineering Development Models. Support Government Development testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The frequency band the performance characteristics required for tactical military requirements are also shared by the cellular telephone industry. This technology could be applied to cellular base stations and potentially cell phones themselves to reduce the number of cell sites required and the robustness of calls with phone users.

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1. Joint Chiefs of Staff Net Centric Operational Environment Project: http://www.jcs.mil/j6/netcentric.html

2. Net Centric Operational Environment: http://www.jcs.mil/j6/ncoeproject.ppt#787,1,Net-centric Operational Environment

3. Joints Net-Centric Operations Campaign Plan, Annex A: http://www.jcs.mil/j6/c4campaignplan/JNO_Campaign_Plan.pdf

KEYWORDS: JTRS; interference; jamming; EMI; Spectrum; Common Timing Protocol.

N08-094 TITLE: Scaleable, Self-Organizing, Self-Healing Distributed Database in a Mobile Ad Hoc Mesh Network (MANET)

TECHNOLOGY AREAS: Information Systems, Battlespace, Human Systems

ACQUISITION PROGRAM: II, III, IV; PEOs Space, C4I, IWS, EIS; PMWs 150, 160, 760, 790, SPAWAR 056

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

OBJECTIVE: Develop a tactical, self-organizing, self-healing, low-bandwidth Mobile Ad Hoc Mesh Network (MANET) that can support a distributed database. The MANET must support fixed, control bandwidth overhead for the routing protocol regardless of network size and be available both low and high-bandwidth links including mobile nodes and fixed wireless links.

DESCRIPTION: Develop a self-organizing, self-healing, low-bandwidth distributed database without a central point of failure or reliance on servers. Any subset of nodes should be able to separate from the network and share information. Broken connectivity will not automatically result in the loss of database capability for the warfighter.

PHASE I: Develop the conceptual framework and demonstrate the feasibility of a scalable self-forming database that meets the following criteria:
1) Distributed database “network” scalable to hundreds of thousands of nodes.
2) Bandwidth usage remains fixed at a minimal percentage regardless of network size.
3) Allow participation by reduced capacity nodes, such as sensors and handheld computers (PDA’s, Blackberry’s, etc.).
4) A subset of nodes must be able to function in the same manner as they would in the larger network. When no communication with the main network is possible, any subset of nodes can separate from the main network and still function in the database.

5) Every node performs the same actions. No special nodes (such as servers) are required that operate in a substantially different manner from other nodes in the network.
6) Every node must be able to both add information to the network and search the network for information.
Make use of Navy resources to develop a thorough understanding of the operational environment and deployment scenarios. Particular emphasis will be paid to determine both the average and worst case scenarios.

PHASE II Prototype the self-organizing database and develop a simulation that mimics the operational environment as closely as possible. It will include both fixed and mobile nodes with varying bandwidths. Demonstrate the feasibility of integrating several ad hoc mesh networks (of different network types) into one network. Use the simulation to test varying data loads and mobility patterns. Expected performance for both average and worst case networks will be compared. Key metrics such as packet delivery ratios, latency and jitter will be recorded. Comparisons will be made against AODV, DSDV and any other protocols available in the simulation suite.

PHASE III: Deploy the prototype in a low-bandwidth, wireless network to test the self-organizing database in typical environments. Bandwidth may vary from 10Kbit to 1000Kbit but control bandwidth usage must be within five to fifteen percent. Integrate out of range nodes into the distributed database by positioning the nodes in a series of hops configuration and test the throughput through multiple hops. Test the systems effectiveness in application sharing by having the Navy provide a list of legacy, single-user applications to be integrated into a Common Operational Picture (COP). Test the protocol in a live network demonstration for 1) Radio Compatibility and Efficiency Analysis.
and test the throughput through multiple hops.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Industries and social agencies (police, fire, CIA, FBI, hospital emergency response, etc.) will benefit from a self-organizing distributed database. Oil and gas industries require hundreds of thousands of sensors and wireless devices that would benefit from a self-organizing database.
The successful implementation of the distributed database for Blue Force will generalize to courier companies and other location dependent services. Police and fire fighters could maintain a distributed real-time database for every unit to track events as they unfold. This would have been enormously helpful during the attacks the World Towers on September 11, 2002.
A self-organizing, self-healing, MANET distributed database would assist Emergency response sensors and wireless devices to monitor unfolding events in natural and manmade disasters. This distributed database would have been enormously helpful during the Hurricaine Katrina disaster in New Orleans.

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1. Bikram S. Bakshi , P. Krishna , N. H. Vaidya , D. K. Pradhan, Improving Performance of TCP over Wireless Networks, Proceedings of the 17th International Conference on Distributed Computing Systems (ICDCS '97), p.365, May 27-30, 1997

2. Josh Broch , David A. Maltz , David B. Johnson , Yih-Chun Hu , Jorjeta Jetcheva, A performance comparison of multi-hop wireless ad hoc network routing protocols, Proceedings of the 4th annual ACM/IEEE international conference on Mobile computing and networking, p.85-97, October 25-30, 1998, Dallas, Texas, United States

3. Holland, G. and Vaidya, N. 1999. Analysis of TCP performance over mobile ad hoc networks. In Proceedings of the 5th Annual ACM/IEEE international Conference on Mobile Computing and Networking (Seattle, Washington, United States, August 15 - 19, 1999). MobiCom '99. ACM Press, New York, NY, 219-230.

4. F. Kordon and Luqi, "An Introduction to Rapid System Prototyping", IEEE Transactions on Software Engineering, Vol. 28, No. 9, September, 2002, pp. 817-821

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6. Luqi and Berzins, V. Rapidly Prototyping Real-Time Systems. IEEE Software. September, 1988

KEYWORDS: Distributed Database; MANET; Scalable; Collaborative; Heterogeneous; ad hoc mesh network; low bandwidth

N08-095 TITLE: High-Strength, Long-Length Optical Fiber for Submarine Communications at Speed and Depth

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

ACQUISITION PROGRAM: Submarine Communications at Speed and Depth (CSD), PMW 770, ACAT III

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

OBJECTIVE: To investigate advanced materials, spool design, and winding/spooling technologies that will facilitate development of a long length (10 km or greater) expendable optical fiber and deployment spool for use in communications and surveillance buoys that can be used by submerged submarines at high speed (15 knots or higher). Current developmental approaches using this technology have been limited in deployment speed and length or are unaffordable in a production system.

DESCRIPTION: Submarines do not have the capability to transmit in the RF domain at any significant data rates while traveling below periscope depth. As a result, submarines operating at tactical speed and depth are unable to be full participants in Network Centric Warfare operations. To give submarines this capability, as well as provide the flexibility of two-way communications while submerged, an expendable communications buoy connected to the submarine by a high-speed-capable, long-length fiber optic tether is being developed.
The buoy must be deployed using the submarine's 3-inch launcher. The fiber needs to be designed to mitigate the hydrodynamic issues arising from deployment and ascent of the buoy.
Key Challenges to achieving the above goals are:
(1) Identifying new or advanced environmentally friendly materials from which to fabricate the optical fiber.
(2) Selecting an appropriate binding agent that will allow high-speed winding of multiple fiber spools simultaneously, while still preserving the fiber's optical properties and integrity, as well as the ability to deploy the fiber underwater at high speed.
(3) Improvement of fiber spool winding technologies, including investigation of both inside and outside fiber payout, and developing the capability to wind multiple fiber spools at high speed simultaneously.
(4) Three dimensional computer modeling of the fiber spooling and deployment to understand the effect of spooling speed tension and the binding agent.

PHASE I: Explore and define innovative materials and approaches to providing submarines with a long (10 km or longer) fiber optic link to the ocean surface. The size constraints of an expendable buoy, type of fiber, speed of the submarine, fiber length, and the maximum load/strain that the fiber can support must all be taken into account. The effort should also include innovative design studies into an automatic system that will provide the capability to wind multiple fiber spools at high speed simultaneously.
The contractor shall perform detailed analysis and modeling of both the optical fiber materials evaluated and the mechanical winding systems investigated or designed. This analysis and modeling should substantiate any recommendations made and show that the chosen design will meet the objectives and criteria set forth herein. The design must address the following risks:

- High strength low bend radius SM fiber (50 um +/- 1um diameter) development at 1550 nm optical band
- Optimum design for the fiber winding pack (10 KM or more per spool)
- Simultaneous, multiple-spool winding technology development
- 3-D Dynamic model development for the fiber pay out

PHASE II: Finalize and optimize the designs chosen in phase I, and build and test prototypes of both the fiber optic spool and the automated spooling machine. Prototype testing shall include demonstrations of both high-speed tether deployment and the ability to simultaneously wind multiple (> 2) spools, to verify that the fiber and spool meet the design specifications.

PHASE III: Transition technology to the Communications at Speed and Depth (CSD) program. Provide units for at-sea use in a tethered expendable buoy.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The oil exploration industry and the oceanographic research community routinely utilize undersea sensors. Although deployment speed is not typically a concern, the requirements for length, robustness, and environmental safety of the deployed optical fiber are similar to those of the military application. The technology developed might also be of value for data exfiltration from Unmanned Undersea Vehicles (UUVs).

REFERENCES:
1. W. Polini and L. Sorrentino, "Influence of winding speed and winding trajectory on tension in robotized filament winding of full section parts", Composites Science and Technology, Vol. 65, Issue 10, August 2005.

2. Naval Underwater Systems Center, New London Laboratory, classified paper "Tethered Expendable Two-way Communications Buoy Development Options Paper Brief", November 1988.

3. Optical fiber winding technology paper presented by Berkeley Process Control, Inc. at 2003 conference on system that reduces spool quality rejections and fiber production costs.

4. M. Kono, "Winding and packing of optical fiber for deployment from remotely controlled underwater vehicles", Proceedings of the winter annual meeting of the American Society of Mechanical Engineers, November 1981.

KEYWORDS: fiber; optical; payout; buoy; submarine; tether

N08-096 TITLE: Atmospheric Acoustic Propagation Prediction

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: NITES ACAT IV

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

OBJECTIVE: Develop a computationally efficient and accurate means to predict atmospheric acoustic propagation (AAP) characteristics for a wide range of sources to include ground and air vehicles and ordinance detonation.

DESCRIPTION: The variability of the physical environment has a significant impact on sensor systems and platform vulnerability of Navy/USMC ground vehicles, boats and aircraft. Of the various aspects of the physical environment, the local acoustic propagation conditions play a significant role in force protection and platform detection by changing the acoustic signature and range characteristics. Anomalous propagation conditions (sound focusing) can enhance or degrade operational detection ranges and ranges at which threats can be detected by friendly forces. Additionally, the same propagation conditions can have a very significant impact on the range at which a ground vehicle, boat or aircraft can be counter detected by an enemy asset. The accurate prediction of local propagation conditions is a prerequisite to effectively managing the impacts of varying atmospheric acoustic propagation and optimizing sensors and systems for tactical advantage.

Over the past few decades, a number of approaches have been recommended and employed to improve local estimates of propagation conditions. Although many provide accurate propagation algorithms that allow for estimation of atmospheric acoustic propagation conditions, they often have less than optimal characteristics such as estimating errors in the overall acoustic performance prediction when environmental forecast errors are present. This requires rigorous assimilation and analysis techniques coupled to a sensing strategy to more fully exploit knowledge about local propagation conditions, while leveraging existing and future sensing capabilities.

The AAP prediction system must couple the physics of the environment to the source's acoustic signature to deliver accurate acoustic predictions for acoustic sensing systems to include the human ear. Innovative techniques to couple source, propagation environments and receiver within an architecture to permit modular upgrades on various source and receiver models as well as physical environmental forecast models. An ability to assimilate available acoustic observations to accurately estimate uncertainty in prediction performance should be a central capability of the AAP Prediction System. The prediction uncertainty should include an analysis of both errors in the source characteristics as well as the errors in the prediction model to include environmental forecast errors.

PHASE I: Develop the conceptual design of an AAP prediction system, based on a four dimension (time and space) atmospheric representation with uncertainty measures based on data assimilation/fusion scheme that is constrained by both the data and physics based models. This architecture must take into account the various confidence levels of collected data and provide for methodologies to develop advanced data quality control and assimilation algorithms. The design must address the uncertainty associated with any data fusion and business logic processes in terms of the parameters provided to operators. The design must be developed in sufficient detail to permit a reasonable evaluation of the approach, using either simulated data or available environmental data to demonstrate the feasibility of the selected technology or technique.

PHASE II: Develop a working prototype system and a conduct demonstration to quantify the accuracy of the system. Test the prototype data assimilation system and document the system characteristics to include system performance in a range dependent time varying environment. Human system interface (HSI) elements should be included in the design of the prototype planning system to facilitate data quality control. Demonstrate the value of the proposed system with the use of performance metrics – e.g. the assimilation and fusion process must be completed within time constraints dictated by the perish ability of the specific data types being fused. Available meteorological forecast data sets can be used in the demonstration as environmental inputs to the acoustic propagation algorithms.

PHASE III: The prototype capability will be transitioned to the Navy Integrated Tactical Environmental Sub-system (NITES) applications suite under the NITES Next Generation POR and provided to the Naval Oceanographic Office to support Reach-back Concept of Operations. The contractor shall work with the METOC Production Centers and NITES Program leads to develop an acceptable concept of operation (CONOPS) for the fusion capability.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology successfully developed in this project will have multiple military and commercial applications. Military applications will include feedback to mission planners to optimize sensor performance with respect to operational range and to assess vulnerability to minimize counter detection risks.

Non-military applications will include the ability to apply this capability to provide improvements to numerous commercial flight operations in support of acoustic noise abatement efforts, assist a wide range of commercial users in predicting acoustic noise level variations and provide tools that permit industrial operators to adjust their activities in order to remain compliant with permitted noise levels under dynamic atmospheric conditions.

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3. Lingevitch, J.F.,Collins, M.D., Dacol, D.K., Drob, D.P., Rogers, J.C.W., and Siegmann, W.L., "A wide angle and high Mach number parabolic equation", J. Acoust. Soc. Am., Vol. 111, No. 2, February 2002, pp 729-34

4. Salomons, E.M., "Computational Atmospheric Acoustics", Kluwer Academic Publishers, 2001

KEYWORDS: Atmospheric Acoustic Prediction; Acoustic Propagation; Four Dimensional Atmospheric Forecast; Data Assimilation; Anomalous propagation; Prediction Uncertainty

N08-097 TITLE: Multiple Channel SINCGARS Multiplexer

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Ships Signal Exploitation Equipment Increment F (ACATIII)

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

OBJECTIVE: To develop a multiplexer that divides up the 30-88 MHz frequency band into a minimum of 30 channels with a minimum of 30 dB isolation between channels from band center to band center. This multiplexer must be smaller than 18 inches X 18 inches X 4 inches and have an insertion loss of less than 8 dB.

DESCRIPTION: Current state of the art in multiplexer design only allows the 30 to 88 MHz to be divided into 14 frequency bands and in an 18 inch X 18 inch X 4 inch package. This task is intended to develop the technology to build a 30 to 88 MHz multiplexer that can provide a minimum of 30 frequency bands with a band center to band center isolation of 30 dB and an insertion loss in band of 8 dB maximum. These bands are required to allow the frequency hopped Single Channel Ground and Airborne Radio (SINCGARS) signal to be blocked in one of these bands and allow desired signal reception in the other bands. The greater the number of frequency bands the less frequency band will be blocked by the SINCGARS signal allowing reception over a greater portion of the band. Two of these multiplexers will be connected back to back in a Comb Limiter Combiner (CLIC) configuration and switches or limiters will be used to eliminate the frequency hopping SINGARS interferer and allowing desired signals to pass through the non-interfering bands.

PHASE I: Assess technical issues and risks associated with developing this multiplexer. Conduct computer modeling and demonstrate that this multiplexer can theoretically be built and provide a plan on how this multiplexer would be built to meet the performance and size requirements.

PHASE II: Design, Develop, manufacture and deliver two each advanced prototype multiplexers in compliance with the above specification. Validate the performance through calibrated RF measurements. DemonstrateShow that when these prototype multiplexers are connected back to back excessive ripple (greater than 6 dB) does not occur due to unmatched filter roll-offs. Under the Phase 2 Option task, the advanced prototype multiplexers will be assembled into the CLIC architecture with switches, limiters or other devices to limit the power through each channel and low noise amplifiers installed after these devices. Demonstrate this CLIC device showing rejection of a SINCGARS-like signal and transmission of desired signals.

PHASE III: Develop a pre-production version of the 30+ channel CLIC system. This pre-production CLIC will be integrated into on board SSEE system and its Military Utility Assessment will be determined in an operational sea trial.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This multiplexer technology could be used by the cellular telephone industry to connect several transmitters to the same antenna, increasing the number of transmit channels that could be coupled to one antenna.

REFERENCES:
1. United States Patent 6549560, Comb limiter combiner for frequency-hopped communications.
C. J. Savant Jr., et al., Electronic Circuit Design, An Engineering Approach, p. 43, 1987.

KEYWORDS: Multiplexer; CLIC; SINCGARS; comb; limiter; Combiner

N08-098 TITLE: High-Capacity Primary Battery for Extreme Environments

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Electronics

ACQUISITION PROGRAM: Joint Tactical Radio System (JTRS) Handheld Manpack Program ACAT I

OBJECTIVE: To develop a primary (non-rechargeable) battery technology that can provide high-energy capacity suitable for low power electronic devices (such as sensors or communications devices) at military operational and storage temperature extremes.

DESCRIPTION: Currently there are no commercially available battery technologies/cell sizes that enable the manufacturing of a battery pack that will meet all of the performance requirements of the JTRS handheld radio (or other portable devices that include high-power consumption devices such as microprocessors and power amplifiers): 12 ampere-hours of capacity at a temperature of -40C when packaged within 14 cubic inches and a weight of 0.7 pounds or less. (Commercially available batteries provide only 25% of this capacity.)

It may be possible to use existing chemical technologies to achieve the desired performance (e.g., Lithium Carbon Monofluoride), but the architecture and construction of the battery cells must be capable of supporting the military range of temperature extremes (operating at - 40 deg C to + 55 deg C and storage temperature range of -51.1 deg C to 71 deg C) and retaining the required compactness and lightweight characteristics of the assembly.
This research effort will also include the development of a State of Charge (SOC) technology for the selected chemistry and cell design, which will enable operators to determine if the battery should be replaced prior to performing the mission. In order to develop this technology, several environmental factors beyond the discharge profile must be factored into the SOC technology (e.g., temperature, humidity and O2 exposure times). Any additional components required to implement the SOC technology should be small and have low power consumption and cost impacts on the overall battery assembly.

PHASE I: Design the battery cell and battery assembly architecture. Build and test laboratory cells to validate the viability of the cell design in regards to capacity, SOC measurement concept, temperature performance, and safety/environmental issues. Use modeling techniques to validate the design of the overall battery assembly based upon the proposed cell design. More than one battery design may be proposed for investigation in Phase II.

PHASE II: Take the most promising candidate(s) and build prototype cells/batteries. Conduct testing on these batteries using the established discharge profiles at the predetermined low temperature benchmarks. Make required changes to the design if required and re-test.

PHASE III: Build production ready samples to test in field conditions. Prepare safety assessment reports. Contractor will support field testing and data collection efforts for the batteries. Provide input required to develop the government performance specification.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Development of this primary battery technology could easily be leveraged by various federal, state, and municipal police, fire department, and first responders which also utilize handheld radios. (i.e. Land Mobile Radio LMR) This ensures that a broad commercial base exists for this technology and the development of an improved battery technology can be incorporated into the existing batteries will increase their operating times and reduce the overall operating and support costs.

REFERENCES:
1. Arek Suszko, “Lithium Carbon Monofluoride: The Next Primary Chemistry For Soldier Portable Power Sources,” 25th Army Science Conference, Nov 2006.

2. Laura M. Cristo and George W. Au, "Large, Multi-cell Batteries for US Army Applications", Proceedings of the 41st Power Sources Conference, 14-17 June 20043. http://assist.daps.dla.mil/quicksearch/; MIL-STD-810F Environmental Test Methods and Engineering Guidelines

KEYWORDS: JTRS; communications; battery; handheld; commercial; technology; COTS; rechargeable; non-rechargeable, State-of-Charge, manufacturing; mission

N08-099 TITLE: Spectrum Planning and Management Capability for Radio Communications

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Tactical Radio System (JTRS) Network Enterprise Domain ACAT I

OBJECTIVE: Develop, test, and demonstrate a software application capable of running in real-time on a Software Defined radio, to monitor and characterize the Radio Frequency (RF) spectrum that is in use in a local area, identify available spectrum for reliable communications, and dynamically allocate spectrum usage to networking and legacy waveforms based upon a pre-programmed rule-set.

DESCRIPTION: Current operations in Iraq and Afghanistan illustrate the increasing scarcity of spectrum resulting in self-jamming and less effective tactical operations. Increasing needs for greater bandwidth to accommodate voice, video and data exchange exacerbate the problem. Current spectrum planning tools are ineffective and allow for exploitation of less than 10% of the available bandwidth. More advanced approaches are needed to monitor and measure spectrum, and intelligently allocate available spectrum based on ongoing tactics, propagation, and available connectivity among numerous users in the tactical arena. The spectrum planning tool must be aware of routing, and link-state properties of each user (networking node), and then make decisions to maximize spectral reuse by networking waveforms. The tool must be able to rapidly recognize and characterize signals in the spectrum and subsequently predict future availability. Maximizing spectral reuse throughout the area of operations involves dynamic allocation of available frequencies to nodes on a time slot by time slot basis without requiring operator management, or relying on extensive mission pre-planning. This capability is expected to be implemented as a real-time software application running in an embedded environment such as a Software Defined Radio (SDR); for example, in the Joint Tactical Radio System (JTRS) family of radios in conjunction with its high capacity networking waveforms.

PHASE I: Design and develop innovative concepts of implementing the spectrum monitoring and predictive algorithms, and implement them as efficient real-time software processes within an SDR. Develop a representative software implementation and environment for demonstration and test of the algorithms. Provide a plan for practical deployment within JTRS and commercial crisis management systems. Establish performance effectiveness parameters (metrics).

PHASE II: Develop a software prototype spectrum planning and management system and provide a demonstration of the capability to JPEO JTRS Network Enterprise Domain. The demonstration should identify potential capabilities that can be adapted by JTRS domains as well as developmental and implementation costs, porting and adaptation of the software to the real-time operating system environment and Application Programming Interfaces (APIs) of JTRS radios, and other concerns if applicable. Demonstrate performance effectiveness with experiments and testing of the prototype system.

PHASE III: Complete development of the application and obtain JTRS Test and Evaluation certification. Under the JTRS family of programs, port software to applicable form-factors for DoD fielding. Provide software upgrades and support to JTRS family of radios over life cycle of software application.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Several recent disasters have indicated the value to emergency services that would be enabled by utilizing un-used RF spectrum in the affected geographical area. This software application can also be ported to commercial SDRs that are currently being developed for civilian emergency and Homeland Security use. The vendor would develop the software to meet the applicable requirements, provide regular updates, and provide life-cycle support for the users.

REFERENCES:
1. Naval Science Foundation – Digital Government / Rapidly-deployable broadband wireless, ITR – Wireless video sensor networks (CNS-0312655), - Advanced networking (DGE-9987586)

Office of Naval Research – Navy Collaborative Integrated Information Technology, Advanced Wireless Integrated Navy Networks (AWINN)
Catalyst Communications Technologies – Peer-to-peer radio interoperability, Project 25 interoperability using radio over IP
Software Communications Architecture, JTRS Standards, JTRS JPEO, http://jtrs.spawar.navy.mil/sca/home.asp

KEYWORDS: spectrum monitoring; dynamic spectral allocation; networking; communications; spectrum management; software; JTRS

N08-100 TITLE: Improved UHF Satellite Communications Networking Waveform

TECHNOLOGY AREAS: Information Systems, Sensors, Space Platforms

ACQUISITION PROGRAM: Joint Tactical Radio System (JTRS) Network Enterprise ACAT I

OBJECTIVE: Design and development of a new SATCOM networking protocol and waveform that is compatible with the legacy Ultra High Frequency (UHF) Satellite Communications (SATCOM) constellation and tactical terminals.

DESCRIPTION: The DoD UHF SATCOM constellation provides critical beyond line-of-sight communication for mobile platforms and dismounted soldiers. Because of world-wide frequency spectrum allocations, the capacity of this resource can only be increased through technology innovation at the physical, link, multiple-access, and network layers of the communication system. The innovation must be compatible with the existing and future UHF satellite constellations and be limited to software-only changes to the current generation of terminal implementations. Capacity increases should be a substantial multiplier to justify changes to the deployed communication devices throughout the DoD. Because the SATCOM system must support voice communication, the new waveform/implementation should not introduce substantial communications latency.

PHASE I: Generate a preliminary design of a new or modified UHF SATCOM waveform. Provide spectral analysis of the waveform, demonstrating compatibility with the spectral mask of the UHF system. Through either closed form analysis or simulation, provide preliminary estimates of system capacity. Provide a system analysis demonstrating how the architecture and design is compatible with the legacy/future satellite constellations and mobile terminals.

PHASE II: Complete the design of the physical, link, multiple-access, and network layers. Develop detailed performance estimates of the proposed waveform. Implement the waveform in a software defined radio environment and measure actual performance. Implementation may be demonstrated at Intermediate Frequency (IF) rather than UHF radio frequencies.

PHASE III: Implement the new SATCOM waveform as a Software Communications Architecture (SCA) compliant JTRS waveform for incorporation into one or more JTRS radios. Support prime radio vendors in the integration and testing of the waveform. Submit data to support the approval of the waveform by regulating agencies. Support vendors of legacy UHF SATCOM terminals in the development of an upgrade to the existing terminals.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial, international and Homeland Security mobile satellite communications is limited by availability of scarce frequency spectrum. Capacity multiplication through an innovative waveform can facilitate additional customers and services.

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1. Gary R. Huckell, Edward W. Chandler, "Datagram-transfer protocol for UHF SATCOM", MILCOM 2000 - IEEE Military Communications Conference, no. 1, October 2000 pp. 640-644.

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3. Sidney J. Graser, "Techniques for improving power and bandwidth efficiency of UHF MILSATCOM waveforms", MILCOM 2001 - IEEE Military Communications Conference, no. 1, October 2001 pp. 647-651.

4. T. L. Tapp, R. L. Mickelson, R. A. Groshong, C. Behmlander, J. T. Graf, J. C. Whited, "Turbo-detected coded continuous-phase modulation for military UHF satellite communications", MILCOM 2002 - IEEE Military Communications Conference, no. 1, October 2002 pp. 147-150.

5. James A. Norris, "Data throughput on MILSATCOM channels using military standard 188-184 and 188-181B", MILCOM 2003 - IEEE Military Communications Conference, no. 1, Oct 2003 pp. 493-498

KEYWORDS: software defined radio; SATCOM; communications; waveform; UHF

N08-101 TITLE: Active Conceptual Modeling Technology Supporting Joint C4ISR

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMW 180 DIO-S, DISA/NECC

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

OBJECTIVE: Improve the automation of Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) activities for warfighters by developing Active Conceptual Modeling (A-CM) technology tools that can capture the dynamics of evolving C4ISR operational scenarios (e.g., Joint Operational Planning, Force Protection, and Maritime Domain Awareness), represent them in a form of database built to contain such dynamic characteristic data, and perform advanced retrospective exploration or analysis on that data to accomplish such things as provide info-forensics, generate trends and their relationships, backtrack data sources to the occurrence of specific events, monitor changes in information and events, extrapolate the future progression of incidents, identify where facts are possibly missing, and support learning from past experiences.

DESCRIPTION: Due to limitations in dynamic modeling and database technology, current DoD C4ISR information systems can only reflect the static characteristics of operational C4ISR domains of interest. Individual static snapshots are captured through an implicit or explicit conceptual model, providing the most recent information only as a single snapshot in time. Therefore the notion of time and spatial relationships between entity/event behaviors and uncertainty is not and cannot be fully modeled. Therefore data changes, schema changes, and historical information and their changes cannot be managed, and the certainty of information cannot be assessed. A wide spectrum of situations resulting from different degrees of importance of relationships from different perspectives cannot be represented. Limitations in modeling and the processing of changes over time have led to inadequate application support for C4ISR in DoD missions such as the Global War on Terrorism (GWOT) and Maritime Domain Awareness (MDA). New methods of conceptualization, new ways of viewing reality, and new types of databases are required. Historical data, which may reveal changes of events/activities, must be available for retrieval, trend analysis, anomaly detection, and future studies/actions.

PHASE I: Explore the feasibility of extending the mathematical framework for Entity-Relationship (ER)-based active conceptual modeling to represent scenario snapshots that include time, space, uncertainty, and perspective dimensions. Also explore mechanisms for the computation and representation of differences between snapshots for model evolution. Evaluate the feasibility of developing information services derived from active conceptual modeling (as identified in the objective section above).

PHASE II: Further develop the mathematical framework for ER-based A-CM and design and develop prototype tools for information services identified in Phase 1. Identify metrics for evaluating these tools and demonstrate the utility of the tools for operational scenarios in mission areas such as GWOT, Humanitarian Disaster Relief, Noncombatant Evacuation Operation, or Crisis Action Planning and Execution.

PHASE III: Develop applications using real world data from major operational exercises or experimentation events. Include efforts to transition technology to military commands and the commercial sector.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Active conceptual modeling can be used for developing dynamic business process models in Service Oriented Architectures (SOAs). Results from the proposed technology development will yield new information services, which are applicable to military and commercial applications including law enforcement, info-forensics, lessons-learned systems, medical/patient information systems, and automated information archiving systems.

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KEYWORDS: active conceptual modeling, Entity-Relationship Approach, multi-dimension conceptual model, info-forensics, learning, Joint decision support

N08-102 TITLE: High Throughput and Low Latency Multi-Hop Mobile Ad-hoc Network (MANET) Multimedia Streaming

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: II, III, IV; PEOs C4I, Space and IWS; PMWs 160, 150, 790, 760, SPAWAR 056

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

OBJECTIVE: While MANET promises to significantly increase the available Navy bandwidth, existing MANET throughput decreases exponentially as the number of hops increases (hops > 4). This research will enable: 1) a multimedia stream to hop over hundreds of nodes without quality degradation and 2) hundreds of multimedia steams to cross a single node without quality degradation; 3) an advance in the state-of-the art videoconferencing and legacy application virtualization.
Develop an end-to-end software solution (based on low-cost commodity hardware) that allows a multimedia stream (voice-over-internet-protocol [VoIP], videoconferencing, screen/application sharing, file transfer, and biological/chemical sensor data) to hop over a large number of nodes without quality degradation as defined by psychological human factor quality-of-service (QoS) requirements.

DESCRIPTION: Existing MANET solutions have difficulty delivering a multimedia stream over a large number of hops. This research will develop novel software solutions to maintain high throughput and low latency for multimedia delivery over a large number of hops. The solution should: allow >1 Mbps and <500 msec of delay over 100 hops and be able to handle the cross-stream interference from multiple steams flowing over a particular node; and allow low-bandwidth videoconferencing for multiple sites (>100); exploit the difference in human factor requirements for QoS for different multimedia (audio vs. video, vs. sensor data, etc) to optimize the streaming of different media types; use advanced compression and networking techniques to achieve a significant reduction (10X) in bandwidth compared to existing commercial solutions; advance in the state-of-the art videoconferencing and legacy application virtualization; adapt to a variety of networks (available bandwidth, packet loss rate and jitter); support FIPS 140-2 256 bit AES encryption; record the training sessions; and be able to run as a web-service or as a stand-alone program on segmented/closed/MANET networks.

PHASE I: Review existing approaches and invent new algorithms specifically for the Navy low-bandwidth environment. Conduct simulation of proposed algorithms and compare to existing approaches. Measure throughput, delay, and multimedia QoS degradation as a function of the number of hops and number of streams. Measure audio, video, and screen sharing fidelity at different network bandwidths and topologies. Verify that the system can automatically adapt to different network streaming topologies and achieve theoretically efficient path discovery. Conduct paper-based user studies on the effectiveness of the proposed user interface. Based on measurements, predict the expected limits of the solution.

PHASE II: Develop a prototype of the proposed solution. The prototype will run on commodity laptops and hand-held PDAs and should not require specialized modifications or dedicated hardware. Measure the scalability of the system as a function of available bandwidth, network topology, number of participants and effectiveness of the user interface. Measure the time required to learn how to use the system; the frequency of user confusion and the smoothness of user experience.

PHASE III: Deploy the prototype in a field trial of at least 100 nodes to validate the solution. Measure throughput, delay, and multimedia QoS degration as a function of number of hops and streams. Test the systems effectiveness in application sharing by having the Navy provide a list of legacy, single-user applications to be integrated into a Common Operational Picture (COP).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS:
If this SBIR can demonstrate that high throughput and low latency multi-hop MANET multimedia streaming is possible, it would solve a parallel need in the business and education communities. It could provide networks to developing countries (e.g. in Africa) where infrastructure-based networks is not cost-effective. The resulting network could deliver distance education, just-in-time remote training and telemedicine. The capability is critical to First Responders in hastily formed networks, where the Internet is not available due to natural or man-made disasters. The system could play an important role in government. In the event of a natural or man-made disaster in the Nation’s Capital, it might be necessary for Congress to meet virtually. The capability would allow Congress members to meet from their home office to carry out their duties.

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KEYWORDS: MANET; multi-hop; display interface; low bandwidth compression; multimedia QoS; videoconferencing