NAVY
PROPOSAL SUBMISSION

INTRODUCTION:

The responsibility for the implementation, administration and management of the Navy STTR program is with the Office of Naval Research (ONR). The Navy STTR Program Manager is Mr. Steve Sullivan. If you have questions of a general nature regarding the Navy's STTR Program, contact Mr. Sullivan (steven.sullivan@navy.mil, 703-696-7830). For inquiries or problems with electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST). For technical questions about a topic, contact the Topic Authors listed under each topic before **19 February 2008**. Beginning **19 February**, for technical questions you must use the SITIS system **www.dodsbir.net/sitis** or go to the DoD website at **http://www.acq.osd.mil/sadbu/sbir** for more information.

The Navy's STTR 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 STTR program can be found on the Navy STTR website at **http://www.onr.navy.mil/sbir.** Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil.**

PHASE I PROPOSAL SUBMISSION:

Read the DoD front section of this solicitation for detailed instructions on proposal format, submission instructions and program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000. The technical period of performance for the Phase I base should be 7 months and will commence on or about 01 July 2008. The Phase I option should be 3 months and address the transition into the Phase II effort. Phase I options are typically only funded after the decision to fund the Phase II has been made. Phase I technical proposals, including the option, have a 25-page limit (see section 3.4). The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award.

All proposal submissions to the Navy STTR Program must be submitted electronically. It is mandatory that the entire **technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR/STTR Submission website at** http://www.dodsbir.net/submission**. This site will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents is submitted separately through the website. To verify that your technical proposal has been received, click on the "Check Upload" icon to view your uploaded technical proposal. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457 (8AM to 5PM EST). Your proposal** must **be submitted via the submission site before** 6:00 a.m. EST, Wednesday, 19 March 2008**. An electronic signature is not required when you submit your proposal over the Internet.**

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

PHASE I ELECTRONIC 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 through the Navy SBIR/STTR website. It must not exceed 700 words and should include potential applications and benefits. 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.

PHASE II PROPOSAL SUBMISSION:

Phase II proposal submission is by invitation only. Only those Phase I awardees who achieved success in Phase I, measuring the results achieved against the criteria contained in section 4.3, will be invited to submit a Phase II proposal. If you have been invited to participate, follow the instructions provided in the invitation. The Navy will evaluate and select Phase II proposals using the evaluation criteria in the DoD solicitation. All Phase II proposals must be submitted electronically through the DoD SBIR/STTR Submission website.

Under the new OSD (AT&L) directed Commercialization Pilot Program (CPP), the Navy SBIR/STTR 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 during 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 through the Navy SBIR/STTR website at the end of their Phase II.

PHASE II ENHANCEMENT:

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy STTR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy may provide a one-to-four match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in additional STTR funds for $1,000,000 match of acquisition program funding can be provided, as long as the Phase III is awarded and funded during the Phase II.

ADDITIONAL NOTES:

1. The Naval Academy, the Naval Postgraduate School and other military academies are government organizations and therefore do not qualify as partnering research institutions or subcontractors. In the special case of an otherwise qualifying proposal, if there is a compelling need for participation by such an institution, a request for a waiver of this regulation will be sent to the Small Business Administration (SBA); and the contract award will be contingent on the receipt of this waiver.

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

3. 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 <u>must be met</u> or your proposal will be REJECTED.

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

____2. Your complete STTR Phase I proposal (coversheet, technical proposal, cost proposal, and DoD Company Commercialization Report) has been submitted electronically through the DoD submission site by 6:00 a.m. EST, Wednesday, 19 March 2008.

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

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

Navy STTR 08.A Topic Index

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N08-T031	Antenna design by genetic algorithms
N08-T032	Ad Hoc Wireless Network for Rapidly Moving Disadvantaged Users
N08-T033	Energy management system for unmanned, untethered sensors
N08-T034	Extensible Affordable Software Defined Radio with Cross-Band Cross-Protocol Capability

Navy STTR 08.A Topic Descriptions

N08-T001 TITLE: Blast and Impact Resistance of Polyurea Coatings on Metallic and Non-Metallic Materials

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Program Manager Advanced Amphibious Assault (PM AAA) - ACAT 1D

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: Research, develop and characterize polyurea materials ability to increase blast and fragment protection.

DESCRIPTION: The Marine Corps EFV is a 76,000 lb armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. The EFV design is limited due to competing requirements: 1) The design must be light weight, 2) must maintain current ground clearance, and 3) must increase survivability. The polyurea family of materials shows the potential to increase blast protection via application onto metallic and non-metallic materials. Further research is required to implement this technology onto ground based vehicles. The selected material(s) must demonstrate the ability to function in extreme operating environments which include but are not limited to -25°F to +120°F, hot dessert blowing sand, full salt water immersion and immersion in petroleum based liquids. In addition to environmental conditions the coating(s) must demonstrate the ability to be applied on and perform on complex geometric shapes and act as a blast mitigator and fragment suppressor. The intent of this technology research is to increase blast and fragment protection up to and including STANAG 4569 Level 4a and 4b.

PHASE I: The contractor shall conduct research into the polyurea family of coating materials suitable for use in the environmental, geometric and blast/fragment condition. The contractor shall develop a methodology for optimizing the thickness and location of the coating on various substrates. Substrate materials will include but are not limited to aluminum alloys, rolled homogenous armor (RHA) and composites. Based on their research, the contractor shall create a conceptual design including estimated weight, cost and performance characteristics

PHASE II: The contractor shall manufacture a prototype(s) and conduct ballistic testing to validate their design meets EFV specified performance levels and characterize the coating performance. The results of the ballistic testing, when applied to the performance of the EFV will be considered classified.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development and characterization of the blast and fragment mitigation properties of polyurea materials should enable the design engineers to select new and innovative methods to optimize design criteria, and to tailor these designs based on the material characteristics. Presently, there is a strong need to develop blast and fragment protective solutions for uses in various military and commercial land and sea based vehicles. This technology is also applicable to the protection of structures.

REFERENCES:
1. EFV S/SS Specification Rev H. dated 21 June 21, 2006.

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

3. MIL-STD-889B Dissimilar Metals

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

5. STANAG 4569

KEYWORDS: Ballistic; Materials; Polyurea; Lightweight; Blast Mitigation; Fragment Protection

N08-T002 TITLE: Innovative Approaches to the Automated Simulation of Aircraft Structural Joints in Structural Analysis Models

TECHNOLOGY AREAS: Air Platform, Weapons

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop an automated expert based approach to accurately represent the details of a structural assembly, including fastener type, hole geometry and detailed parts.

DESCRIPTION: Aircraft structural optimization requires significant detail in the analysis models used to evaluate strength and fatigue capabilities. The aerospace industry has seen great improvement in the design and manufacturing of parts and assemblies due to advances in CAD geometry and automated manufacturing. On the analysis front, current pre-processor tools are improving in their automation of meshing a single part. However, the ability to automatically create a high fidelity analysis model of structural assemblies does not exist. During analysis, detailed models of assembled structures that include the full geometry are not attempted. Instead, simplified and inadequate models of the assembly are used, resulting in inaccurate representations of the effects on the global structure and highly inaccurate analyses. The deficiencies with the current analytical approaches can be witnessed in an array of full scale test programs with major premature failures resulting from the unexpected failure at assembly locations deemed “non-critical” during structural analysis. Such an approach leads to costly retrofits and/or program delays. The ability to perform accurate structural analysis on assembly locations the first time would allow development programs to proceed on schedule without the interruptions created by test failures.

Innovative structural simulation algorithms are sought to automate the geometry integration and allow structural joints to be represented in multiple levels of detail appropriate for the target of a given analysis. A tool is sought that could be applied organically on existing programs and by OEMs on new and existing programs to allow precise simulation of structural assemblies to better understand design details and impact of repairs and detail changes. The linkage between design/geometry and analysis should be maintained from the top level model down to the lowest level detail model. This may allow for full comprehension of the effects of design changes on all aspects of a structures performance prior to building a single part. This innovation should provide the ability to perform iteration of a design leading to optimization of structural details for efficient and maintainable designs.

PHASE I: Develop and conceptually demonstrate the proposed approach to automating the simulation of aircraft structural joints in structural analysis models.

PHASE II: Develop the algorithm(s) required to produce the prototype software tools. Demonstrate use of the prototype tools through creation of an analytical model of a selected structural component and determine its structural response under test conditions. Perform structural testing on the selected component to validate the developed structural simulation tools.

PHASE III: Implement the validated algorithm(s) and process in a released version of software. Apply this analysis tool to structural analysis applications on aircraft program structural improvement and development efforts.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This structural analysis algorithm and process as implemented in the structural simulation software will be directly applicable to all commercial aerospace developers. The ability to perform accurate structural analysis the first time allows development programs to proceed on schedule without the interruptions created by test failures. Additionally, reliability/repairability issues can be highlighted and addressed in the design phase rather than later when the cost to fix the problem is significantly escalated.

REFERENCES:
1. J. Bortman and B. A. Szabo, Nonlinear models of fastened structural connections, Computers and Structures, 43, 909-923 (1992).

2. Lambert, John C.; Merritt, Brent J. Automated Stress Analysis - Reducing Stress Analysis Time by an Order of Magnitude, MSC 1995 World Users' Conf. Proc., Paper No. 41, May, 1995.

3. M.W. Hyer, "Effects of Pin Elasticity, Clearance, and Friction on the Stresses in a Pin-Loaded Orthotropic Plate," Virginia Polytechnic Inst. & State University, VPI-CCMS-85-04, March 1985.

4. AD-TR-61-153, "Load Deflection Characteristics of Joints," Appendix B, p. 158-170.

KEYWORDS: Structural Simulation; Structural Analysis; Structural Assembly; Fastener Analysis; Joint Analysis; FEM

N08-T003 TITLE: Low-Expansion, Thermal-Shock-Resistant Sensor Windows and Domes for High Speed Flight

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-201

OBJECTIVE: Develop low-thermal-expansion (<0.5 ppm/K), thermal-shock-resistant infrared-transparent sensor windows and domes for high speed flight.

DESCRIPTION: Sapphire is the most thermal-shock-resistant material currently available for high speed sensor domes and windows, but its thermal shock resistance is insufficient for some applications. When subjected to rapid heating, the difference in thermal expansion between hotter and cooler parts of the window shatters the material. Expensive, impractical active cooling systems can protect the window. The purpose of this STTR topic is to identify and develop new infrared-transparent materials with very low thermal expansion (<0.5 ppm/K) and low emissivity at elevated temperature. These materials will survive rapid heating without active cooling and will be able to operate at high temperature.

The selected material must provide good transmission, low optical scatter (<1%), and low emittance (<1%) in the 3-5 micron wavelength range. For infrared transmission and operation at temperatures up to 600ºC or higher, metal oxides are likely candidates. Heavy metallic elements increase the range of infrared transmission wavelengths. Silicates are not likely candidates because they generally do not transmit well at 3-5 ?m. If a composite composition is made, both phases would have to be nanoparticles—much smaller than the wavelength of infrared radiation—so that the 2-phase material does not have significant optical scatter.

The goal by the end of this project is to produce optical quality disks and domes with a diameter of 75 mm and a thickness of 2 mm.

PHASE I: Identify a material or composite system with near zero thermal expansion over a wide range of temperature (0-600ºC) and good infrared transmittance in the 3-5 micron wavelength range. Prepare the material and measure its thermal expansion and infrared transmission. Single crystals, pressed powders or powders could be used for these measurements.

PHASE II: Fabricate optical quality specimens and measure infrared transmission and scatter, thermal expansion, thermal conductivity, Young's modulus, and mechanical strength. Fabricate optical quality disks and domes.

PHASE III: Develop a commercial process to provide sensor windows and domes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In addition to its military market, there is a small commercial market for thermal-shock-resistant windows for industrial process monitoring and spacecraft applications.

REFERENCES:
1. T. Suzuki and A. Omote, "Zero Thermal Expansion in (Al2x(HfMg)1-x)(WO4)3," J. Am. Ceram. Soc. 2006, 89, 691.

2. J. Catafesta, J. E. Zorzi, C. A. Perottoni, M. R. Gallas, and J. A. H. da Jornada, "Tunable Linear Thermal Expansion Coefficient of Amorphous Zirconium Tungstate," J. Am. Ceram. Soc. 2006, 89, 234 and references cited therein.

3. D. C. Harris, "Materials for Infrared Windows and Domes," SPIE Press, 1999.

KEYWORDS: Infrared Window; Infrared Dome; Sensor Window; Thermal Shock; Ceramics; Low Thermal Expansion; High Speed Missiles

N08-T004 TITLE: Knowledge Optimized Displays of Information in Human Computer Interaction (HCI)

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PMA-205 Aviation Training

OBJECTIVE: Develop and demonstrate innovative software inclusive of cognitively optimized design solutions and guidelines for display of highly complex performance assessment data in the Common Operating Picture (COP) to assist instructors in trainee performance assessment in Live, Virtual and Constructive (LVC) training events.

DESCRIPTION: Knowledge optimized displays of information are required to easily and rapidly digest the diverse streams of information inherent to large-scale, LVC distributed simulation-based training events. Instructional environment management and performance assessment is dependent on rapid access to shared high quality knowledge, and the synchronizing, de-biasing and integration of diverse data types into shared knowledge vehicles merging into a knowledge rich COP. Innovative approaches to development of algorithms and interface designs for graphic user interfaces are sought.

The goal is to develop software to enable and sustain readiness, fitness and endurance of individuals engaged in knowledge management and decision making involving any form of Human Computer Interaction (HCI). Proposed solutions should maintain a COP across the various military echelons and diverse platforms represented in LVC training events. This development should be built upon a sound theoretical framework based in the cognitive sciences and computer engineering. Proposed designs should minimize cognitive overload by capturing complex information and transforming it into organized knowledge structures easily consumed by instructors. Moreover, this technology is expected to be ready and demonstrable for information integration at the team level. Solutions should be highly intuitive to human operators and users, and require minimal to no on-the-job training.

PHASE I: Demonstrate feasibility of using knowledge optimized displays of information in instruction in to represent complex data sets and enhance training effectiveness. Provide a proposed concept of operations for the prototype to be developed in Phase II.

PHASE II: Develop and demonstrate HCI-based prototype in an information dense distributed team decision making environment across dissimilar positions to validate the efficacy of this approach in a simulation-based training environment. Develop a base object model to define data required to populate GUI knowledge structures.

PHASE III: Develop guidelines for extension of this technology to team knowledge displays (repositories and displays) and harden the architecture of the Phase II prototype for transition. Transition the technology to the LVC training environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be applied in any industrial-organizational setting that requires the integration of masses of data to support distributed team decision making. This technology could also be extended to modality disabled communities (visually or auditorily impaired individuals, including veterans) to enhance accessibility.

REFERENCES:

1. Adams, R. (2006). Decision and stress: cognition and e-accessibility in the information workplace. Universal Access in the Information Society, 5, 363-379.

2. Bahr, G. S., Balaban, C., Milanova, M. & Choe, H. (2007). Nonverbally Smart User Interfaces: Postural and Facial Expression Data in Human Computer Interaction. In C. Stephanidis (Ed.), Universal Access in HCI, Part II, HCII 2007, LNCS 4555, 740–749. Berlin, Germany: Springer-Verlag.

3. Wheeler Atkinson, B., Bennett, T., Bahr, G. S. & Walwanis Nelson, M. M. (2007). Multiple Heuristics Evaluation Table (MHET): Software Development and Usability Analysis Heuristics Table. In C. Stephanidis (Ed.), Universal Access in HCI, Part I, HCII 2007, LNCS 4554, 563–572. Berlin, Germany: Springer-Verlag.

KEYWORDS: Knowledge; Graphic User Interface; Display Design; Human Computer Interaction; Command and Control; Display Algorithms

N08-T005 TITLE: VSTOL Perceptual Skills Training

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA-205 Aviation Training

OBJECTIVE: Develop intelligent training system technology that would accelerate skill acquisition rates of vertical short take-off and landing (VSTOL) platform operators. Application of basic research findings could enhance VSTOL operator training via greatly simplified visual perceptual sets that actually promote situation awareness.

DESCRIPTION: Innovative perceptual skills trainer technology is needed to enable VSTOL operators to discriminate between mission-critical visual cues and distracters (e.g., objects such as rocket propelled grenades), and safely navigate environmental dangers while piloting their aircraft. Training VSTOL operators to react visually to these environmental dangers is a difficult task because they occur both rarely and under a variety of conditions including brown outs (i.e., dust clouds), dim lighting, poor weather, crowded airspace, and varied altitudes, orientations, and speeds.

Crashes resulting from the lack of experience combined with poor perceptual cues may be alleviated if operators were trained to instead respond to a radically different and greatly simplified set of visual cues. Recent entomological research examining the visual cues employed by flying insects suggest that an extremely simplified set of perceptual cues that emphasize motion over depth perception may be all that are required for safely performing even sophisticated acrobatic flight maneuvers in challenging (i.e., sight limited) environments. In addition, NASA research has examined the benefits of simple 2D visualizations [7] [5] for enhanced flight situation awareness.

Additional research is needed to leverage the results from previous work done on the benefits of 2D visualizations and simple visual cues used by flying insects and combine that basic research with recent advancements in camera lens technology enabling humans to see images as with an insects compound eye [8]. The purpose of this new research would be to optimize these areas of work into a new approach to VSTOL skills training.

An intelligent tutoring system with a greatly simplified visual display is sought. The prototype trainer would need to be compact enough to be used in a classroom or ready-room onboard ship. The prototype trainer must provide visual and signal stimuli in a self-paced and progressive manner that enables operators to rapidly reach expert skills for VSTOL operations. It should enable discrimination, classification, and estimation of other objects near the vehicle in a manner that captures the variety of potential errors (e.g., hits, misses, false alarms, correct rejections) along with the context in which these errors occur. It should also provide a trainee the same sensitivity and responsiveness of the actual controls for such vehicles, in order to rapidly condition the operators' motor skill development. The prototype trainer should provide training managers with evidence of the system's effects on trainee performance and also must be reconfigurable, in order to keep pace with today's rapidly evolving weapons platforms.

PHASE I: Conduct basic experiments that demonstrate feasibility of a simplified visual display system for effective flight control. Conduct a gap analysis of current methods of training VSTOL operators and restate as new behaviorally-based pilot performance objectives. Identify interfaces that would allow for self-paced intelligent tutoring based upon proposed prototype trainer.

PHASE II: Design and build prototype training device based on research conducted during Phase I. Conduct test and evaluation of the prototype device with sponsoring VSTOL platforms at locations to be determined. Produce Instructor/Operator manuals for the device. Propose how the research findings could be applied to other current and future VSTOL platforms. Propose how cockpit flight instrumentation could be reengineered for safer and more intuitive VSTOL flight operations.

PHASE III: Enhance prototype developed in Phase II and install at training facilities. Transition the prototype to other VSTOL training organizations.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Such systems could also have a dual application of serving as a new simpler user interface for operation of VSTOL. The training system would also have a wide law enforcement (e.g. border patrol) market.

REFERENCES:
1. Bone, Elizabeth; Bolkcom, Christopher (2003) Unmanned Aerial Vehicles: Background and Issues for Congress, Report for Congress, Order Code RL31872. Link to: http://www.fas.org/irp/crs/RL31872.pdf on July 13, 2007.

2. Cuntz, H., J. Haag, F. Förster, I. Segev and A. Borst, Robust (2007). Coding of flow-field parameters by axo-axonal gap junctions between fly visual interneurons, PNAS, online first, June 12, 2007 Link to: http://www.physorg.com/news102085519.html AUG 15, 2007.

3. Dickinson, Michael H. (2003). Come fly with me. Engineering and Science, California Institute of Tech. Link to:http://pr.caltech.edu/periodicals/EandS/articles/LXVI3/fly.html. AUG 15, 2007.

4. Estock, J.L., Alexander, A.L, Gildea, K.M., Nash, M., Blueggel, B. (2006). [New technology for assessing fidelity requirements for attaining training objectives] A model-based approach to simulator fidelity and training effectiveness. Proceedings of the 28th Annual Interservice/Industry Training, Simulation and Education Conference, Orlando, FL.

5. Prinzel, Lawrence J., III; Kramer, Lynda J.; Arthur, Jarvis J.; Bailey, Randall E.; [2006]; Multi-Dimensionality of Synthetic Vision Cockpit Displays: Prevention of Controlled-Flight-Into-Terrain; 50th Annual Meeting of the Human Factors and Ergonomics Society, 16-20 Oct. 2006, San Francisco, CA, USA; Link to: http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20060053287_2006255400.pdf ; July 13, 2007.

6. Staff and AFP (2006). Police launch eye-in-the-sky drone above LA 12:37 19 June 2006 New Scientist News Service. Link to: http://www.newscientist.com/article/dn9359.html July 13, 2007.

7. Wickens, C. D., Todd, S.,&Seidler, K. (1989, December). Three-dimensional displays: Perception, implementation, and applications (Tech. Rep. No. CSERIAC SOAR 89-001). Wright-Patterson Air Force Base, OH: Crew System Ergonomics Information Analysis Center.

8. Zyga, Lisa (2007) Focus images instantly with Adobe's computational photography. Physorg. http://www.physorg.com/news111141405.html

KEYWORDS: VSTOL; UAV; Perceptual; Training; Simulation; Brown out

N08-T006 TITLE: Stochastic Characterization of Naval Aircraft Electromagnetic Vulnerability

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Potential interest across all PEOs/PMAs

OBJECTIVE: Develop computational electromagnetic tools capable of characterizing the electromagnetic fields within Naval aircraft and the associated currents on avionic systems and their interconnecting cables in the operational electromagnetic environment. A key component of this tool is its ability to quantify the results in a stochastic sense in order to facilitate weapon system performance risk assessments.

DESCRIPTION: Naval aircraft come replete with interconnected electronic systems (e.g., communication, radar, and navigation systems). As the operating frequencies broaden and systems become more complex, their proper functioning is increasingly threatened by electromagnetic interference (EMI) from high-power external sources encountered in their operating environments [1-5] as well as internal sources. Because experimental testing of these systems' electromagnetic compatibility (EMC) in their operational environments comes late in the acquisition process, simulation tools are needed to gauge their system level immunity to EMI [6] as early as possible in the program in order to minimize acquisition cost and timeline. For such simulation tools to be useful, they have to be capable of accounting for the complexities encountered with this problem. This includes computing the fields within Naval aircraft cockpits, cabins and equipment bays as well as currents on objects such as avionic systems and the cables that interconnect them. Computations must be done over a broad frequency range representative of the operational electromagnetic environments and a nearly infinite number of source geometries fields on and within these complex structures. Computations should consider the presence of (imperfectly shielded) coaxial cables as they present additional coupling paths for noise to propagate to sensitive circuitry [7-9].

In reality, the complexity of both the physical structures and the variability of the electromagnetic sources are the source of significant uncertainty. First, the source may be a variety of shipboard radar or communication systems illuminating the aircraft either on the flight deck or as it operates in close proximity to the ship. The aircraft may be in nearly countless number of locations and orientations relative to the source antenna. Second the physical structure of the cockpit and cabin are not constant. The presence of cargo as well as the aircrew can significantly alter the field within the aircraft. New computational technologies that permit the characterization of EMC/EMI phenomena in complex systems while accounting for their stochastic nature and uncertainties in their composition and input-output characteristics are needed.

PHASE I: Develop a detailed description of the scope of the electromagnetic vulnerability problem and determine the feasibility of computational electromagnetic tools employed to stochastically characterize the fields within cockpits, cabins and equipment bays of Naval aircraft. Assess the required fidelity aircraft geometry models in order to adequately characterize the fields and currents in a statistical sense. Initially, emphasis should be limited to source frequencies below 2 GHz but ultimately addressing problems through 17 GHz. Proposed methods should be justified by both theoretical and experimental analysis.

PHASE II: Develop, demonstrate and refine a prototype computational electromagnetic and stochastic inference tool capable of assessing Naval aircraft electromagnetic vulnerability. The tools are to focus on system level analysis and should be robust in the face of geometry model fidelity variability. Usability is a key performance parameter. The performance of these tools is to be assessed through both experimental and theoretical methods.

PHASE III: Develop a commercial application suitable for use in evaluating a wide variety of commercial and military systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic has direct utility to a wide variety of commercial and military electronic EMC and EMI problems.

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KEYWORDS: Electromagnetic Interference; Electromagnetic Vulnerability; Statistical Electromagnetics; Electromagnetic Cavity; Radio Frequency Interference

N08-T007 TITLE: Photonic Switched True Time Delay (TTD) Beam Forming Network

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-290, PEO(T), PEO(W), PMA-231, PMA-265

OBJECTIVE: Develop innovative large tunable time delay technology in microwave domain radar and communication systems using advanced fiber-optic true time delay (TTD) beam forming networks.

DESCRIPTION: Photonics and microwave technologies offer new opportunities for accurately controlling thousands of array elements as well as the wide bandwidth of shared aperture antennas. Photonics technologies are providing an interconnect solution for future airborne phased array radar antennas where bandwidth, EMI immunity, size and weight requirements are becoming increasingly difficult, if not impossible, to meet using conventional electrical interconnect methods.

Phased array antennas offer many advantages including no physical movement, accurate beam pointing, increased scan flexibility in two dimensions, precise phased array element amplitude and phase, low sidelobes, and reduced power consumption and weight. The implementation of large tunable time delays in the microwave domain is quite complex, resulting in bulky and heavy beamforming networks. The use of optics has been proposed to alleviate these problems in the microwave domain since fiber-optics offer low weight, immunity to electromagnetic interference, and true time delay (TTD) capability. However, the attenuating effects of optical solutions have made TTD solutions impractical to implement.

Recent commercial and DARPA supported efforts are developing low loss photonic switches for the telecommunications and military market. A new approach to optical switching using 3D micro electrical mechanical systems (MEMS) integrated on silicon VLSI chip is making this possible. Photonic switched true time delay (TTD) beam forming networks are needed to control the myriad of array elements while handling the broad bandwidth required of a shared antenna. Efficient elemental vector summation (in the receive mode) or distribution (in the transmit mode) must be obtained independent of frequency and angle. Proposed TTD solutions must demonstrate several bit accuracy which supports >1000 antenna elements within a minimal volume (<0.1 m3), require less than 100 W of power, and exhibit environmental ruggedness over an approximate -40 to 100°C range. TTD beamforming systems have recently been demonstrated using wavelength-division multiplexing (WDM) fiber-optics, photolithographically defined ultra-low-loss polymeric waveguides and wavelength tunable optical modules (OPLL), among others. This system should be able to operate at much higher frequencies with a reduced cost compared to existing systems.

PHASE I: Determine the feasibility of a true time delay (TTD) technology scalable to thousands of elements and capable of multi-beam formation. Take into account bandwidth, precise phased array element amplitude and phase, ease of packaging, package size and power, and environmental ruggedness over the –40 to 100°C temperature range. Include error detection and correction technology as needed.

PHASE II: Develop and fabricate a packaged testbed to demonstrate a true time delay (TTD) unit meeting the specifications above. Include aircraft representative fiber optic cable plant interconnect technology into the characterization testbed.

PHASE III: Transition the True Time Delay (TTD) Beam Forming Network for use in next generation phased array radar and electronic warfare systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The research under this program could extend beyond military radar systems to commercial radar systems and networks. Further, the effort here to reduce the size and weight even gives a competitive advantage in the commercial telecommunications marketplace.

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KEYWORDS: True Time Delay (TTD); Beam Forming Network; Shared Aperture Antennas; Next Generation Phased Array Radar; Electronic Warfare Systems; Fiber Optics

N08-T008 TITLE: <u>Viscous Modeling for Automated Flow Simulation</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Weapons

ACQUISITION PROGRAM: PMA-201, PMA-242, PMA-259

OBJECTIVE: Develop and demonstrate viscous modeling methodologies and algorithms applicable to Cartesian-based flow solvers that provide a high degree of automation and adaptive accuracy.

DESCRIPTION: Computational Fluid Dynamics (CFD) tools have become common components of aerodynamic design and development programs. Their usefulness, accuracy and applicability have been repeatedly demonstrated. However, due to significant time, labor and computer resources required for the generation of an aerodynamic database using general CFD methods it is commonplace to employ reduced order aerodynamic prediction tools such as linear potential methods or empirically based engineering tools extensively during a design process. Independent efforts within the Navy, NASA and academia over the last decade have produced tools that are able to provide rapid analytical results for complex vehicle geometries but these tools are limited to inviscid modeling. In the weapons development environment, inviscid modeling tools are of very limited usefulness and a general viscous capability is a requirement.

The focus of this STTR is to generate methodologies and algorithms that will allow viscous modeling capabilities within a Cartesian-based solver. The data structure of Cartesian-based flow solvers contains several features that make them amenable to CFD modeling. First, mesh generation is largely automated with few user parameters. Secondly, octree data structures enable adaptation to flow features by splitting or combining cells. Other features include uniform accuracy, low memory requirements, and the ability to model arbitrarily complex geometries, however, the octree data structure is not well suited for viscous modeling. The goal will be to implement a framework for viscous terms that will couple with existing technology for inviscid flow modeling and will provide a means by which common turbulence models can be easily incorporated into the solver. Innovative methodologies must be applicable to arbitrarily complex static geometrical configurations, address subsonic through high supersonic flow/vehicle speeds, provide for a high degree of automation, and impart the capability for solution based adaptation of viscous-dominated flow regions. The proposed framework should be able to support algebraic, one-equation and two-equation turbulence models as well as laminar flow. Resulting algorithms should be validated by comparing results against a selected set of benchmark experimental or computational cases that are generally applicable to external air vehicle flows. Demonstration of internal flow modeling validation cases applicable to air vehicle flowpath simulation may also be considered.

PHASE I: Develop and demonstrate conceptual methodologies. Efforts may assume that existing technology available for octree-based CFD methods is sufficient for inviscid simulation. Methodologies will be evaluated upon the following criteria; ease of implementation, numerical accuracy, resource requirements (CPU time, memory), generality and robustness when applied to arbitrarily complex geometries.

PHASE II: Develop, implement and demonstrate prototype algorithms based on Phase I research. Fully document the algorithmic formulations and validation data.

PHASE III: Work with the government to integrate the algorithms into a general capability that can be used to support Navy weapons development, acquisition and integration programs. This general capability may be used to generate aerodynamic databases for isolated weapons, generate aerodynamic heating rates for high-speed vehicles, assess flowpath performance for air-breathing vehicles and assess loads on weapons in carriage configurations. A Phase III effort may involve discussions and presentations across DoD to demonstrate the new capabilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Computational Fluid Dynamics (CFD) analysis has become quite popular within the private-sector due to affordable large-scale computer systems and demonstrated results across several disciplines. Industries currently making use of CFD technology include, medical research, chemical processing, automobile design, marine design and of course, air-vehicle design which today extends from large aircraft manufactures to small businesses designing and selling unmanned air systems (UAS). All of these industries are possible users of the technology developed under this STTR. Several possibilities exist for transition including direct engagement with contractors supporting DoD acquisition programs, performing research in support of government air vehicle technology development programs, or using resulting program documentation to construct or tailor an application to provide demonstrated analytical capability.

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KEYWORDS: CFD; Viscous; Turbulence; Cartesian; Adaptive; Modeling

N08-T009 TITLE: Multi-Channel Dense Wavelength Division Multiplexed (DWDM) 10 Gbps Optical Transmitter

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-290, PEO(T), PEO(A), JSF, PMA-265, PMA-209

OBJECTIVE: Design, develop, and demonstrate a packaged tunable multi-channel Dense Wavelength Division Multiplexed (DWDM) 10Gbps optical transmitter for use in MIL-AERO fiber optic local area networks.

DESCRIPTION: When applying DWDM networks to military subsystems there is a need for selective flexibility in the amount of bandwidth that can be allocated during specific phases of a particular platform’s mission. Also, there is a need to quickly reconfigure the interconnect structure to accommodate a variety of different type of missions and mission payloads. DWDM networks offer the potential of very high bandwidths, low weight, immunity to electromagnetic interference (EMI), and adaptability. In order to effectively implement a DWDM network, a family of building block interface components is necessary.

Innovative designs are sought to develop a multi-channel transmitter for high performance sensor applications that can operate at various optical wavelengths to provide the necessary aggregate bandwidth. Successful development would result in a significant reduction in the amount of electronic module board space and elimination of complicated optical fiber cabling harnesses. Also, the need for external optical couplers would be greatly reduced, thereby minimizing packaging complexity and DWDM network optical power budget loss. The availability of a single packaged multi-channel optical transmitter would enable severely space constrained sensor applications to transmit large amounts of information efficiently via a single DWDM network connection. The ability to put this raw sensor information onto a DWDM network would allow critical processing to be performed remotely without the need for data reduction. This would also relieve the burden of co-locating the processors with the sensors.

The requirements for this multi-channel transmitter are as follows:

1. Size: 40mm x 20 mm x 5 mm (height)
2. Power: 1W/channel
3. Environmental: -40ºC to +100ºC; 6grms
4. Performance: 10 Gbps/channel
5. Wavelength range (tunable channels): 1550 nm C-Band ITU Grid (32-40)
6. Number of simultaneous transmit channels: 8
7. Output power: 10 mW/channel
8. Output fiber: Single Mode Fiber (Mode Field Diameter: 5-10 um)
9. On/Off speed: 1 usec
10. Built In Test (BIT) Capability: Yes
11. Removable pigtail: Yes

PHASE I: Determine the feasibility of developing a multi-channel DWDM transmitter chip and package design that operates between 2.5 Gb/s and 10 Gb/s and can select a minimum of two (2) simultaneous channels. Analyze and model design alternatives for a multi-channel transmitter with built-in test capability. Take into account launched optical power, wavelength stability, wavelength selectivity, coupling efficiency, aircraft link fault detection and isolation, ease of packaging, package size and power, and environmental ruggedness over the –40 to 100 ºC temperature range.

PHASE II: Develop and test a prototype packaged multi-channel DWDM transmitter device capable of operating in an avionics representative, 9 micron mode field diameter single-mode, fiber optic cable plant environment (i.e., –40 to +100 ºC ambient operational temperature range, 100 meter long transmission distance). Characterize the packaged multi-channel DWDM transmitter (minimum of two channels with a development path for expanding it to four channels) device over the full ambient temperature range. Include aircraft representative fiber optic cable plant interconnect technology in the testbed.

PHASE III: Design, build and test an engineering model multi-channel DWDM transmitter (minimum of four channels) for use in next generation avionics WDM network evaluation test-beds.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector applications include computer and telecommunication networks incorporating fiber optic interconnects.

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KEYWORDS: Multi-channel Transmitter; Tunable Laser Transmitter; Wavelength Division Multiplexing; Fiber Optics; Packaging; Built-In Test

N08-T010 TITLE: Innovative Approaches to the Development of Corrosion Resistant Aircraft Alloys

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter and PMA-275

OBJECTIVE: Develop analytical methodologies to promote the modeling and design of corrosion resistant alloys.

DESCRIPTION: The selection and engineering of materials for Navy and Marine Corps aircraft is driven by the unique maritime operational requirements and harsh corrosive environment in which the aircraft operate. These carrier-based aircraft operate in the most severe natural corrosive environment on the planet. The overall cost of corrosion for the Department of Defense is between ten and twenty billion dollars per year, with an estimated cost of 4.4 billion dollars to the Navy alone. Within the Navy, the effects of corrosion on Naval aviation are overwhelming. Over 100 million work hours and nearly a billion dollars were spent by NAVAIR from 1994 to 2004 on corrosion related problems. In addition to financial impacts, corrosion also affects safety and military capability. As our aircraft and weapon system alloys degrade, the operational readiness and number of aircraft available for tasking diminish, coupled with drastic increases in maintenance costs. Previous efforts have addressed materials protection and maintenance. Advanced paints, sealants, and corrosion prevention compounds have been employed in order to mitigate the effects of corrosion; however, they do not address the root cause: it’s the alloy that corrodes. With ongoing materials by design research efforts, alloy design methodologies are now possible. To ensure a fully capable fleet there is a need to develop highly corrosion resistant aircraft alloys.

PHASE I: Develop a methodology to enable the multi-scale computational modeling and simulation of aircraft alloys for the purpose of designing corrosion resistant materials. Demonstrate feasibility of the approach by providing a mechanistic understanding of the fundamental physical and chemical interactions of the alloy and its environment.

PHASE II: Fully develop the methodology into a prototype analysis tool. Design a corrosion resistant alloy for a representative aircraft component. Produce a sufficient quantity of the material and perform testing to verify the expected performance. Develop a test plan to fully qualify the new alloy.

PHASE III: Perform the required testing to develop the material allowables database required for transition into a military platform. Transition the technology for the development of corrosion resistant materials to other applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed technology will enable the design of exploratory alloy systems that are compatible with scaleable manufacturing process. This will provide transition opportunities for these alloys to both commercial as well as military aircraft and other applications requiring corrosion resistance.

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KEYWORDS: Corrosion; Mechanical Properties; Alloy Modeling; Microstructure; Corrosion Modeling; Navy Environment

N08-T011 TITLE: Preventing Simulator Sickness of Onboard Flight Simulators

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA-205

OBJECTIVE: Develop innovative solutions, usage guidelines, or training tools in order to minimize the adverse impacts of onboard flight simulators on training and flight performance.

DESCRIPTION: Flight simulators play a key role in pilot training and establishing and maintaining readiness for Naval aviation. This role is expanding as simulator capability continues to increase and can strongly supplement actual flight, in some cases provide training credit for specific flight events, and deliver mission rehearsal capabilities for deployed aviation. However, problems with simulator sickness are expected to encumber inclusion as a viable forward deployed training component. The causes of these negative effects have long been understood, but remain one of the largest impediments to successfully integrating flight simulation systems onboard ships. Utilizing flight simulators on-ship introduces the additional complication of potentially short lag times between simulation and actual flight. Without simulator sickness remediation, emerging portable flight simulation mission rehearsal systems may impair actual mission performance.

Research suggests that issues such as transport delay/latency, refresh rates, field of view, vestibular-ocular uncoupling are at the heart of simulation sickness and cyber-sickness. These studies have presented some potential mitigation and prevention techniques. Innovative solutions, usage guidelines, or training tools are sought to prevent simulator sickness. Possible solutions include but are not limited to are visual entrainment, visual backgrounds, predictive algorithms for latency reduction, structured exposures, as well as gaining greater insights into understanding individual differences to sickness susceptibility and concepts such as field blanking.

PHASE I: Identify candidate usage guidelines/tools/methodologies to minimize simulator/cyber-sickness and demonstrate proof of concept. Conduct an analysis of current impact of ship-based simulator/cyber-sickness and predicted value of mitigation.

PHASE II: Develop comprehensive systems-based approach combining technical solutions and practical usage guidelines. Design and build prototype device or process based on research conducted during Phase I. Conduct test and evaluation of the prototype device/process on simulated ship-motion base. Produce any necessary manuals for trainers and instructors / operators of the forward deployed simulation devices.

PHASE III: Enhance prototype developed in Phase II and integrate/install in existing flight simulators. Transition the prototype to other flight training organization as well as other relevant training groups.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Such systems could also have a dual application for any type of simulator (ground, undersea, surface, etc.). The training system would also have a wide applicability to commercial aviation.

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KEYWORDS: Training; Simulation; Sickness; Aviation; Mission-Rehearsal; Onboard Training System

N08-T012 TITLE: Tunable Polarization Insensitive Digital Fiber Optic Wavelength Converter with Built-In Test

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

ACQUISITION PROGRAM: Joint Strike Fighter and PMA-290

OBJECTIVE: Develop a packaged tunable polarization insensitive wavelength converter photonic chip for use in fiber optic local area networks.

DESCRIPTION: In commercial networks, route planning can be expensive and untimely using static wavelength circuits that are not reconfigurable. Without wavelength conversion, a wavelength division multiplexed (WDM) network can be highly blocking. Wavelength converters offer the option of connecting disjoint wavelengths together to form one circuit. If the wavelength conversion is dynamic, then networks can grow with capacity and tolerate failures without blocking occurring. Recent developments in photonic integrated circuits (PICs) have introduced the possibility of very low cost integrated tunable, reconfigurable wavelength converters.

Tunable, polarization-insensitive, digital fiber-optic wavelength converters with built-in test are sought as an important step in reducing the cost of deploying, maintaining and operating large scale WDM networks for telecommunications and in enabling a true future-proofed WDM-based local area network for ground-based systems and onboard aerospace, ship and submarine platforms.

Proposed solutions should satisfy important specifications. Some of these specifications include input and output operating wavelength and optical power ranges, regeneration capabilities, and tuning speed and accuracy. The packaged wavelength converter should operate over the center of the 1550 nm C-band in the ITU grid and be compatible with low profile (i.e., 5 mm height), –40 to +100 ºC ambient temperature range packaging. Wavelength converter optics should be compatible with standard telecom grade SMF-28 fiber optic inputs and outputs. The tunable laser wavelength converter output should enable tuning speeds on the order of 1 microsecond or less at 3dBm output power. The wavelength converter device must operate in a polarization insensitive fiber optic cable plant environment, include built-in test capability to monitor receiver/transmitter signal strench, and maximize wide dynamic range (i.e., 20 dB) in order to minimize the need for external optical amplification. A means to incorporate in-situ wavelength characterization of incoming and outgoing optical signals should also be incorporated into the wavelength converter design.

The pros and cons of incorporating a detachable fiber optic connector with the wavelength converter device should also be considered. A final ruggedized wavelength converter package fit with a fiber optic connector is envisioned to consist of a temperature controlled hermetically sealed wavelength converter chip with built-in test features to monitor link loss and optical signal wavelength characteristics. Package size, weight and power should be minimized.

PHASE I: Demonstrate the feasibility of a tunable polarization insensitive digital fiber optic wavelength converter chip and package design with built-in test (BIT) capability that operates between 2.5 Gb/s and 10 Gb/s. Analyze and model design alternatives. Take into account dynamic range, wavelength detection and control, aircraft link fault detection and isolation, ease of packaging, package size and power, and environmental ruggedness over the –40 to 100°C temperature range. Include error detection and correction technology as needed.

PHASE II: Design, fabricate and test a prototype BIT-capable tunable polarization independent wavelength converter devices capable of both 2.5 and 10 Gb/s data transmission in an avionics representative 9 micron mode field diameter single-mode fiber optic cable plant environment (i.e., –40 to +100ºC ambient operational temperature range, 100 meter long transmission distance). Characterize the packaged BIT-capable tunable polarization independent wavelength converter device over the full –40 to +100°C ambient temperature range. Include aircraft representative fiber optic cable plant interconnect technology in a wavelength converter characterization test bed.

PHASE III: Fully develop a wavelength converter based network interface cards for use in next generation avionics WDM networks.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector applications include computer and telecommunication networks incorporating fiber optic interconnects.

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KEYWORDS: Wavelength Converter; Tunable Laser Transmitter; Wavelength Division Multiplexing; Fiber Optics; Packaging; Built-In Test

N08-T013 TITLE: Innovative Concepts for Non-Thermal Based Anti-Icing/De-Icing of Rotor Blade Leading Edges

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PEO(A): V-22, H-53, H-60 and H-1

OBJECTIVE: Develop a non-thermal based anti-icing/de-icing system compatible with both metallic and polymer-based composite leading edges.

DESCRIPTION: Existing rotor blade leading edge protection caps are made out of metallic materials to prevent erosion. These materials may be substituted by erosion resistance polymer based composite materials. The de-icing system underneath the leading edge is thermal based and is the only system approved by the DoD and the FAA to prevent ice accretion under icing conditions. Due to large power consumption and economic drawbacks of thermal de-icing, rotary wing aircraft may have to limit their operational capability under severe icing conditions. Thermal de-icing systems are heavy and require large electrical power. As a result, the de-icing system is only run periodically, allowing ice accretion on the rotor. Furthermore melted ice may flow and refreeze further aft. De-bounded pieces of ice could impact sensitive parts of the aircraft [1, 2, 3].

A non-thermal based anti-icing/de-icing system for rotary wing aircraft is needed. The proposed technology should reduce the overall power needed for anti-icing/de-icing the leading edges of rotor blades and improve safety of the aircraft in severe icing condition. Specifically, the proposed technology should demonstrate the anti-icing/de-icing capability through a 0.15” thick leading edge layer within 20 seconds. Suitability of the proposed solution for rotor blade applications should be demonstrated via subscale bench tests.

PHASE I: Develop approaches for non-thermal based anti-icing/de-icing of rotor blade leading edges. Demonstrate the proof of concept through an initial development effort that indicates scientific merit and feasibility of the anti-icing/de-icing mechanism for metallic and polymer based leading edge materials.

PHASE II: Fully develop and optimize the proposed concepts. Design, fabricate and conduct appropriate subscale level experiments to mimic typical severe icing conditions for rotor blades. Demonstrate satisfactory anti-icing/de-icing capability. Demonstrate cost-effectiveness of the proposed technology and feasibility for full-scale rotor blade applications.

PHASE III: Demonstrate the proposed technology on a full-scale rotor blade under icing conditions, and in concert with a major Navy rotor blade manufacturer, qualify and transition this technology to a rotary wing platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of non-thermal based, low-power consumption anti-icing/de-icing systems should enable implementation of the system on all civil rotor blades. Lower-cost, innovative vehicles able to fly under adverse icing conditions will be introduced into the market. Presently, there is a strong need to create a system that prevents ice accretion to allow helicopters to fly during icing conditions [1].

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4. Palacios, J., L., Smith, E., C., “Dynamic Analysis and Experimental Testing of Thin-Walled Structures Driven By Shear Tube Actuators,” 46th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics & Materials, AIAA-2009-2112, Austin, Texas, April 2005.

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KEYWORDS: Anti-Icing; De-Icing; Ice Accretion; Rotor Blade; Leading Edges; Icing

N08-T014 TITLE: Acoustic Mitigation System For Horizontal, Planar Surfaces Onboard Naval Ships

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

ACQUISITION PROGRAM: PMS 500 (DDG 1000), ACAT I

OBJECTIVE: Develop an innovative, affordable material system that mitigates acoustic radiation through the hull induced by airborne noise in shipboard compartment’s containing Electronic Modular Enclosures (EMEs).

DESCRIPTION: Future naval ships will require additional risk mitigation strategies for anticipated acoustic emissions levels in below deck compartments. Currently available acoustic treatment solutions have inferior performance characteristics at frequencies below 200 Hz.

The Navy seeks a material system that will provide acoustic mitigation as specified in Reference 2 to reduce airborne noise coupling on horizontal, planar surfaces around EMEs. The material trade space shall include, but not be limited to, the following axes: reduction of noise transmitted through treatment; reduction of vibration as a result of acoustic excitation on the structural panel on which the treatment is attached; material and installation costs comparable to existing solutions; thickness not to exceed 4.25 inches; weight not to exceed 3 lbs/sq. ft.; minimal required maintenance. Concepts proposed shall be composed of materials that are known to be non-hazardous by the USN.

Solutions are sought that will provide an additional 2 dB transmission loss better than the current treatments being installed on Navy ships, as well as, provide better performance in band between 60 Hz and 200 Hz. The challenge will be to provide the solution sought within the identified trade space at the frequency ranges specified in Reference 2. Of special interest are solutions proposing innovative, alternative methods of acoustic mitigation including the method by which the solution is applied to horizontal, planar, metallic surfaces in interior shipboard spaces. Acoustic treatment application and installation strategies that use innovative application methods to reduce treatment application manpower costs and improve schedule requirements with regards to current Navy treatments are sought.

PHASE I: Demonstrate the feasibility of an acoustic system that will provide the acoustic mitigation as described in Reference 2. Develop an initial concept design identifying potential materials, configuration, application techniques, etc. and establish performance goals and metrics/methods to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability.

PHASE II: Develop and demonstrate the prototype(s) as identified in Phase I. Through laboratory testing, demonstrate and validate the performance goals as established in Phase I in an application with a minimum surface area of 1500 sq. ft. Refine and demonstrate the capabilities of the system. Develop a cost benefit analysis and a Phase III testing and validation plan. Provide preliminary installation procedures and address anticipated installation sensitivities. Provide an empirical or physics based plot/graph that will allow a user to predict the performance of the prototype solution on candidate shipboard application(s).

PHASE III: Working with the Navy and commercial industry, develop manufacturing and tooling plans for initial production of the treatment. Develop installation procedures for equipment spaces and test in a representative shipboard environment. Refine empirical plot/graph provided in Phase II and demonstrate ability to predict the performance of the material system in targeted shipboard environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technologies as a result of this topic have direct application to commercial shipbuilding industry such as the cruise industry where the attenuation of noise could impact the quality of life of the customer. Another maritime application would be scientific research vessels/laboratories where the attenuation of noise could disruptive to sensitive equipments and/or test scenarios. Other potential private sector commercial potential include the commercial aerospace industry (fuselage noise reduction) and building construction (conference rooms, concert halls, etc.).

REFERENCES:
Available at http://www.astm.org
1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

Available at www.dodsbir.net/sitis
2. Supplemental Information for Acoustic Mitigation System Development

KEYWORDS: acoustic treatments; airborne noise; structure-borne noise; sound curtains, EME

N08-T015 TITLE: <u>Submarine ES System RF Groom & Certification</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: NAVSEA PMS435 AN?BLQ-10(V)

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 STTR submission is to research and develop a capability to organically test, measure, calibrate, and certify radio frequency (RF) signal paths outside of a laboratory environment by end-users. This tool would be used to determine the performance level and suitability of an automated system which provides the capability to acquire, process, and identify a variety of electromagnetic signal types over a wide frequency range.

DESCRIPTION: In order for a RF system to operate optimally it is imperative that the system be calibrated, The objective of this STTR submission is to research and develop a capability to organically test, measure, calibrate, and certify radio frequency (RF) signal paths outside of a laboratory environment by end-users. This tool would be used to determine the performance level and suitability of an automated system which provides the capability to acquire, process, and identify a variety of electromagnetic signal types

PHASE I: Develop a conceptual design for a hardware and/or software approach for adapting calibration waveforms, measuring degradation like group delay and attenuation, and developing correction table designs that can be applied to the individual subsystems.

PHASE II: Design, Fabricate and Develop a prototype of the hardware and/or software mechanism designed in Phase I.

PHASE III: Test the prototype design developed in Phase II to validate the required calibration techniques. The testing will be classified and will be conducted at a Navy facility (NUWCDIVNPT).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Embedded test, measurement and certification of RF systems will provide benefits across DoD organizations as well as the Department of Homeland Security an the United States Coast Guard ships and Aircraft. Additionally, the telecommunications industry could leverage from the efforts of this development.

REFERENCES:
1. Joint Fleet Maintenance Manual Volume II

2. Submarine Surveillance Equipment Program

KEYWORDS: Electromagnetic Propagation; Radio Frequency; RF Groom; Certification; Submarines; ELINT; Electronic Warfare

N08-T016 TITLE: Expendable Glider for Oceanographic Research

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace

ACQUISITION PROGRAM: PEOC4I, PMW120, Littoral Battlespace Sensing Fusion & Integration ACAT

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 expendable glider to enable efficient wide area oceanographic sensing to support environmental characterization and predictive systems in support of Battlespace on Demand persistent environmental surveillance, mine warfare (MIW) and anti-submarine warfare (ASW) missions.

DESCRIPTION: The need to acquire oceanographic observations is increasing. This data is used by Commander, Naval Meteorology and Oceanography Command (COMNAVMETOCCOM) through the Naval Oceanographic Office (NAVOCEANO), to characterize the operational environment, constrain predictive models for MIW and ASW mission planning, to predict sensor performance, and guide future platform and sensor placement. Current oceanographic sensing is accomplished using specialized ships, specialized floats, reusable ocean gliders, and moored instrumentation that requires deployment and retrieval from either ships or small boats.

The Navy’s highly capable T-AGS class ships, managed by COMNAVMETOCCOM, conduct multi-mission oceanographic survey in response to Fleet Commander tasking. However, they are few in number and have significant operating costs - $30,000 to $40,000 per day. The present generation of profiling floats can be air or surface ship launched and provides one affordable form of environmental measurements via satellite. However, these sensors float with the current and can not station keep, direct their motion or adapt to new desires to exploit the environmental field. The present class of Ocean Gliders are able to persist for a few months measuring the environment and transmitting the findings back to shore. These gliders use buoyancy engines as propulsion to maintain position or move to a new specified location. These gliders cost roughly $100,000 per instrument and due to their relative scarcity and high desirability are used repeatedly and refurbished regularly requiring ship launch and recovery. The Oceanographer of the Navy (OPNAV N84) acquisition program “Littoral Battlespace Sensing, Fusion and Integration” (LBSF&I) is in the process of procuring approximately 150 current generation ocean gliders for Navy operational use.

A new lower-cost, surface ship or air deployed Expendable Glider (XG) is desired that will last sufficiently long that recovery is not required. One can clearly see the economics of a slightly lower cost glider to provide data and adaptation without the added cost of ship launch and recovery. To achieve the cost savings and certifications for air deployment, the XG should be a sealed unit that should not have to be opened for operation or maintenance. It should be able to activate and self locate, communicate with a ground station over Iridium, receive mission plans, and run the planned mission, transmit the data back to shore site, and at the end of its life sink to the bottom of the ocean without causing environmental harm.

To meet the cost benefit ratio, the XG should cost less than $50K. It should carry a CTD (Conductivity, Temperature and Depth sensor) and optical backscatter sensors at a minimum. The XG should have an endurance of 2-4 months and be capable of transecting major ocean currents, similar to existing ocean gliders. The XG should be depth rated to at least 1000 meters in order to maximize its navigability. Detailed performance tradeoff studies (comparing options involving maximum depth-payload-persistence-speed, etc.) are desired to help inform Phase II and Phase III. The LBSF&I program is the logical transition program for this STTR.

PHASE I: Complete and deliver detailed performance tradeoff studies comparing options involving maximum depth, payload, persistence, battery types, cost and speed. Develop a preliminary design for the XG. Develop operational concepts for air and surface launch. Perform and deliver results of bench-level testing to demonstrate a proof of concept as applicable.

PHASE II: Complete the system design based on Phase I study results and fabricate 4 prototype XG vehicles. Test prototype(s) in the ocean verifying the XG's endurance, mission control, environmental data collection, and data transmit functionality.

PHASE III: Test ship and air launched operational concepts. Complete certification for shipboard and aircraft usage. Build 10 additional XG for certification testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The XGs could have extensive use in academic organizations to provide a low cost approach for environmental data collection for oceanographic research.

The Oil and Gas industries could use the XGs for environmental data collection during oil exploration and in preparation for installing drilling rigs.

REFERENCES:
1. Navy UUV Masterplan 2000, http://www.navy.mil/navydata/technology/uuvmp.pdf

2. Navy UUV Master Plan Update 2004

KEYWORDS: Oceanographic sampling, gliders, UUVs

N08-T017 TITLE: Ultrahigh Loading of Carbon Nanotubes in Structural Resins for Advanced Composites

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

ACQUISITION PROGRAM: This program could support future UAV, USV and UUV programs in the future

OBJECTIVE: To develop a scientific understanding of the fundamental impediments to a well dispersed, ultrahigh carbon nanotube (CNT) loaded nanocomposite. To investigate new approaches to the purification, dispersion, functionalization and processing of carbon nanotubes (CNTs) that will lead to ultrahigh loading of CNTs for advance composites.

DESCRIPTION: Carbon Nanotubes (CNTs), despite their extraordinary mechanical properties, have shown only limited improvements to the mechanical properties of structural resins. The most interesting results have been obtained with very low concentration of carbon nanotubes, where relatively small improvements of some mechanical properties (example: 20% - 40% improvement on the interlaminar shear strength of glass vinyl ester composites) of structural composites have been reported. There is a lack of good scientific work in the area of high loading (larger than 5% weight ratio) of CNTs into structural resins. The main obstacle for this lack of scientific work with high CNTs loading ratios being the exponential growth of the viscosity of the mixture with CNT loading.

Most dispersion methods are based on chemical functionalization followed by ultrasonic insonification but these methodologies appears to be limited to low weight ratios. New methodologies are required for the incorporation of high loading ratios of CNTs in structural resins. This STTR requests proposals that develop a clear scientific understanding of the main obstacles to ultrahigh CNT loading in nanocomposites and that proposes new methods or approaches to increasing the loading of well dispersed CNTs in structural resins beyond 10% weight fraction. It also requests that an understanding and characterization of the degree of dispersion and loading of the CNTs in the resin system and of the effects of these on the mechanical and physical properties of final nanocomposite materials be obtained.

PHASE I: During the Phase I research effort the PI will determine, quantify and model the fundamental impediments to well dispersed and highly loaded CNT composites. He will propose alternative methodologies for loading structural resins with CNTs and demonstrate the ability to disperse at least 10% weight fractions of single wall (SWNT), double wall (DWNT) or few wall carbon nanotubes (FWNT) (even though SWNTs, DWNTs and FWNTs are more expensive that MWNTs, it is anticipated that these will be easier to control and characterize than MWNTs due to their higher degree of crystallinity) into structural thermoset resins such as vinyl ester or epoxy and into structural thermoplastic resins such as PEEK. A very important part of this research effort is to develop and demonstrate a technique for the characterization of the degree of dispersion of the CNTs in the resins system. The PI will characterize the degree of loading and dispersion of the CNTs and correlate them with the mechanical performance of small nanocomposites coupons.

PHASE II: The PI will determine the maximum loading capability of well-dispersed CNTs that the new methodology offers. The PI will also demonstrate the capability of manufacturing large nanocomposite panels (4”x4”x1/64”) and of the ability to machine them to appropriate geometries for mechanical characterization. The PI will manufacture nanocomposites with various CNTs loading ratios up to the maximum possible value and characterize their mechanical properties. The PI will determine the cost of the methodology in a per pound of nanocomposite basis and propose methods for lowering the cost. The PI will explore methodologies to expand the production capability.

PHASE III: This phase is not funded by the STTR program office. The PI will seek Navy program funding geared at demonstrating this technology in a larger scale. The proposer will transition technologies deemed beneficial, affordable, and sustainable (as a result of testing in Phase II) into a scalable demonstration.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: If the technology proves feasible and the potential for low cost manufacturing exists, it will have a large number of commercial applications such in the sports area, civil engineering, transportation, energy and others. Everywhere were composite currently apply, this technology could be a replacement with better performance.

REFERENCES:
1. Z. Wang, Z. Liang, B. Wang, C. Zhang and L. Kramer, “Processing and Property Investigation of Single-Walled Carbon Nanotube (SWNT) Buckypaper/Epoxy Resin Matrix Nanocomposites,” Composite, Part A: Applied Science and Manufacturing, Vol. 35, No. 10, pp. 1225-1232, 2004

2. Frankland SJV, Caglar A, Brenner DW, Griebel M. “Molecular simulation of the influence of chemical cross-links on the shear strength of carbon nanotube-polymer interfaces”. J Phys Chem B 2002;106:3046-3048.

3. Brenner DW, Shenderova OA, Areshkin DA, Schall JD, Frankland SJV. “Atomic modeling of carbon-based nanostructures as a tool for developing new materials and technologies.” CMES 2002;3:643-673.

4. Krishnan A., Dujardin E., Ebbesen T.W.,”Young’s modulus of single–walled nanotubes”, Phys. Rev. B.58, No20, (1998-II), 14013-14019

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KEYWORDS: Carbon Nanotubes; Dispersion; SWNT; nanocomposites; nanotechnology; composites

N08-T018 TITLE: Cryogenic RF Excision System (CRES) for Electromagnetic Interference (EMI) Cancellation

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMW120, Cryptologic Carry-On Program (CCOP) ACAT III

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

OBJECTIVE: The objective of this topic is to provide an active but analog solution to the co-site interference problem experienced by highly sensitive receivers on ships. This is one of several complementary approaches that may be combined to maximize the interference protection while also minimizing the system complexity. While other approaches may be proposed, one means of achieving this objective is to implement a Cryogenic RF Excision System (CRES).

The CRES architecture employs multiple antennas and angle-of-arrival (AOA) algorithms to perform below decks EMI cancellation (rejection). The algorithms are based on AOA characteristics of co-site and SOI. The multiple antennas sense energy from different angles-of-arrival for each co-site interferer and a single AOA for each off-board SOI. As a consequence of the variation between co-site and SOI angles-of-arrival, algorithms can derive a co-site cancellation signal. The use of cryogenic temperatures and superconducting materials to implement the architecture minimizes signal attenuation and thermal noise, yielding more accurate cancellation.

The CRES architecture is composed of transversal spatial notch filters (SNF) that combine the outputs of multiple antennas to synthesize and subtract an analog estimation of the interferer waveform at the receiver. The coefficients of these filters are adjusted by real-time computerized feedback based upon blind excision techniques. The coefficients are adjusted to track the effects of such things as rotating antennas, doors opening, antenna resonant changes, water wave effects, etc. Once the interference power at the receiver has been reduced to reasonable levels, new processing algorithms detect, copy, and DF low-level target signals by compensating for the effects of the SNF.

DESCRIPTION: On board Navy ships, the intercept of agile signals in the presence of co-site, co-channel agile communications, radar, and jamming signals is not currently possible without the introduction of significant RF attenuation. The high power nature of these transmitters can produce power levels approaching 10 Watts at the intercept receivers. This power level is large enough to cause severe intermodulation and saturation effects in addition to damage within these receivers. The agile nature of the transmitted waveform is difficult to track and notch out using conventional notch filter technology.

The CRES technology has the potential to substantially reduce this co-site Interference and lower system noise figure, thereby increasing the exploitation range of modern signals of interest (SOIs) and reducing ship vulnerability to anti-ship missiles in the littorals.

PHASE I: Phase one will develop a preliminary design that will be modeled and its predicted performance will be evaluated to determine the feasibility of proceeding to a Phase II development and demonstration.

PHASE II: After an initial component system design and component development period, the components will be fabricated and integrated onto a cooler. The superconducting version of the system will utilize superconducting channelizers with cryogenic amplification, power limiting and dual tunable band pass and/or notch filters in each channel (Dual Tunable Filter LNAs - DTFLs). The CRES analog excisor will follow and be implemented as narrow band if necessary – a narrow band version of the fundamental component has already been demonstrated in the lab. If possible, CRES components will have both a narrow band (freq domain) and wide band (time domain) capability with automatic equalization. Demonstrate a 3 channel RF excision system which utilizes Space-Time Adaptive Processing (STAP) and frequency isolation while achieving low system noise temperature, e.g. via the use of cryogenically cooled components. The target performance value for the CRES is a 30-dB interference rejection with a 5 dB signal noise figure.

PHASE III: The expected transition of the product within the government as a result of the Phase II will be into classified military VHF and UHF antenna systems where strong co-site interference is present. Several appropriate Navy systems have been identified.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The private-sector application of the product will be in the Communications and Wireless industry where strong co-site interference is present.

REFERENCES:
1. V. P. Koshelets and S. V. Shitov, "Integrated superconducting receivers," Supercond. Sci. Technol., vol. 13, pp. 53–69, 2000.

2. T. Van Duzer and C. W. Turner, Principles of Superconducting Devices and Circuits, 2nd ed. Englewood Cliffs, NJ: Prentice-Hall, 1999.

3. M. Kadin, Introduction to Superconducting Circuits. New York: Wiley, 1999.

4. Abelson and G. Kerber, "Superconductor integrated circuit fabrication technologies," in Proc. IEEE, vol. 92, Oct. 2004, pp. 1517–1533

KEYWORDS: Superconducting electronics; cryogenics; filters; EMI mitigation; SIGINT; co-site interference

N08-T019 TITLE: Automated Modeling and Simulation Tool for Lightening the Load of Warfighters

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: MARCORPSYSCOM PM MERS (Program Manager Marine Expeditionary Rifle Squad)

OBJECTIVE: Develop an intuitive easy-to-use tool for field use or lab use, that predicts the motion of an individual Warfighter, optimally distributes equipment among squad members based on individual capabilities and training, and then automatically minimizes the load each individual caries based on mission goals.

DESCRIPTION: A critical issue for today's Warfighter is the balance between necessary equipment and the restrictions of excessive weight. This research effort should combine approaches for dynamic motion prediction (i.e. Kim et al, 2006; Xiang et al, 2007; Chung et al, 2007) and optimal distribution of equipment among members of a squad, to yield a simulation tool for reducing the load on a Warfighter, thus enhancing the efficiency with which any task or mission can be completed. It is critical to link together equipment-distribution optimization code that considers Warfighter characteristics, optimization-based motion prediction capabilities that simulate the motion of the Warfighter, rigid-body dynamic models that simulate the motion of various pieces of equipment, and a database of equipment characteristics with respect to mission objectives. The result should be an all-inclusive umbrella optimization system that not only distributes equipment based on the strengths of different individuals, but actually highlights which pieces of equipment are most restrictive and then minimizes the load that each Warfighter carries, based on mission requirements for the squad. A key element of this work will be the linking of modeling and simulation capabilities for the individual human with optimization software for actually designing a squad.

With respect to the individual, this effort should include modeling and simulating human motion, predicting visually and numerically how an individual reacts to various changes in anthropometry and the environment. This motion prediction (MP) module should allow one to conduct trade-off analysis and cause-and-effect of changes in the simulation.

The predicted motion of a Warfighter should then be linked with rigid-body dynamic models that simulate the motion of various pieces of equipment. This dynamic equipment module would enable the user to study how various pieces of equipment interact with the human body and with other pieces of equipment.

With respect to the squad, optimization methodologies should be used to determine how equipment is distributed across a squad of Warfighters. This equipment distribution module should consider as input characteristics of individuals (size, strength, fitness, agility, experience, etc.), training history, mission details (threat level, objective, insertion method, etc.), and environment characteristics. As output, this module should determine how to distribute equipment among squad members most effectively.
Finally, the above mentioned modules must be integrated to provide a tool that automatically lightens the load on the Warfighter while considering all parameters. This utility should take as input the users assessment of the available equipment, indicating what types of equipment are critical to the mission. In addition, a database of equipment characteristics is needed, indicating physical properties of the equipment as well as uses for different pieces of equipment.

PHASE I: Determine the feasibility of integrating the various modules. Develop a comprehensive plan indicating the transfer of I/O between modules. This plan should include an indication of critical tasks for the individual as well as exemplary squad missions.

PHASE II: Develop predictive optimization code for each module. The development of these utilities will be based on the plan outlined in Phase I

PHASE III: Refine the functional code provided in Phase II, and conduct a validation of predictive capabilities. In addition, develop the user interfaces to yield a finished product.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology will be directly applicable to law enforcement, sports equipment manufacturers, and vehicle manufacturers.

REFERENCES:
1. Abdel-Malek, K., Yang, J., Marler, T., Beck, S., Mathai, A., Zhou, X., Patrick, A., and Arora, J. (2006), "Towards a New Generation of Virtual Humans," International Journal of Human Factors Modelling and Simulation, 1, 1, 2-39.

2. Arora, J. S. (2004), Introduction to Optimal Design, 2nd Ed., Elsevier Academic Press, New York.

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5. Xiang, Y., Chung, H. J., Mathai, A., Rahmatalla, S., Kim, J., Marler, T., Beck, S., Yang, J., Arora, J. S., and Abdel-Malek, K. (2007), "Optimization-based Dynamic Human Walking Prediction," SAE Human Modeling for Design and Engineering Conference, June, Seattle, WA, Society of Automotive Engineers, Warrendale, PA, SAE paper number 2007-01-2489.

KEYWORDS: optimization, human modeling, modeling and simulation, dynamics, lighten the load, motion

N08-T020 TITLE: Heat and Nonlinearity in Underwater Acoustic Projectors

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA-264 Littoral ASW Multistatic Project and PEO IWS5 Deep Water Active Dis

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: Twofold, to develop materials, devices, and techniques to dissipate heat generated in the interior of high powered underwater acoustic transducers and to develop an understanding of nonlinearity in underwater acoustic projectors. These two concepts can be related or they may be treated separately with only one of the objectives being addressed. The intent of the first objective is to efficiently dissipate heat generated by the transducer driving mechanism to the water medium as a means to control heat build-up within the transducer and thus optimize device performance. The second objective strives to understand nonlinearity in high power transducers with the end goal of designing devices that will minimize this effect that limits performance.

DESCRIPTION: The performance of naval systems for Anti-Submarine Warfare (ASW) is limited by the size and power of current sensor systems. Although current systems are adequate for current missions, improved sensors, and specifically active projectors, are required for maintaining tactical advantage against future adversaries. This STTR topic will address two topical problems of high power projectors: overheating that results in decreased performance and/or catastrophic failure and nonlinearity caused by excessive electrical, mechanical or thermal stresses that limits the output power capability of the projector. There is a real need for designing underwater acoustic projectors that are capable of very high acoustic output powers at high duty cycles while maintaining a small profile. Addressing the topic area of heat dissipation in transducers (which may or may not be combined with the second issue of nonlinearities in transducers) it has been observed that in the majority of high power underwater projectors the active driver assembly that produces the force to translate to displacement in the transducer for acoustic output has finite losses that result in generation of heat that ends up being contained within the transducer since the typical transducer, designed to keep water out of its interior and to protect the device from physical or environmental damage, has no easy thermal path for the dissipation of heat to the water medium. In the case of the second topic issue it is understood that under high drive conditions electrical stresses in the active drive material along with mechanical overstressing in both the active driver and the other components of the transducer produce nonlinearities that are seen as acoustic distortion. The addition of heat build-up under these conditions complicates the situation. These stresses can combine and result in the transducer exceeding its operational limit and this then results in reduced performance or failure. The ability to understand the constitutive components of nonlinearity and distortion will assist in developing designs and techniques that can temper the root causes and thus open the opportunity to design a transducer that can work harder and be more reliable.

PHASE I: For the case of effects of heat on transducer performance, analyze candidate projector designs that utilize either piezoelectric ceramic or magnetostrictive material as the active driver and determine possible means to extract heat from the driver assembly without impairing the performance or reliability of the device. It should be assumed that the transducer’s duty cycle will be 100% and thus the extracted heat needs to be able to be efficiently dissipated to the water medium in either a passive or active means. Develop a useable thermal model to analyze the proposed method. If the effort is focused strictly on nonlinearity effects analyze the transducer components and their use that contribute to the creation of nonlinearities. Conceptualize a means to predict this behavior and determine how it may be quantified.

PHASE II: For the specific focus on heat remediation develop a complete thermal model to couple with an appropriate transducer model to permit a complete evaluation of the approach at the predictive level. Develop prototype components and after evaluation integrate into a prototype transducer for tests and evaluation and validation of the model. Determine the performance parameters of the candidate transducer and predict efficiencies for a variety of other transducer types. For the focus of nonlinearity in transducers develop a complete analytical/numerical model to predict the inception of nonlinear operation in an underwater acoustic projector and the means to identify, isolate and analyze where the distortion begins and the mechanisms involved. Develop prototype components of a notional transducer and test its linear and nonlinear behavior as a means to evaluate and validate the model. Determine the performance parameters of the notional transducer and undertake parametric studies to determine a component’s sensitivity to nonlinear operation. Phase II efforts may require the need for access to classified information.

PHASE III: For both areas of interest utilize the design approach and mechanisms developed to adapt advanced transducer developments to be able to operate more reliably and at high drive levels than originally planned by vastly improving the thermal limits of the device and understanding the contribution of nonlinearity on the performance limitation of the device.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The broad applicability and market for this technology across the Navy for both transducers and actuators should lead to a commercially successful result in the oil and natural gas exploration industries and to a variety of commercial products that now operate ‘hot’ and/or distorted and are limited because of that.

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KEYWORDS: ASW; sonar; projectors; heat dissipation; nonlinearity; underwater

N08-T021 TITLE: Ocean Energy Extraction for Sensor Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: Oceanographer of the Navy; PMS EOD: UUV, NAVO

OBJECTIVE: Develop and test small, affordable 100-200W power technology derived from ocean energy extraction. Sensor applications requiring energy will be located on a buoy.

DESCRIPTION: The motivation for the development of a buoy-based observatory is the need to acquire long-duration time series measurements of a variety of processes. Obviously, the type and number of the sensors deployed at the observatory dictates the buoy power and data telemetry budgets. Current sensors that might be deployed at an observatory require under 200 W of power. It is anticipated that ocean energy extraction can serve as a power source for these sensors. The compact size of the energy conversion hardware is desired to minimize the potential impact on the buoy platform and sensor system. Affordability is a key aspect of this energy extraction; therefore, the system should be operational for a few days in some applications and a few weeks in other applications. Long-term at-sea issues such as corrosion and bio-fouling are not a significant issue for this system.

PHASE I: Proof of concept demonstration of the ocean energy conversion technology in water to exceed 50 W of power generation. A good physical understanding of the conversion methodology to scale the technology. Prediction tools should be used to estimate power generation. The plan to achieve the power objectives and system miniaturization should be established.

PHASE II: Proof of concept demonstration of the ocean energy conversion technology in a water to achieve 100-200 W of sustained power generation on a representative navy buoy for 2-3 days.

PHASE III: The energy conversion system will transition to the Oceanographer of the Navy. A battery recharge capability for UUVs could be a significant potential market for the energy extraction technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A significant range of applications require energy; ocean energy extraction could provide power for sensor monitoring systems on buoys for oceanographic measurements, harbor defense, surveillance, etc.

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KEYWORDS: Hydromechanics; Oceanography; Sensors; UUVs; Ocean Energy; Renewable Energy

N08-T022 TITLE: Development of Microstructure/Properties Simulation Tools

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO ships, NAVSEA 05P

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

OBJECTIVE: Develop and validate the computational tools necessary to simulate microstructural evolution and resultant mechanical properties in marine grade aluminum alloys. Specifically, to develop and validate the computational tools to predict the effects of composition, deformation and heat treatment on the microstructure, the types and size distributions of precipitates that form within the microstructure, and the mechanical properties (strength, ductility, toughness, fatigue, etc.) that are exhibited by those microstructures, as well as the tools to integrate the above components into a single, cohesive computational package, in a specific marine-grade alloy system.

DESCRIPTION: Current efforts to reduce certification times for introduction of a new material in naval construction (or the application of an existing material for a new application) by developing computational tools to simulate microstructures and predict final material properties are limited by the capabilities of currently-available computational packages. If adequate computational tools were available, simulation of the microstructures produced through various deformation and processing procedures, and prediction of the mechanical properties expected from such microstructures, could replace much of the effort that is currently required for certification. Only verification tests of appropriately processed material would be required to check the validity of the models, rather than the much more extensive effort that is currently required.

To meet this goal, it is necessary to develop computational tools to simulate the full microstructural development that occurs during processing (including the effects of deformation, heat treatment, diffusion, phase transformations, precipitate reactions, and recrystallization), the mechanical properties (strength, ductility, toughness, fatigue, etc.) exhibited by that microstructure, and the computational tools to integrate these sometimes disparate components.

In addition to developing the computational tools that can perform some or all of these simulations, it is also required that those computational tools accurately predict the characteristics of interest. Thus, this program also requires a validation component to support the development of the computational tools.

Technical hurdles that remain are alloy- and design-requirement-specific. Such issues are best resolved through the concurrent engineering approach enabled by the STTR program. A small business that currently produces similar computational tools is best suited to developing the components required for this effort, but is not likely to have the appropriate resources to validate the model predictions. Alternatively, university performers are well suited to developing the processing-microstructure-property relationships that are required for the different computational tools. The small business would benefit immensely from the university-led research and could guide that research in a focused and productive manner in the process of developing the appropriate computational components.

PHASE I: Demonstrate feasibility of approach and identify means of integrating computational tools into a larger protocol. Identification of challenge problem (specific alloy and application) that would be attempted in Phase II.

PHASE II: Demonstrate effectiveness of computational tools for the alloy system identified, showing ability to accurately predict microstructure and mechanical properties for a range of realistic compositional variations and relevant processing parameters. Fully integrate system with other relevant computational tools and databases. Develop business case analysis to support adoption of system by DoD commercial industry.

PHASE III: Phase III will be marked by comparison of the developed protocol against the conventional certification requirements and demonstration of a 70% reduction in required mechanical tests for a given alloy and application.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector, commercial applications are numerous throughout the transportation industry. General principals developed in this project could be readily applied to components for civilian shipping, aerospace, train, automotive and public transport vehicles.

REFERENCES:
1. J. Allison, D. Backman, and L. Christodoulou "Integrated Computational Materials Engineering: A New Paradigm for the Global Materials Profession" and other articles in this issue, JOM 58(11) 2006.

2. Accelerating Technology Transition: Bridging the Valley of Death for Materials and Processes in Defense Systems. National Research Council, The National Academies Press, Washington, DC 2004.

3. H.-J. Jou, P. Voorhees, and G.B. Olson, "Computer simulations for the prediction of microstructure/property variation in aeroturbine disks", Superalloys 2004. Proceedings of the Tenth International Symposium on Superalloys, TMS, Champion, PA, pp. 877-886 2004.

KEYWORDS: certification, aluminum, cost reduction, simulations, materials, prediction

N08-T023 TITLE: Design Tools for Applying Characteristic Modes to Platform Integrated Antennas

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

OBJECTIVE: Develop and demonstrate effective design tools for optimizing the electromagnetic radiation efficiency of military platform integrated antennas.

DESCRIPTION: There is interest in improving the performance of vehicular antennas in the HF through lower UHF bands (i.e., 2 MHz through 450 MHz). At the same time, there is a desire to reduce the visual signature of the antennas. Newman showed that the radiation efficiency of a small antenna, mounted on a structure, could be increased substantially by positioning it appropriately. In essence, the antenna functions as a probe that excites currents on its supporting structure. The position of the probe is chosen to induce currents that produce the desired response in terms of some predefined performance criteria, such as power gain or radiation pattern.

More than one location may be necessary in order to meet the criteria over a given frequency band. Some locations may result in substantial improvements in radiation efficiency, while others may result in little or no improvement. A second and related problem is the selection of an operating frequency which optimizes the radiation efficiency. The optimum location at one frequency may not be the optimum at another frequency. The antenna designer may not have complete freedom in selecting location and frequency. However, how the efficiency varies with frequency and location can help in the design of an optimal military platform integrated antenna.

For some simple configurations, the optimum positions might be determined merely by examining the approximate current distribution on the platform. However, in general the optimum probe position is not obvious. The focus of this topic is the development and demonstration of effective design tools for optimizing military platform integrated antennas. There may be several possible approaches to this development. However, the Method of Characteristic Modes, first described by Garbacz and then refined by Harrington and Mautz, may prove to be useful. The determination of Characteristic Modes may involve considerably less computation and also give more physical insight. The Characteristic Modes are real currents on the surface of a conducting body. The Characteristic Modes have orthogonality of the radiated fields. Associated with each Characteristic Mode is an eigenvalue. The eigenvalues are important because the radiation of a particular Characteristic Mode is indicated. In order to improve substantially the efficiency of an antenna mounted on a military platform it is necessary to excite modes which are effective radiators. The use of the Method of Characteristic Modes would be most applicable where the platform is not electrically large. As the electric size of the support structure increases, more and more characteristics modes are effective radiators. In this case, the exact antenna location and operating frequency is likely to be less critical.

PHASE I: Assemble a preliminary design framework for optimizing the electromagnetic radiation efficiency of a military platform mounted antenna. Perform a preliminary evaluation of the design tools to demonstrate utility.

PHASE II: Develop the user-oriented design tools for optimizing the electromagnetic radiation efficiency of a military platform mounted antenna. Demonstrate the utility of the design tools with application to military platforms with special emphasis on HF through UHF antennas on USMC platforms.

PHASE III: Dual Use Applications: This effort will provide an important foundation for optimizing the performance of platform embedded antennas in appropriate frequency bands.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The focus of this topic is the development and demonstration of effective design tools for optimizing military platform integrated antennas. This value of this capability is not limited to military platforms. As indicated in the professional publications, antenna engineers are attempting to address antenna integration in a wide variety of commercial platforms, including automobiles, trucks, boats and airplanes. This topic could provide a capability that would substantially improve antenna engineering for both military and commercial applications.

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KEYWORDS: Computer-Aided Design; Computational Electromagnetics Antennas; Characteristic Modes; antenna-platform coupling; RF radiation; antenna efficiency

N08-T024 TITLE: <u>IMAGING OF OBJECTS FROM RF RADAR RETURNS</u>

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PG13 Infantry Weapons MARCORSYSCOM

OBJECTIVE: Develop algorithms and visualization methodologies that interpret raw high resolution radar returns of objects of interest (in particular objects of interest detected behind walls) into virtual renderings of these objects based on parametric information contained in raw image data. Virtual rendering of human posture and orientation signatures is of particular interest. Movements of the human body provide characteristic RF features that provide information on the location of human limbs and joints as well as human body orientation and direction of travel. Interpreting these signatures within the radar returns avails the generation of virtual renderings of the detected human. It is the objective of this STTR, to exploit these subtle "micro-Doppler" features and develop the algorithms to real-time display a virtual image of the interpreted radar return.

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. In many surveillance applications radars are employed to image a given region in order to detect targets of interest such as weapons caches and personnel. Images created from these raw radar returns are difficult to interpret visually due to variations in single-to-noise, limited resolution, clutter interference, shadowing, and other impairments. However, a wealth of additional information about detected objects is contained within the raw radar data such as resonances, Doppler, and characteristic signatures. This additional information can be combined with the imagery to identify objects of interest and their locations, orientations, and trajectories. It is the intent of this STTR to develop algorithms to merge this characteristic information in order to generate virtual renderings of the object onto an imaging display. As an example, the articulation of limbs of a moving human provides unique Doppler signatures at different spatial locations. These limb movements are then extracted and interpreted from the raw radar data in order to provide a virtual rendering of the object onto the radar image.

PHASE I: Conduct research to evaluate the viability of techniques to specifically interpret RF radar signatures of objects of interest. Techniques found to be the most promising should be simulated.

PHASE II: Produce a working software prototype and demonstrate that prototype in a relevant environment. The prototype should translate raw radar returns into a rendering of human posture and orientation and be able to identify selected objects of interest.

PHASE III: Integrate developed software into a tactically relevant user terminal, support field user evaluation and mature interfaces with the specific radars developed under the Transparent Urvan Structures enabling capability program on behalf of Program Manager, Infantry Weapons.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed under this topic has direct applicability for civilian law enforcement. The technology as the potential to allow law enforcement to understand the behaviors of individuals behind walls.

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2. Michael Otero, "Application of a continuous wave radar for human gait recognition", MITRE Corp document # 05-0330, Dec 2005.

3. U. Tiede, T. Schiemann, K. H. Hhne, "Visualizing the Visible Human," IEEE Compute. Graphics Appl. 16, pp. 7-9, 1996.

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5. Sarah C. M. Brown and John C. Bennett, "High-Resolution Microwave Polarimetric Imaging of Small Trees", IEEE Transactions On Geoscience And Remote Sensing, Vol. 37, No. 1, January 1999.

KEYWORDS: radar, RF scattering, RF signatures, virtual display technology

N08-T025 TITLE: <u>Development of a non-invasive diver monitoring system</u>

TECHNOLOGY AREAS: Biomedical, Battlespace, Human Systems

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 work is to develop a system to non-invasively monitor diver's health. This system would monitor not only the diver's vital signs but would also monitor the diver's cognitive status.

DESCRIPTION: Divers are subjected to extreme environmental conditions which may lead to human errors and ultimately, death. The diving environment imposes great demands on the human body and the systems involved in maintaining homeostasis are routinely challenged when diving. Military divers, including special forces and SEALs, function in clandestine operations, use pure oxygen, perform long swims in the ocean environment and are subjected to battle stress. In addition, these functions are performed at remote, isolated areas without access to a diving medical officer or recompression chamber. The situation is complicated by differences in individual susceptibility. That is, divers may get decompression sickness using a dive profile that they have successfully used in the past; or divers using the same profile may show signs of oxygen toxicity on one day but not the next. Besides the extreme environmental conditions to which divers are exposed, they also must cope with the increasingly complex diving equipment and increasingly complicated mission plans.

Biomedical issues that must be addressed when diving include barotraumas, hypo/hyperthermia, nitrogen narcosis, oxygen toxicity, decompression sickness, arterial gas embolism, high pressure nervous syndrome, fatigue, stress, mental fatigue, sleep deprivation, underwater blasts, and diving in polluted water. In the case of surface supplied divers, the divers have communication with Master Diver on the surface. The Master Diver must make mission critical decisions based on his communication, or lack thereof, with the diver. The safety and efficiency diving operations would be greatly improved if diver's vital signs could be monitored by personnel on the surface. Prospective monitoring might include: 1) bubble monitoring to correlate with decompression sickness, 2) core and skin body temperature, 3) partial pressure of nitrogen, carbon dioxide and oxygen, 4) respiratory rate, 5) EEG, 6) ECG, 7) heart rate, 8) ambient water temperature, 9) depth, 10) time of dive 11) blood pressure, 12) noise dosimetry and 13) a battery of cognitive measures to determine fatigue and/or stress.

The U.S. Navy is interested in developing a non-invasive instrument to monitor diver's physiological and cognitive health. This instrument would allow the monitoring or detection of physiological and cognitive states and would vastly improve the safety and efficiency of diving operations. Such an instrument might virtually decrease the number of divers who are injured by DCS, oxygen toxicity, and hypothermia. It would be a new tool in the prevention, detection and treatment of injuries caused by alterno-baric environments

PHASE I: Provide initial development effort that demonstrates capabilities of proposed diver health monitoring system. Development should include divers that are surface supplied in adddition to free swimming divers. This phase would provide key information about the uses and limitations of the system.

PHASE II: Use instrument/algorithms to correlate data with known clinical pathologies such as DCS, hypothermia, oxygen toxicity, mental fatigue.

PHASE III: This phase would concentrate on hardening the equipment/standard operating procedures so that the device could be used by surface supplied divers. Since surface supplied divers have a connection to the surface, telemetry of data would not be necessary. However, cables and couplings would need to operate in a sometimes challenging environment. The system should also be adaptable to free swimming divers telemetry of data would be useful.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would be of interest to not only the military diving community and probably NASA, but also commercial (underwater construction and oil companies) and the large recreational diving communities. There are millions of divers world-wide who would use this system. In addition, NASA would be interested in this system to monitor astronauts on EVA (extra-vehicular activity).

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KEYWORDS: DCS; bubble detection; cognition; hypothermia; Oxygen toxicity seizure; HPNS

N08-T026 TITLE: Bi-Static High Range Resolution Radar Image Processing

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: Program Executive Office Integrated Warfare Systems II, 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: Analyze, model, develop, and evaluate algorithms that register and correlate monostatic and bi-static high resolution radar returns to generate image signatures of ship targets that can be used to detect features and attributes for identification and evaluation of maritime traffic.

DESCRIPTION: Protection of Naval ships and facilities against hostile maritime traffic remains a Navy priority. All-weather day-night surveillance depends heavily upon radar sensors to detect and locate potential hostile maritime traffic. The Navy is interested in developing a capability whereby two or more geographically dispersed high resolution radars can be used to generate integrated monostatic and bistatic radar signals that can be simultaneously processed to provide image-like signatures of targeted ships from which identification features can be extracted. Adaptive waveforms implemented in high range resolution radar (HRR) and/or inverse synthetic aperture radar (ISAR) systems are potential sources of monostatic and bistatic radar signals that could be processed to correlate and derive a common image with potentially greater image fidelity than that obtained from single surveillance radars. In addition, multi-aspect data and calibrated range/azimuth measurements can be associated with bistatic radar image generation. Research should evaluate the potentials of bistatic image processing by developing algorithms that can process multi-source radar waveforms and generate images that can be used for identification of maritime radar contacts. Research is needed to define the requirements for synchronization of timing and establishing phase references of bistatic radar waveforms to enable processing algorithms to register bistatic received waveforms, provide coordinate alignment of bistatic image data with monostatic image data, correlate image data from radar contacts in a common coordinate system, and locate signatures and features that characterize the radar contact under surveillance. While the primary interest of the research is monostatic/bistatic radar image processing, consideration should be given to determining the image fidelity improvements that may be obtained if multi-static radar sources can be used to generate images for target identification.

PHASE I: Analyze and develop processing concepts and techniques that combine and process monostatic and bistatic high resolution radar signals. Examine the registration issues, timing issues and waveform compatibility issues essential to structuring processing algorithms that provide high fidelity imagery useful for ship target identification. Documentation, assumptions, calculations and results will be presented in the form of a feasibility report at the conclusion of the Phase I effort.

PHASE II: Develop bistatic processing algorithms and target models. Simulate processing of combined monostatic and bistatic high resolution radar signals from fixed-site surface surveillance radars conducting surveillance of maritime traffic. Generate image data and evaluate the value-added performance provided by the bistatic image processing versus monostatic-only image processing. A report will be presented at the conclusion of the efforts including simulation plans, results, techniques and methods used in the bistatic image processing development.

PHASE III: Apply the bistatic image processing algorithm suite to a real-time radar test program that includes multiple radar sites capable of supporting bi-static operations. Conduct test and evaluation of bistatic radar image generation. A technical report and users manual detailing the algorithm design and implementation along with a test report highlighting the operating characteristics and performance of the algorithm suite will be generated at the conclusion of the test program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The US Coast Guard and other Department of Homeland Security organizations have needs for harbor surveillance and quality imaging of maritime traffic addressed by this research. If highly cost effective, may contribute to congested harbor traffic control through improved ID and awareness.

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2. A. Hone and G. Yates, “Bistatic Synthetic Aperture Radar”, IEE Radar, 2002.

KEYWORDS: Bistatic Radar, Data Registration, Image Focusing, High Range Resolution (HRR), Inverse Synthetic Aperture Radar (ISAR), Data Correlation

N08-T027 TITLE: High Sensitivity Analog to Digital Converter

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMW120 Topside antennas

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 work is to increase the amplitude sensitivity within a receiver for improved digital representations of minimum signal(s) across a desired frequency bandwidth.

DESCRIPTION: Many naval RF receivers and commercial wireless systems have their coverage range determined by the minimum amplitude signal they can receive. Advanced space time adaptive processing (STAP) can sometimes be used to lift the signals out of the environmental noise, but quantification of the complete signal spectrum including the noise is often needed. However, many analog to digital converters set the least significant bit to be half a bit above the receiver noise temperature and do not address techniques to lower receiver noise temperature below the environmental noise temperature. This topic requests efforts to do those things to achieve sensitivities in excess of 90 dBm over at least the HF band, 0.1-30 MHz.

PHASE I: Proposal should include a design concept for a data converter and numerical techniques that would enhance minimum signal sensitivity. A numerical simulation of the entire approach should be developed and demonstrated by the close of the first phase. In addition to the modeling of the noise floor characteristics, the ADC dynamic range and spur free dynamic range should be calculated.

PHASE II: Convert the design into an appropriate circuit layout for fabrication and test. Iterations to improve the size, weight, power, and especially performance of the design are expected.

PHASE III: Incorporate ADC into a high sensitivity receiver such as the Navy's SSEE.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In sparse signal environments such as rural areas, wireless tower coverage is limited by the attenuation of the distance and maximum handset battery draw. If the towers could extend their range or hear via the diminished signals associated with multipath, there would be fewer coverage dead zones and improved service. In addition, in urban areas, all handsets could turn down their transmitter power for longer battery life.

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KEYWORDS: analog to digital converters; sparse signal environments; noise floor; non-linear amplification; thermal fluctuations; environmental noise; STAP

N08-T028 TITLE: Microbial Fuel Cell for Distributed Seafloor Sensor Network Powering

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

ACQUISITION PROGRAM: FORCEnet FNC- GWOT Focused Tactical Persistent Surveillance Enabling Capab.

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 enable practical use of benthic microbial fuel cells (MFC) to power distributed sensors positioned on or near the river- or sea-floor. Power densities achieved by state-of-the-art, mediatorless MFC require optimization to allow replacement of marine batteries for sensor powering. Given that organic carbon derived from marine/terrestrial detritus is the renewable fuel for the MFC, and that the devices themselves are simple in design - MFCs may be inexpensively and sustainably deployed and operated, from the shallows to the abyssal ocean

DESCRIPTION: ONR has invested in basic and applied research to reveal microorganisms and mechanisms responsible for energy harvesting with benthic microbial fuel cells (BMFC). Operation of these cells has been demonstrated in a number of different marine and riverine environments, including shallow waters (with both sandy or silty mud sediments) and extremely deep, cold seeps (950 m)1. By utilizing supercapacitors and power converters, small but useful amounts of electricity may be obtained2-4.

While it is clear that electricity may be generated through electron transfer from certain microbes to electrodes (principally anodes), and that we have begun to understand the physiological adaptations and mechanisms by which this occurs3-4, theoretical electron yields from organic fuels have been unattainable in practical cell designs. It has been postulated that several factors may contribute to sub-optimal performance of the MFC5-7, such as (1) Internal resistance due to slow proton transfer through the media (water, biofilm) surrounding the electrode, along with interfering inorganic cations (Na+, K+, Ca2+); (2) Poor oxygen reduction kinetics at the cathode, due to scavenging of the O2 by aerobic bacteria at the electrode surface8 and suboptimally reactive cathode materials.

In order to efficiently power devices such as seafloor sensors (acoustic sensor arrays, optical sensors) or recharging stations for autonomous underwater vehicles, new designs that overcome cathodic limitations and internal resistance issues are required. Ideally we will retain the appealing simplicity of the BMFC by utilizing natural microbial populations in ocean sediments and seawater as the source of microbial catalysts, with inexpensive and environmentally-friendly electrode materials - but will exceed the power density (5.85W/m2) maxima reported for a complex tungsten carbide anode with a soil-derived microbial catalyst9.

PHASE I: Devise a laboratory microbial fuel cell design utilizing natural seawater or sediment microbial populations, that consistently provides >2.5W/m2 with a benign small-molecule or complex organic matter fuel.

PHASE II: Devise a laboratory MFC design utilizing natural seawater or sediment microbial populations, that consistently provides >5.8 W/m2, for a period of at least 3 months. Develop and test a prototype benthic MFC in the field, and demonstrate that power densities of >4W/m2 can be achieved and sustained for a period of at least 4 months. Develop, test and integrate a simple power management system to enable economic and optimal use of MFC-generated electricity to power a device for acoustic recording and identification of vessel traffic (to include datalogging)

PHASE III: During this phase, prototype devices will be developed that can record acoustic signals collected from vessels transiting near the device, record the vessel position (within 30m) and transmit this information via a to-be defined communication route. The device will be capable of deployment in a riverine or shallow water (=30m) setting for no less than 6 months, and have a footprint of <1m2 , and will be powered by a BMFC. Proposers will also work with topic authors to identify the most desirable sensors for this phase of research.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The benthic microbial fuel cell should find utility in the private sector for powering of sea floor instruments used for geotechnical surveying, seismic monitoring, monitoring noise inputs to the ocean (by commercial vessels, oil drilling equipment), for port security (vessel traffic monitoring) and for monitoring movements of threatened and endangered species such as marine mammals.

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KEYWORDS: microbial fuel cell; sustainable energy; undersea sensor networks; microbial catalyst; energy harvesting; electrode

N08-T029 TITLE: Novel Fiber Optic Methods for Sensing Shape, Orientation and/or Heading of Undersea Arrays and Tethers

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMS-485, PEO-LMW, PEO-SHIPS

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 array-cable/tether-cable shape, orientation, and/or heading sensing system concepts that use purely fiber-optic sensing methods to remotely measure the position and orientation of a tethered payload as well as the tether itself.

DESCRIPTION: Existing methods for performing array element localization and cable orientation in the Navy’s fixed and towed array systems, tethered unmanned vehicles, and other tethered undersea systems rely on devices such as hydrophones and magnetic heading/orientation sensors that are embedded into the cable itself. Electrical power, space, and weight reservations must be made within the overall cable design to accommodate traditional orientation sensors, historically leading to design compromises, electromagnetic interference risks, and increased complexity and cost. Recent breakthroughs in Fiber Bragg Grating (FBG) technologies indicate that distributed FBG, or similar purely optical interferometric means, can be used to continually sense the curvature, shape, and twist of a cable at regular intervals along the fiber optic cable in order to know the position of not only the payload at the cable-end but also the cable itself in three-dimensional space. This topic seeks proposals that address how Fiber-Optic Shape, Heading, or Orientation Sensing (FOSHOS) technology could be used when incorporated into naval array/tether cable systems that fall into one or more of the following length regimes: short (5m - 50m), medium (50m - 500m), long (500m – 5 km), and very long (5 km+).

PHASE I: The contractor shall select at least one of the four stated length regimes to study. The contractor shall identify one or more approaches to apply FOSHOS technology to the selected length regime(s). The contractor shall deliver a concept study that, at a minimum, assesses accuracy, power consumption, size, weight, cost, and technological risk of the selected FOSHOS approach(es). Concepts for the supporting processing, electronics and opto-electronics that would be needed to interface FOSHOS technology to an external processor should be part of this Phase I study. Opportunities for integration of FOSHOS technology with other fiber optic sensors such as hydrophones, magnetometers, strain sensors, temperature sensors etc. should also be a part of this Phase I study.

PHASE II: The contractor shall develop, demonstrate, and deliver a minimum working set of six prototype FOSHOS systems, including prototype electronics and fiber-optic cable assemblies manufactured in accordance with the Phase I study results.

PHASE III: The contractor shall refine the FOSHOS technology, including electronics miniaturization and improving the power efficiency, reliability and manufacturability. The contractor shall incorporate the product into undersea array cable and/or tether cable systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are many potential applications for this technology in areas where GPS positioning is denied or otherwise unavailable. In the undersea domain, FOSHOS could provide improved positional information for tethered vehicles designed for ship hull inspection/cleaning, force protection/harbor security, tethered diver systems, and in oceanographic research arrays. For land-based applications, tethered underground search and rescue robots/vehicles and directional drilling systems could easily benefit. The product of this SBIR topic will extend the utility of any cabled, remotely operated system where the position and orientation of the cable and/or the payload it is connected to is critical and GPS-based positioning at the payload is unavailable.

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1. A. Othonos and K. Kalli: Fiber Bragg Gratings: Fundamentals and Applications in Telecommunications and Sensing. Artech House Publishing.

2. R. Kashyap: Fiber Bragg Gratings. Academic Press Inc.

3. K. Grattan and B. Meggitt: Optical Fiber Sensor Technology (Volumes 1 through 3). Kluwer Academic Publishers.

KEYWORDS: Fiber optic; shape sensing; fiber Bragg gratings; tethered systems; interferometry; undersea systems

N08-T030 TITLE: Efficient, Highly Maneuverable Artificial Fish for Stealthy Surveillance

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Navy Future Naval Capability Program, Sea Shield, Defense of Harbor ...

OBJECTIVE: Design, build and test a new generation of low cost, energy efficient, silent, agile artificial fish utilizing multiple degree of freedom muscle-like actuators and shape changing body and fins.

DESCRIPTION: Although UUVs (autonomous as well as remotely piloted) are proving to be valuable for marine surveillance operations, significant improvements in efficiency, stealth, maneuverability and autonomous operation need to be achieved to fully realize the potential of these systems. Biology provides promising solutions to many of these problems but development of a successful AUV requires the combination of appropriate bioinspired solutions with state-of-the-art approaches in manufacturing, materials, controls, actuators and sensors. Flexibility (of body and fins) is a hallmark of animal swimming and is likely the key to the amazing propulsive and maneuvering capabilities of fish. AUVs that exploit this property could potentially have capabilities that far exceed current AUVs. Although considerable work has been done on understanding the propulsive characteristics of individual fish fins, a better understanding of how fish use all their fins (median, paired, caudal etc) to enhance their propulsive performance, maneuverability and stealth characteristics is needed. For instance, dorsal and caudal fins have been found to work in concert to significantly improve the thrust and propulsive efficiency. Fins not only provide propulsive forces but are used in a variety of combinations to produce maneuvering forces and to stabilize the fish which is dynamically unstable.

In addition, further advancements in affordable manufacturing techniques, and cost-efficient but effective actuators, sensors and materials are also needed. Stealth and higher efficiency can be achieved by moving away from traditional rotary electric motors to other actuators such as artificial muscles or linear, Lorenz force motors.

PHASE I: (1) Using an appropriate fish model, develop quantitative understanding of role of various fins (medial, caudal, paired) and body flexibility on propulsive performance, dynamic stability and maneuverability of the fish. (2) Develop a man-portable (<700 mm in any dimension), artificial fish breadboard prototype which employs multiple flexible fins driven by artificial muscle or other non-conventional actuators and which can self propel along a linear bearing track in a stable manner (prototype may be remotely piloted through a tether)

PHASE II: Develop and test a fully autonomous, artificial fish which is able to demonstrate the ability to maneuver along a complex three-dimensional underwater path (at depth >1 m) to a target at a distance of >50 m, acquire data (photographic, sonar or other) on the target and return to point of entry. Fully characterize the performance (propulsive, electrical, acoustic) of the artificial fish.

Investigate cooperative swimming and biological behaviors. Construct 3+ heterogeneous AUVs with different payloads capacities, AUV-AUV communications and sonar based sensing. Explore cooperative behaviors such as group synchronized swimming and turning of schools, search patterns and repositioning after loss of AUV.

PHASE III: Produce and demonstrate efficient, highly maneuverable, heterogeneous, fish based AUV platforms capable of executing autonomous individual and multi-unit, school based operations.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The artificial fish are expected to be used in a wide variety of non military markets including: oil rig inspection, wharf and bridge pylons safety monitoring, sports fishing active lures, under water swimming robotic companion, and entertainment.

REFERENCES:
1. The Navy Unmanned Undersea Vehicle (UUV) Master Plan, Nov 9, 2004.

2. G.V. Lauder, P. Madden, R. Mittal, H. Dong and M. Bozkurttas, "Locomotion with Flexible propulsors: I. Experimental analysis of pectoral fin swimming in sunfish", Bioinspiration and Biomimetics: Learning from nature, vol. 1, S25-S34, 2006.

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4. Tangorra, J. L., Davidson, S. N., Hunter, I. W., Madden, P. G. A., Lauder, G. V., Dong, H., Bozkurttas, M., Mittal, R. The development of a biologically inspired propulsor for unmanned underwater vehicles, IEEE J. Oceanic Eng., Jul 2007

5. Tangorra, J. L., Anquetil, P.A., Fofonoff, T. Chen, A., DelZio, M., Hunter, I.W., The application of conducting polymers to a biorobotic fin propulsor, Bioinsp. Biomimet. 2007; 2, S6-S17

KEYWORDS: AUV, Artificial Fish, muscle-like actuators, pectoral fin, shape changing fins, swarms

N08-T031 TITLE: <u>Antenna design by genetic algorithms</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

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 is to develop a methodology for antenna optimization on a platform.

DESCRIPTION: Develop a genetic algorithm to determine the best placement for antennas (or array elements) on a platform. A genetic algorithm would search an optimization space that considers antenna elements with parasitic effects and reflections from the host platform. The optimization criteria would consider radiation pattern objectives and spectrum co-utilization.

PHASE I: Describe a genetic algorithm to place antenna elements (including 3-D arrays) on a platform. The genetic algorithm shall consider the platform (e.g. wire frame, CAD/CAM) model, antenna models, and constraints in a typical scenario.

Metrics to be examined are directionality and omni regularity for a set of antennas and/or antenna elements. Also to be considered is spectrum utilization efficiency for a typical scenario to be defined by a hypothetical ISR configuration and communications plan.

The phase I deliverable will provide abstract genetic representation, methodology/criteria and data sources that would enhance platform design.

PHASE II: Demonstrate the genetic algorithm to optimize antennas and/or placement on platforms from the antenna model(s) and CAD/CAM model of a naval surface combatant for which the data is most available.
The phase II deliverable would be simulation results to support an engineering change proposal to affect improvements of phase I metrics.

PHASE III: Optimize antennas and/or placement on selected air, surface, subsurface or ground platforms. The algorithm would be hosted on a high performance cluster or sensor grid. A specific phase III objective would optimize platforms. A general objective would be to institutionalize the methodology for design validation and virtual testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: All DoD and commercial communications will benefit. Commercial applications include air transport, automatic and medical industries.

REFERENCES:
1. IEEE std 1900 series

2. MHQ w/MOC CONOPS Brief (ONR BAA 07-021 dated 10 April 2007)
NAVSEA 9085.3A Selected Drawings for Ship Acquisitions

3. Ship drawing repository: https://www.dlis.dla.mil/medals/pdfs/NAVSEA_PLANNING_YARD.pdf

4. http://en.wikipedia.org/wiki/Genetic_algorithm

5. C4ISR Architecture Framework

KEYWORDS: genetic algorithm; antenna design; ISR apertures; conformal antennas; platform integration; cosite interference

N08-T032 TITLE: <u>Ad Hoc Wireless Network for Rapidly Moving Disadvantaged Users</u>

TECHNOLOGY AREAS: Information Systems, Electronics

ACQUISITION PROGRAM: Joint Program Executive Office Joint Tactical Radio System, 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: To develop an ad hoc mobile network capability that provides seamless secure Internet-Protocol data connectivity using a physical-layer-independent approach that can be adapted to military, emergency services (homeland security), and commercial applications.

DESCRIPTION: Commercial wireless networks such as 802.11 have established expectations for seamless connectivity with relatively static or slowly changing locations. Security forces, whether DOD, Homeland Defense, or commercial, need a network that can adapt to users that are moving in vehicles, running, hiding, or generally engaged in active movements that stress conventional network routing and address distribution. Additionally, the number of simultaneous users on a given network is likely to be in the hundreds due to the nature of military operations. Existing commercial network standards might provide adequate performance in many respects, but they are typically realized in Radio Frequency (RF) band specific implementations that are not suitable for relatively long-range line-of-sight or inter-building communications (e.g., 802.11). In addition, the ease of detecting and jamming these commercial RF systems by an adversary makes it imprudent to rely on their usage for defense or homeland security applications.

Since this application inevitably will result in an inferior RF physical-layer capability compared to that of a typical commercial wireless network (e.g., 802.11 in a hotel, airport, or office), the performance priority is data transfer reliability rather than data throughput. The near-guaranteed delivery of data messages is required, but the data throughput and message-delivery latency can be comparable to that of commercial cellular phone text or email messaging (e.g., GSM EDGE).

This capability should also support packetized voice, which imposes additional performance and interface requirements. Most networks presently in use do not necessarily have interface or performance characteristics that integrate well with tactical voice communications.

The objective of this project is to develop a physical-layer independent implementation of a wireless networking capability that is based upon a proven commercial or military standard but is modified to meet the needs of disadvantaged mobile users in a hostile environment, as described above. The concept is to develop a thin software layer between the Physical Layer (PHY) and the commercial open-standard networking waveform. A robust PHY achieving military requirements can then be substituted but with the networking waveform still providing the expected open-standard interfaces. The intent of this project is to produce reusable and maintainable code that can be ported into military and commercial Software Defined Radios (SDRs) and also potentially implemented as an inexpensive commercial chipset.

PHASE I: Perform a study of applicable commercial and military network standards and their expected performance when used in the environments typically encountered by defense, homeland security, and emergency services users. Identify the primary network attributes for this application and a Modeling and Simulation (M&S) methodology for validating performance. Develop a preliminary architecture for a network that is optimized for security forces, provide preliminary M&S results derived from the modified network design, and propose an approach for the development and implementation of the capability.

PHASE II: Building upon the results of Phase I, continue the development of the improved network. Complete protocol and architecture definition of the network design begun in Phase I and perform detailed communications modeling and simulation Compare M&S results of the modified network to those of the original. Create a prototype capability using an available Software Defined Radio platform. Demonstrate capability and improvement to the original network with a small-scale field experiment using a minimum of five nodes operating in a military frequency band at a transmit power level appropriate for a battery-powered tactical device.

PHASE III: Develop a complete implementation of the new network protocol on a JTRS or commercial SDR radio platform. Demonstrate and document network performance. Transition software upgrade into the JTRS programs of record.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is an increasing demand for a ubiquitous ad hoc mobile wireless networking capability in the business, consumer, and commercial markets. The product of this project is directly applicable to next-generation versions of commercial wireless networks (e.g., 802.11) and public networks. This technology could potentially enable IP connectivity in remote, rural, or heavily forested areas that cannot practically obtain wireless coverage using currently available network systems. It could also enable new capabilities for emergency services (e.g., the transmission of voice, video, data, personnel identification, and navigational coordinates) in locations where access to conventional line-of-sight communications systems or satellites is unavailable.

REFERENCES:
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2. Khosroshahy, M., Turletti, T., Obraczka, K., Snapshot of MAC, PHY, and Propagation Models for IEEE 802.11 in Open-Source Network Simulators, Institut National de Recherche en Informatique et en Automatique (INRIA), September 2007, No. 6310, http://hal.inria.fr/docs/00/17/54/56/PDF/RR-6310.pdf

3. Tuttlebee, Walter H. W. (Editor) Software Defined Radio: Enabling Technologies, (Wiley, 2002), ISBN: 978-0-470-84318-5

4. Reed, Jeffrey H., Software Radio: A Modern Approach to Radio Engineering, (Prentice Hall, 2002), ISBN: 978-0130811585

KEYWORDS: radio; SDR; JTRS; software; wireless; communications; network

N08-T033 TITLE: Energy management system for unmanned, untethered sensors

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

ACQUISITION PROGRAM: TBD

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 is to increase persistence of remote sensors in support of ISR CONOPS.

DESCRIPTION: Develop a comprehensive energy management system for unmanned untethered vehicles and unattended sensors. The usefulness of such systems is limited by power to support the mission payloads. We need a comprehensive energy management system to extend life of remote sensors.

Metrics include power to weight and power to volume ratios as well as mission life. Power requirements for the metrics include the support of the payload and housekeeping infrastructure). Weight/Volume pertains to power management support hardware and power source(s).

PHASE I: Develop a concept for energy sources and a management system that optimizes the operation of untethered unmanned vehicles and unattended sensors. Candidate sources should include, but not be limited to, engines, batteries and fuel cells. The system would also harvest energy, of all feasible types to include, but not be limited to, motion, light, thermal, radiation (RF). The conceptual vehicle and sensor system concept would identify and/or specify communications using power aware protocols and an allocation strategy for critical and non-critical components.

The concept would define a feasibility trade space that would include size, weight and power metrics, efficiency, energy density, processing and control, cost and candidate mission profiles (e.g. duty cycle). The concept might define classes in a performance trade space.

Deliver a model that demonstrates performance goals. For the purpose of this model, a nominal vehicle would support a size of 12 inch diameter by 72 inch length for power and power management. Nominal mission duration is 30 days with a round trip (surface or subsurface) transit of 300 km with speed greater than 3 knots. Payload peak power requirement is nominally 300W but can be decomposed to manage the duty cycle of critical sensor, communications and housekeeping components. Key metrics are the energy to weight (joules/kilogram) and energy to volume (joules/liter) ratios. It must be clear that the demonstrated metrics are greater than that of conventional power sources without harvesting and management. Consideration would be given for innovative management strategies or better metrics.

PHASE II: Deliver a refined model that characterizes a configuration trade space sufficient for detailed design options.

The power system prototype shall include a processor and communications such that non-critical components are managed by priority and a mission rule set. The rule set would consider power capacity, mission requirements, and applicable conditions (e.g. navigation and environment) and allow for recovery. The rule set would be represented by XML for on air reprogramming priorities and reuse. A MATLAB/SIMULINK simulation will be demonstrated for power management algorithms and strategies.

Build , demonstrate and test a prototype power management subsystem for the most applicable configuration in the trade space.
Phase II deliverables would include model files, a bill of material with cost data for the prototype, the schema rule sets and a software description document.

PHASE III: Refine, build and integrate applications of this concept. Multiple products will be considered with a greater focus on cost/benefit/performance optima. A modular power management, appropriately scaled, would apply to most remoted sensors. Early transition is anticipated for experimentation.
Remoted sensors would be controlled by current systems (POR's) on stand-off platforms. These POR systems would be configured for remoted sensor interfaces and used as available as organic sensor augmentation.
Payloads may be classified.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial: environmental sensors.
Military: force protection; ISR

REFERENCES:
1. SEACON 2007 (ad hoc networking)

2. MHQ w/MOC CONOPS Brief (ONR BAA 07-021 dated 10 April 2007)
Naval Post Graduate School Masters Thesis (Jon M. Seguin): Simulating Candidate Missions for a Novel Glider Unmanned Underwater Vehicle, March 2007

3. Mathworks 2007 World Tour Hybrid Electric Vehicle model

KEYWORDS: energy harvesting; power management; remoted sensors; ad hoc networking; unmanned vehicle; unattended sensor

N08-T034 TITLE: Extensible Affordable Software Defined Radio with Cross-Band Cross-Protocol Capability

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: Joint Porgram Executive Office Joint Tactical Radio System, 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: To develop and demonstrate a scalable and extensible consumer/commercial/military universal multi-channel Software Defined Radio (SDR) architecture and platform that is capable of bridging wireless communications networks operating at different radio frequency bands, physical layers, data/voice protocols, vocoders, and encryption methods. Fundamentally, the architecture of this system must be such that inexpensive realizations are possible with minimal capabilities suitable for consumer products and expendable sensors, and it must also be scalable and extensible to encompass high-performance military and commercial applications.

DESCRIPTION: A versatile Software Defined Radio (SDR) platform is required that can be implemented as an inexpensive single-function, single channel radio suitable for expendable or consumer use or scaled-upward to be a high-performance multi-application, multi-channel communications system. When configured as a multi-channel system, a gateway capability will be possible that will enable real-time bridging among a broad variety of legacy, current, and emerging radio frequency communications standards. For example, the gateway could bridge a military aircraft network with a military ship/ground network, a US military network with a coalition network, or an 802.11 WiFi network with emergency services VHF radios. The Joint Tactical Radio System (JTRS) multi-channel radio products can provide these types of capabilities, but the cost of the systems limits their immediate use outside of military applications.   A system architecture is needed that is less expensive to implement, meets a subset of JTRS requirements, and can be scaled in nearly all aspects to enable the production of SDR radios that can be produced as commodity or as high-performance/high-end products –all utilizing a common pool of portable software. The approach would enable portability of communications applications among consumer/commercial/military SDR radios to ensure interoperability, provide affordable SDR application development platforms for small businesses and academia maximize maintainability at minimal cost, and enable rapid changes of communications waveform characteristics in response to hostilities. In addition, this approach would build an industrial base of hardware (e.g., chipsets) that would result in an order-of-magnitude reduction in the cost of SDRs and improve interoperability through organized or ad hoc standardization.

PHASE I: Document requirements for the SDR radio described above, encompassing military, commercial, emergency services, and consumer applications. Develop a scalable architecture that is applicable to all identified requirements. Using modeling and simulation, generate evidence that the proposed architecture can be implemented using available hardware technology. Propose a two-channel multi-band radio with gateway capability to design and demonstrate in Phase II (e.g., 802.11/VHF emergency services)

PHASE II: Complete the design of the radio hardware and software proposed in Phase I. Use modeling and simulation as required to minimize design risk. Fabricate a brassboard suitable for demonstration. (If the proposed design relies upon a custom chip set to reduce production costs, use a surrogate implementation for this breadboard.) Demonstrate communications and gateway capabilities of the radio system in field-testing. Propose implementations of the architecture into military, emergency services, and consumer radio products.

PHASE III: Develop a prototype VHF/UHF small form factor tactical radio with line-of-sight, MUOS satellite communications, and Type I encryption capability that can be integrated into expendable devices (e.g., sonobuoys, submarine-launched sensors and communications buoys, deployed sensors), UAVs, aircraft radios, and handheld radios. Document the hardware architecture, interfaces, APIs, specifications, and all other aspects required to define this standard.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An immediate need for affordable SDRs exists in the Emergency Services market. Major emergencies such as large-scale forest fires require the combined efforts of the firefighting forces of many communities. Often, the radio communications equipment used by these forces is not interoperable. By providing the leader of an organization with an SDR radios, he can load the applications that he needs to speak to the leaders of partner organizations. By using the gateway functionality of a multiple-channel system, it would be possible to bridge the communication networks of each community and enable firefighter-to-firefighter communications within a given repeater zone.   Clearly these same capabilities would also be of value to certain police forces and municipal/state homeland security operations.

It is also possible that this technology will have direct application in consumer communications devices. If true SDR functionality can be built into a consumer radio, then it would be possible for manufacturers to build international, WiFi, walkie-talkie, and another communication modes into extremely small phones, since the multi-functionality capability is enabled with software rather than with additional chips.

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3. Software Defined Radio (SDR) Forum: http://www.sdrforum.org/

4. JPEO JTRS: http://jpeojtrs.mil/

KEYWORDS: radio; SDR; JTRS; software defined; wireless; communications