NAVY
11.2 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

The responsibility for the implementation, administration and management of the Navy SBIR Program is with the Office of Naval Research (ONR). The Director of the Navy SBIR Program is Mr. John Williams, john.williams6@navy.mil. For general inquiries or problems with electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8:00 am to 5:00 pm ET). For program and administrative questions, please contact the Program Managers listed in Table 1; **do not** contact them for technical questions. For technical questions about the topic, contact the Topic Authors listed under each topic prior to **26 May 2011.** Beginning 26 May 2011, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in section 1.5c of the program solicitation must be used for any technical inquiry.

TABLE 1: NAVY SYSCOM SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	Activity	Email
N112-087 thru N112-127	Ms. Donna Moore	NAVAIR	navair.sbir@navy.mil
N112-128 thru N112-142	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N112-143	Mr. Todd Groszer	NAVSUP	todd.groszer@navy.mil
N112-144 thru N112-145	Mr. Stephen Stachmus	NSMA	stephen.stachmus@navy.mil
N112-147 thru N112-167	Mrs. Tracy Frost	ONR	tracy.frost1@navy.mil
N112-168 thru N112-170	Ms. Summer Jones	SPAWAR	summer.m.jones@navy.mil

The Navy's SBIR Program is a mission oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. Companies are encouraged to address the manufacturing needs of the Defense Sector in their proposals. Information on the Navy SBIR Program can be found on the Navy SBIR website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I GUIDELINES

Follow the instructions in the DoD Program Solicitation at **www.dodsbir.net/solicitation** for program requirements and proposal submission. Cost estimates for travel to the sponsoring Syscom's facility for one day of meetings are recommended for all proposals and required for proposals submitted to MARCOR and NAVSEA. For NAVSEA proposals, a recommended proposal template can be found at http://www.navysbir.com/navsea. The Navy encourages proposers to include, within the 25 page limit, an option which furthers the effort and will bridge the funding gap between Phase I and the start of Phase II . Phase I options are typically exercised upon the decision to fund Phase II. **The base amount of Phase I should not exceed $80,000 and six months; the Phase I option should not exceed $70,000 and six months.**

The Navy will evaluate and select Phase I proposals using the evaluation criteria in section 4.2 of the DoD solicitation in descending order of importance with technical merit being most important, followed by qualifications and commercialization potential of equal importance. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

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

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

PHASE I SUMMARY REPORT

All awardees must submit a non-proprietary summary of their final report (without any proprietary or data rights markings) through the Navy SBIR website. 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". A template is provided for you to complete. This summary, once approved, may be publicly accessible via the Navy's Search Database.

PHASE II GUIDELINES

Phase II proposal submission is by invitation only. If you have been invited, follow the instructions in the invitation. **Each of the Navy Syscoms has different instructions for Phase II submission. Visit the website cited in the invitation to get specific guidance before submitting the Phase II proposal**.

The Navy will evaluate and select Phase I proposals using the evaluation criteria in section 4.2 of the DoD solicitation in descending order of importance with technical merit being most important, followed by qualifications and commercialization potential of equal importance. 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 does NOT participate in the FAST Track program.

The Navy SBIR Program structures Phase II contracts in a way that allows for increased funding levels based on the project's transition potential. This is called the Phase II.5 and is accomplished through either multiple options that may range from $250,000 to $1,000,000 each, substantial expansions to the existing contract, or a second Phase II award. For existing Phase II contracts, the goals of Phase II.5 can be attained through contract expansions, some of which may exceed the $1,000,000 recommended limits for Phase II awards.

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

The Navy typically awards a cost plus fixed fee contract for Phase II.

PHASE II ENHANCEMENT

The Navy has adopted a Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since Phase III awards are permitted during Phase II work, some Navy Syscoms may match on a one-to-four ratio, SBIR funds to funds that the company obtains from an acquisition program, usually up to $250,000. The SBIR enhancement funds may only be provided to the existing Phase II contract. For more information, please contact the Syscom SBIR Program Manager.

PHASE III

A Phase III SBIR award is any work that derives from, extends or logically concludes effort(s) performed under prior SBIR funding agreements, but is funded by sources other than the SBIR Program. Thus, any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR contract and awarded to the company which was awarded the Phase I/II SBIR is a Phase III SBIR contract. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was a SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR award. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description, which includes according SBIR Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR Phase I/II effort(s). The government's prime contractors and/or their subcontractors shall follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect rights of the SBIR company.

ADDITIONAL NOTES

Because of the short timeframe associated with Phase I of the SBIR process, the Navy does not recommend the submission of Phase I proposals that require the use of Human Subjects, Animal Testing, or Recombinant DNA. For example, the ability to obtain Institutional Review Board (IRB) approval for proposals that involve human subjects can take 6-12 months, and that lengthy process can be at odds with the Phase I time to award goals. Before Navy makes any award that involves an IRB or similar approval requirement, the proposer must demonstrate compliance with relevant regulatory approval requirements that pertain to proposals involving human, animal or recombinant DNA protocols. It will not impact our evaluation, but requiring IRB approval may delay the start time of the Phase I award and if approvals are not obtained within 6 months of notification of selection, the award may be terminated. If you are proposing human, animal and recombinant DNA use under a Phase I or Phase II proposal, you should view the requirements at **http://www.onr.navy.mil/About-ONR/compliance-protections/Research-Protections.aspx.** This website provides guidance and notes approvals that may be required before contract/work can begin.

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

PHASE I PROPOSAL SUBMISSION CHECKLIST:

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

____1. Include a header with company name, proposal number and topic number to each page of your technical proposal.

____2. Include tasks to be completed during the option period and include the costs in the cost proposal.

____3. Break out subcontractor, material and travel costs in detail. Use the "Explanatory Material Field" in the DoD cost proposal worksheet for this information, if necessary.

____4. The base effort does not exceed $80,000 and six months and the option does not exceed $70,000 and six months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

____5. Upload your technical proposal and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and Cost Proposal electronically through the DoD submission site by 6:00 a.m. ET, 29 June 2011.

____6. After uploading your file on the DoD submission site, review it to ensure that it appears correctly. Contact the DoD Help Desk immediately with any problems.

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N112-130	Pulse Compressor for Long Stretch Factor in High-Energy Ultrafast Fiber Lasers at Eye-Safer Wavelengths
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NAVY SBIR 11.2 Topic Descriptions

N112-087 TITLE: Cumulative Moisture Sensor for Ceramic Fabrics

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

OBJECTIVE: Develop a passive sensor to measure the cumulative moisture absorbed by ceramic fabric.

DESCRIPTION: Ceramic fabrics are used during the production of ceramic matrix composites. The ceramic fabric spools are stored in a climate controlled environment prior to use. During production, the spools are removed from the controlled environment and the required amount of fabric is removed from the spool. In some cases during storage, the environment may be compromised due to equipment failure or dry-bag leaks. These events lead to moisture ingress into the ceramic fabric and cause the moisture content to rise above acceptable limits, rendering the fabric unusable. Longer exposure at lower humidity may be more detrimental than a short spike in humidity.

The current industrial practice is to use qualitative humidity sensors. These sensors change color when a certain trigger-humidity is reached and is not indicative of actual moisture absorbed by the fabric. This is combined with manual logs used to record the out time of the fabric while on the shop floor and the temperature and humidity in the shop at the time the fabric is exposed. To enable stricter monitoring of the moisture content and also to minimize human error, a passive traveling sensor is desired. This sensor will be stored with the fabric and will be exposed to the same environment as the fabric. The sensor should absorb moisture in a manner that can be calibrated to that absorbed by the fabric. The absorption has to be measurable either through a change in mechanical or electrical property or another property. This property should be readable quickly and in a non-destructive fashion.

PHASE I: Develop an approach to sense the cumulative moisture absorbed by the ceramic fabric. Demonstrate the feasibility of such approach by formulating a laboratory study.

PHASE II: Develop a cumulative moisture sensor prototype based upon the Phase I approach. Evaluate the process through fabrication and testing of the prototype sensor.

PHASE III: Transition the approach to appropriate platforms and additional propulsion and high temperature applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This sensor could be used in the small but growing ceramic matrix composite (CMC) industry in the civilian sector. It could also be adapted for use in any civilian application needing monitoring of cumulative moisture content of stored inventory.

REFERENCES:

1. Chawla, K. K. (2003). Ceramic matrix composites, 2nd Edition, Kluwer Academic Publishers.

2. Control Company - http://www.control3.com/4192p.htm

KEYWORDS: ceramic fabric; sensor; humidity; moisture; quality control; usable life sensor

N112-088 TITLE: Operational Engine-Inducted Sand and Dust Loading Rate Detector

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

OBJECTIVE: Develop innovative sensors (or an assembly of sensors) to be positioned in an aircraft engine's gas path to measure particulate load rates, specifically for sand and dust.

DESCRIPTION: The majority of today's military engagements are occurring in desert environments which present unique challenges for aircraft operation. Sand negatively impacts part durability, increasing compressor erosion and reducing turbine cooling flow. An innovative sensing capability is needed to measure sand and dust loading rates in an operationally deployed engine. Particle sensors in the aircraft engine's main gas path at the inlet and exhaust and in the engine's secondary flow path are needed to measure sand and dust flow through the engine and to detect and measure particle size distribution, mineralogy, and chemistry.

This integrated sensing capability will provide information to help manage the health and durability of the aircraft's engine. The sensor's first application would be to study durability impacts from sand and dust loading rates followed by engine repair and overhaul management of engines operating in sandy environments. Engine environment will constrain sensor design with inlet distortion, hot exhaust gas temperatures, and secondary air passage geometry.

PHASE I: Define and determine the feasibility of providing a dependable sensor (or an assembly of sensors) to measure particulate load rates given the constraints mentioned. Initiate the design to the conceptual level for one or several engine systems, such as the Joint Strike Fighter P&W F135 or GE/RR F136, Sikorsky SH60 GE T700, F/A18E/F GE F414, E-2C RR T56-427, or a similar future naval air systems platform. A prototype sensor assembly may be demonstrated in bench tests if feasible.

PHASE II: Produce a detailed design(s) and prototype the assembly (preferably via strong coordination with selected-engine OEM and/or multiple designated second-party partners, especially relating to the signal data bus transmission scheme, data acquisition and processing approach, and specific assembly interface to the engine case).

PHASE III: Finalize engine sensor assembly integration with major DOD end users and engine manufacturers and conduct the necessary qualification testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These sensors will provide information to help manage engine health and durability of both military and commercial aircraft operating in sandy environments.

REFERENCES:
1. Intra, P., & Tippayawong, N. (2007). An overview of aerosol particle sensors for size distribution measurement. Maejo International Journal of Science and Technology, 1(2), 120-136. Retrieved from http://www.mijst.mju.ac.th/vol1/120-136.pdf

2. Simon, D. L., Gang, S., Hunter, G. W., Guo, T.-H., & Semega, K. J. (2004, June). Sensor needs for control and health management of intelligent aircraft engines. Paper presented at ASME Turbo Expo 2004, Vienna, Austria. Retrieved from http://gltrs.grc.nasa.gov/reports/2004/TM-2004-213202.pdf

3. Walsh, W. S., Thole, K. A., & Joe, C. (2006, May). Effects of sand ingestion on the blockage of film-cooling holes. Paper presented at the ASME Turbo Expo, Barcelona, Spain. Retrieved from http://www2.mne.psu.edu/psuexccl//p46.5.pdf

4. Land, C. C., Joe, C., & Thole, K. A. (2010). Considerations of a double-wall cooling design to reduce sand blockage. Journal of Turbomachinery,132. Retrieved from http://asmedl.aip.org/getpdf/servlet/GetPDFServlet?filetype=pdf&id=JOTUEI000132000003031011000001&idtype=cvips

5. Scala, S. M., Konrad, M., Mason, R. B., Semick, J., & Skelton, D. (2004, July). Sensor requirements to monitor the real time performance of a gas turbine engine undergoing compressor blade erosion. Paper presented at the 40th Joint Propulsion Conference and Exhibit, Fort Lauderdale, FL.

6. Powrie, H., & Novis, A. (2006, July). Gas path debris monitoring for F-35 Joint Strike Fighter propulsion system PHM. Paper presented at the IEEE Aerospace Conference, Big Sky, MT. Retrieved from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1656114

7. McDonald, E., & Caldwell, T. (2004). Geochemical and physical characteristics of Iraqi dust and soil samples. U.S. Army Research Office, Final Project Report No. 6310-653-4560. Retrieved from http://www.defenseindustrydaily.com/files/Iraq_Dust_2004-10_DRI_Report.pdf

KEYWORDS: sand erosion; propulsion; desert operations; sensors; prognostics health management; particle sensor

N112-089 TITLE: Mid-Infrared Fiber Coupler for Multiband Infrared Countermeasure (IRCM) Lasers

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-272, Infrared Countermeasures

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

OBJECTIVE: Develop a Mid-Infrared (Mid-IR) fiber coupler system capable of receiving multiple semi-conductor laser sources (e.g., quantum cascade lasers emitting at different Mid-IR wavelengths, solid-state lasers, optically pumped semiconductor lasers) so as to achieve a single output beam.

DESCRIPTION: Next generation infrared countermeasure (IRCM) systems must have the capacity to offer greater output power and wavelength range through a fiber than presently available in order to counter advancing threat technologies. Current Mid-IR sources are limited in the power and bandwidth they can deliver. Development of a Mid-IR fiber coupler can be a way to combine current IRCM laser sources to produce ultra broadband IRCM sources to gain higher output powers. We seek an all Mid-IR fiber coupler with capability to combine wavelengths from all IRCM bands (2-5 microns) into one fiber. This device should be able to combine powers of up to 100 watts and have low insertion losses less than 5 percent (-0.2dB) and maintain or improve beam quality.

PHASE I: Design, develop and prove feasibility of a Mid-IR fiber coupler. Model the losses and powers that can be combined in several iterations (various increments input lasers) of the fiber coupler.

PHASE II: Based on the design in Phase I, fabricate four sets of fiber coupler prototypes (two, four, six and eight input lasers) that are capable of combining outputs of several multiband IRCM laser sources. Test and evaluate the prototypes for performance, losses, beam quality and other characterization points.

PHASE III: Continue improving the fiber coupler in terms of increasing the number of input laser sources to achieve greater output power. Transition the technology to appropriate platforms and systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications of this technology include chemical and explosive detection systems, Mid-IR fiber lasers, Light Detection and Ranging (LIDAR) is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target and free space optical communications.

REFERENCES:

1. Eyal, O., Shalem, S. & Katzir, A. (1994). Silver halide mid-infrared optical fiber Y coupler. Optical Letters 19, 1843-1845. doi:10.1364/OL.19.001843

2. Lippert, E., Nicolas, S., Arisholm, G., Stenersen, K. & Rustad, G. (2006). Mid-infrared laser source with high power and beam quality. Applied Optics, 45, 3839-3845. doi:10.1364/AO.45.003839

3. Mecherle, G. S. (1986). Laser diode combining for free space optical communication. Proceedings SPIE 616, 281. http://sciencestage.com/d/3388305/laser-diode-combining-for-free-space-optical-communication.html

4. Fan, T.Y. (2005). Laser beam combining for high-power, high-radiance sources. Selected Topics in Quantum Electronics, IEEE Journal of, 11 (3), 567.
http://ieeexplore.ieee.org/Xplore/login.jsp?url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F2944%2F32477%2F01516122.pdf%3Farnumber%3D1516122&authDecision=-203

KEYWORDS: mid-IR fiber coupler; IRCM; countermeasure; power scaling of lasers; spectral beam combining; coherent beam combining

N112-090 TITLE: Improved Target Classification Using Continuous Synthetic Aperture Radar (SAR) Imaging of Ground Moving Targets

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA 265, F/A-18 Hornet Strike Fighter

OBJECTIVE: Develop innovative techniques to provide target classification of ground moving target indication (GMTI) contacts using simultaneous and continuous streaming SAR imagery of moving targets within the scene.

DESCRIPTION: Modern GMTI equipped radar systems are capable of tracking moving land vehicles and even dismounts from significant standoff ranges. However, conventional GMTI does not provide sensor operators with a means to sort out specific vehicle types from other vehicles. At short ranges and suitable weather conditions electro-optic sensors can be used to provide classification. However, an all-weather, long-range capability is needed. Without such a capability, sensor operators can be swamped by the volume of tracks without the ability to separate out critical targets from others, all of which can result in a breakdown of the kill chain.

A SAR image is formed by processing many radar pulse returns from a target. Each pulse provides information as to the range to the target and the pulse-to-pulse variations at a given range provide the necessary information to extract the azimuth target position. A moving target will pass through many range resolution cells during this data collection process (which may be in the order of many seconds) producing a blurred image using conventional ground focused SAR image formation techniques. SAR focusing on moving targets can be improved by utilizing GMTI information on the particular target. The implementation we seek is to quickly and efficiently combine a GMTI mode with the ability to provide focused moving target SAR on multiple targets in the scene. In order to improve sensor operator understanding of the scene, a continuous stream of SAR images of specific targets is needed. Utilizing the same waveform for both SAR and GMTI is desired for typical operation with higher resolution SAR waveforms interleaved as required by the sensor operator to improve classification performance.

PHASE I: Determine the technical feasibility of the innovative technique to provide a GMTI and moving target SAR for improved target classification. Develop an RDT&E plan addressing performance metrics, integration tasks and human-system interface.

PHASE II: Design and demonstrate a prototype system in an operationally representative environment utilizing a Navy airborne radar system or suitable surrogate.

PHASE III: Transition the developed technology to appropriate platforms and the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The method can be utilized in both commercial SAR systems as well as homeland security applications.

REFERENCES:

1. Diego Cristallini, Fabiola Colone, Debora Pastina, and Pierfrancesco Lombardo, "Integrated Clutter Cancellation and High-Resolution Imaging of Moving Targets in Multi-channel SAR," Proceedings of the 6th European Radar Conference, 30 September - 2 October 2009, Rome, Italy, pp. 57-60.

2. Daniele Perissin and Alessandro Ferretti, "Urban-Target Recognition by Means of Repeated Spaceborne SAR Images," IEEE Transactions On Geoscience And Remote Sensing, Vol. 45, No. 12, December 2007, pp. 4043-4058.

KEYWORDS: Synthetic Aperture Radar; Target Classification; Ground Moving Target Indication; Multi-Mode Radar; Tactical Sensor Exploitation; High Value Unit Tracking

N112-091 TITLE: High Voltage Actuator Battery Development

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMA-259, Sidewinder AIM 9X Block Upgrade

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OBJECTIVE: Develop a robust high voltage battery that reduces internal impedance and supports conformal shapes. The new batteries should have cell voltage levels and high temperature storage performance comparable to existing cylindrically shaped lithium thermal batteries, while offering improved pulse power densities.

DESCRIPTION: Missile batteries are designed to perform in extreme captive carry and free flight environments following an extended period of storage: shelf life requirements of 20 years under high temperature conditions (71degrees Celsius) are typical. These batteries produce hundreds of high current pulses, often exceeding 4 amps/cm2, for very short durations and are required to perform within very short rise times of 0.3 seconds following precondition temperature environments of negative 54 to positive 71 degrees Celsius.

Such batteries must also survive captive carry vibration, acceleration, and shock imposed by the launch platform and then perform under even more stressful vibration, acceleration, and shock during free flight. They must remain safe and not vent or otherwise produce an ignition source following activation, whether in free flight or if the missile remains captive during a hung store condition. The batteries must also remain safe if activated with abnormal electrical loads and despite inadvertent manufacturing errors. Of primary interest is a high voltage actuator battery capable of sustaining the minimum voltage level under pulse loading of 10 amps/cm2, within a rise time of 0.3 seconds, that is also robust enough to survive the severe captive carry temperatures and vibration environment of an air launched missile. To meet the voltage regulation requirement, the internal impedance of this battery should be no more than 4 milliohms per cell. This effort must demonstrate a thermal battery with cross section ratio (width/thickness) of three to one or better.

The prototype device should be thin, stackable, and/or flexible enough to fit the spaces available on a rocket or missile and capable of providing scalable output. Achieving this goal would allow one standard battery technology to be used instead of many. The resulting common manufacturing process and increased production runs should both improve reliability and reduce manufacturing costs.

PHASE I: Develop solutions for a robust high voltage battery that meets the most critical engineering challenges identified. Demonstrate these solutions in lab experiments or single cell testing.

PHASE II: Design, fabricate, and test a prototype device meeting generalized performance requirements and conformal shape. The battery must contain a sufficient number of cells to confirm that all of the critical challenges have been overcome.

PHASE III: Design, fabricate, and test a sample quantity of batteries meeting actual missile performance, envelope, and weight requirements. These batteries will be subjected to non-operational environmental, performance, and U.S. Navy safety testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Highly reliable, compact, long-term electrical power storage devices would be useful as a reserve power source for electrical and plug-in hybrid vehicles. If a secondary battery can demonstrate the necessary performance and safety requirements under these environments, it could potentially be used as the main vehicle battery for plug-in hybrid vehicles.

REFERENCES:
1. Assistant Secretary of the Navy. (1991, September). Navy Primary and Secondary Batteries (NAVSO P-3676, Stock No. 0518-LP-207-7600).

2. Linden, D. (1984). Handbook of Batteries and Fuel Cells. NY: McGraw Hill.

3. Naval Ordnance Safety and Security Activity. (2004, August 19). Technical Manual for Batteries, Navy Lithium Safety Program Responsibilities and Procedures. (S9310 AQ SAF 010). Port Hueneme: Naval Surface Warfare Center.

KEYWORDS: reserve; thermal; battery; missile power; conformal; lithium

N112-092 TITLE: Non-beam-steering Global Positioning System (GPS) Anti-jam Solution with Minimized Pseudo-range Errors

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

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

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OBJECTIVE: Develop advanced algorithms with Global Positioning System (GPS) anti-jam capability to meet stringent accuracy requirements and operate with small antennas.

DESCRIPTION: Small Navy platforms will require technology to meet the operational availability and accuracy requirements for upcoming systems. Most common GPS Anti-jam (AJ) antenna systems employ a multi-element phased array antenna known as a Controlled Reception Pattern Antenna (CRPA) working in conjunction with an Antenna Electronics (AE) to minimize interference in the GPS band. Most of the current systems use “nulling” techniques that steer antenna nulls toward the interfering signals by adapting antenna weights. Studies suggest that these techniques introduce error into the GPS solution that may be unacceptable for precision approach and landing. These studies also indicate that a digital beam-steering design rather than a beam-nulling design can better maintain the required accuracies. Although digital beam-steering offers one way of minimizing the carrier phase and pseudo-range biases, it requires a large array (14 inch diameter antenna). These digital beam-steering architectures are very dependent on accurate antenna calibrations and require a tightly coupled digital interface with the GPS receiver. Currently Navy platforms do not have GPS receivers that could directly interface with a digital beam-steering system. Additionally, small Navy platforms may not have the physical room for a 14 inch CRPA. The requirements for a tightly coupled GPS receiver and a 14 inch CRPA drive the cost of the anti-jam solution up to the extent that digital beam-steering anti-jam solutions may not be affordable on many of the Navy's smaller platforms. Size, weight and power (SWAP) constraints further restrict the ability to add anti-jam capability on smaller platforms. Innovative non-beam-steering antenna signal processing solutions are required to address this technology gap.

Non-beam-steering AJ solutions offer the advantage of requiring no calibration, having smaller antenna array size, lower unit and integration costs, and could be fielded with our current and planned future GPS systems. Determine if there is a non-beam-steering AJ solution, utilizing a small antenna array, (for example, < 5 in. diameter), that maintains the unique carrier phase accuracy and reliability requirements for precision approach and landing while in a jamming environment.

PHASE I: Develop and demonstrate feasibility of innovative non-beam-steering antenna signal processing algorithms. Emphasis should be on mitigating carrier phase distortions in jamming and non-jamming environments. This phase will result in the identification of algorithms, and the assessment of implementation feasibility including complexity. This phase should include detailed simulations and a recommendation on the selected algorithm.

PHASE II: Further develop and mature the algorithm by implementing it in an antenna electronics system and demonstrate its performance with a small antenna array in conjunction with a military avionics GPS receiver. The anti-jam performance and carrier phase integrity should be demonstrated.

PHASE III: Transition the technology developed to an existing Navy platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed under this effort will have potential applications to commercial air vehicles where unintentional interference can occur.

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KEYWORDS: Global Positioning System (GPS); anti-jam; optimum adaptive algorithm; antenna electronics; carrier phase; phase compensation

N112-093 TITLE: Innovative Heat Sink Technology for Application to Aircraft Systems

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-231, C-2 / E-2 Program

OBJECTIVE: Develop and demonstrate innovative heat sink technology and/or different methods of heat sink utilization that can be used to provide supplemental cooling for aircraft systems and/or components.

DESCRIPTION: Methods are needed to increase mission capability of thermal management systems. Thermal management is widely viewed as one of the key challenges for next-generation tactical aircraft systems. Fourth- and fifth-generation tactical aircraft are already pushing the envelope for cooling capacities; typical heat rejection requirements for these aircraft are in the neighborhood of 30-40 kW. For these aircraft, there are portions of the flight envelope where the environmental control system or thermal management system cannot provide adequate cooling capability for mission systems or air vehicle equipment. Furthermore, these heat loads are projected to increase significantly in next-generation fighter aircraft with the potential introduction of directed energy weapons (DEWs) and other high-power mission systems. DEWs provide a good example of the type of equipment that might present particular challenges for future aircraft – transient, high-power (approximately 1MW), short duration. Such systems may require an order-of-magnitude increase in heat rejection capacity. Complicating matters further is the conflicting survivability requirement which includes reducing heat sources radiating or exhausting from the aircraft. This means that, at least in threat environments, thermal management must be performed adiabatically. State-of-the-art for current-generation tactical aircraft typically consists of one or more bootstrap air cycles, supplemented by liquid cooling circuits. Compressed air for the air cycle is extracted from engine bleed air (approximately 1100 degrees F), and delivery air temperature for avionics and mission systems is approximately 30-40 degrees F. Fuel is also used increasingly as a heat sink, but there are limits to fuel temperature, and fuel burn during the mission decreases the size of the available heat sink. Possible ways to regain cooling margin may include new materials and technologies as well as innovative applications of new and existing technologies. Advanced heat sink technology can either be applied to improve heat transfer at the individual weapon-replaceable assembly level or be integrated into the aircraft's cooling system.

PHASE I: Conceptualize and design an innovative, lightweight, durable, heat sink technology or demonstrate the feasibility of applying existing heat sink technology in an innovative manner that will result in a sufficient cooling margin.

PHASE II: Provide practical implementation of a production-scalable process to implement the recommended approach developed under Phase I. Evaluate the approach by showing concept maturity, initial fabrication of a prototype, and capabilities validated. Develop an integration hardware design scheme to add a developed system to improve thermal performance.

PHASE III: Transition the approach to appropriate platforms, systems, or hardware.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Heat sink technology can be used to solve various similar thermal problems within aircraft and ships, both military and commercial.

REFERENCES:
1. Wong, R. & Lui, C. (2003, July). Dual expansion energy recovery (DEER) environmental control system. Paper presented at the International Conference on Environmental Systems, Vancouver, BC, Canada. Retrieved from http://papers.sae.org/2003-01-2399/;WebLogicSession=MYkZt3jyHLL0H6c7nLHH1w4FyHrX4LKT3qSJhVWp1vvf9JQXKfVj!-1234461123

2. Lillibridge, S. T. & Stephan, R. (2009, July). Phase change material heat exchanger life test. Paper presented at the International Conference on Environmental Systems, Savannah, GA. Retrieved from http://papers.sae.org/2009-01-2589/

3. Aldoss, T., Ewing , D. J., Zhao, Y. & Ma, L. (2009). Numerical investigation of phase change materials for thermal management systems. SAE International Journal of Materials and Manufacturing, 2(1), 85-91. Retrieved from http://saematman.saejournals.org/content/2/1/85.abstract

KEYWORDS: heat sink; thermal capacitance; electronic overheat; endothermic agent; thermal storage; thermal transfer; avionics

N112-094 TITLE: Carriage Life Monitoring Of External Stores

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: PMA-242, Direct and Time Sensitive Strike Warfighting Capablities

OBJECTIVE: Develop a monitoring device that will accurately measure, log, and report captive carry exposure hours for fixed and rotary wing external stores.

DESCRIPTION: Vibration design criteria for fixed and rotary wing external stores are typically developed from vibration measurements acquired during noise and vibration flight testing. Noise and vibration flight tests employ instrumented measurement vehicles (IMV), which have equivalent mass properties and dynamic response characteristics to the tactical stores they are designed to mimic. Upon processing and quantifying the IMV noise and vibration data and correlating the store dynamic response to platform maneuvers and associated service use time statistics, vibration design criteria are established in terms of vibration level and exposure time. Vibration test criteria, which consist of test amplitudes and associated test duration, are then derived from the vibration design criteria for demonstrating captive carriage life of the external store. In addition to vibration, other dynamic environments such as adjacent store releases, adjacent weapon firings (e.g. missiles/gunfire), store upload/download cycles, catapult launch, and arrested landings influence the life of the store and are also characterized in terms of design and test criteria. A captive carriage design life is established for the store and is then demonstrated with a series of laboratory ground vibration and mechanical shock tests; however, upon successful demonstration of the laboratory life test, the actual carriage life of the store is rarely investigated through continued testing. Furthermore, as the store is utilized during Fleet operations, it is desirable to monitor and track its usage hours for purposes of assessing and validating its design carriage life, as well as for determining the potential for service life extension. Thus, the ability to measure, log, and report captive carriage hours for external stores would provide a basis for quantifying actual carriage life and indicate to the Fleet when a store is approaching the end of its life so that it can be removed from service or reworked for continued use.

Complexities associated with logistics and unique store functionality for both training and wartime mission-use do not allow for manual tracking and logging operations to ascertain captive carry exposure hours. Likewise, many external store systems have no electrical interface or onboard electrical power source available for integrating readily available instrumentation and data logging technology. As such, an autonomously automated tracking device will likely be required to provide accurate measurements, logging, and reporting of the desired store carriage hour information.

The prototype device should be a self-generating (i.e. provides its own power) sensor able to sense, record, and log a wide range of dynamic events (such as platform startup/shutdown, steady state and maneuvering flight, adjacent weapon firing, gunfire, etc.) and then correlate the measured events with known mission use statistical information for estimating store carriage hour accumulation. The device must be able to log data for extended periods and data should be downloadable for input to a store environmental exposure -accumulation software tool.

PHASE I: Develop a self-generating measurement sensor capable of accurately measuring, correlating, and logging a wide range of dynamic events associated with external store carriage.

PHASE II: Develop a complete data logging tool, incorporating the sensor from Phase I along with data storage capacity for up to 100 hours of carriage life, a data transfer mechanism, and a software tool for inputting the output data to determine store carriage accumulation.

PHASE III: Produce a validated carriage life monitoring device based on the sensor, data logging, and software tools developed in Phases I and II. Transition technology to the applicable platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Structural life monitoring for buildings, bridges, etc., will benefit through extension of this technology base.

REFERENCES:
1. Arnau Vives, A. (2008). Piezoelectric Transducers and Applications. Berlin: Springer-Verlag.

2. Eren, Halit. (2006). Wireless Sensors and Instruments: Networks, Design, and Applications. Boca Raton, FL: CRC Press.

KEYWORDS: vibration; carriage life; service use statistics; structural dynamics; Micro-Electro-Mechanical System (MEMS); self-generating sensors; data storage; software; data transmission

N112-095 TITLE: High-Integrity Global Navigation System for Unmanned Aircraft

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA-264 Air Anti-Submarine Warfare Program Office

OBJECTIVE: Develop a high-integrity Global Navigation System (GNS) that is not vulnerable to jamming, spoofing, or electromagnetic interference (EMI) damage and that is capable of meeting the stringent size, weight, and power (SWaP) constraints imposed by size Group 2 Unmanned Aircraft Systems (UAS) and above.

DESCRIPTION: The continued exploitation of Intelligence, Surveillance, and Reconnaissance (ISR) in a Global Positioning System (GPS)-contested environment demands a high-integrity GNS that is not vulnerable to jamming, spoofing, or EMI damage. This system must also satisfy the SWaP constraints imposed by size Group 2 Unmanned Aircraft Systems (UAS) and above.

Current GNSs, such as the U.S. GPS, utilize fixed reception pattern antennas (FRPAs), amplifiers, and a receiver. Improving only one component of the system, such as the jamming- and spoof-susceptible FRPA, can lead to expensive and complex solutions. For example, while omnidirectional phase array antennas, multiple steerable antennas, encoded signals, and Doppler satellite tracking have high integrity and are effective against multiple-source jamming, they require power-hungry data conversion and processing.

To meet both SWaP and anti-jamming requirements for size Group 2 UASs and above, an integrated approach must be taken. Coupling state-of-the-art hardware components such as chip-level receivers and miniature low-power inertial navigation systems with novel processing techniques will lead to robust GNS solutions.

The objectives of this SBIR topic are, in order of priority, to provide a 1) high-integrity, 2) small form factor, and 3) low-cost GNS solution that is suitable for all Navy size Group 2 UASs and above. Meeting these goals will require new and innovative techniques and a creative approach.

PHASE I: Conceptualize and design an innovative approach for developing a high-integrity GNS that is not vulnerable to jamming, spoofing, or EMI damage. This phase should include a detailed system design approach for Phase II.

PHASE II: Develop and produce a system prototype capable of bench-top laboratory-level operation. Develop and execute an experimental demonstration plan for the prototype to measure susceptibility to jamming, spoofing, and EMI. Further mature and harden the prototype for field demonstration. Develop and execute a chamber and/or airborne field demonstration of the system’s vulnerability to jamming, spoofing, and EMI.

PHASE III: Develop a preproduction system suitable for manufacture and commercialized production and generate pertinent documentation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A successful and reliable solution that can be manufactured in a small, low-weight, low-cost footprint has the potential to be adopted and used by both the private and commercial airline sectors to achieve the levels of safety of operations that are expected to be mandated in future Federal Aviation Administration (FAA) regulations governing unmanned aircraft.

REFERENCES:

1. Fyfe, P., & Kovach, K. (2000). Navstar GPS space segment/navigation user interfaces, (ICD-GPS-200C with IRN-200C-004). Fountain Valley, CA: ARINC Research Corporation. http://www.navcen.uscg.gov/pubs/gps/icd200/icd200cw1234.pdf

2. Hofmann-Wellenhof, B., Lichtenegger, H., Collins, J. (2001). GPS theory and practice, 5th ed. New York: Springer-Verlag.

3. Leick, A. (2004). GPS satellite surveying, 3rd ed. Hoboken, NJ: John Wiley.

4. Parkinson, B. W., & Spilker, J. J. (1996). Global Positioning System: theory and applications. Washington, DC: American Institute of Aeronautics and Astronautics.

5. Warner, J. S., & Johnson, R. G. (2003). “GPS spoofing countermeasures.” The Weekly Homeland Security Newsletter, wttp://www.homelandsecurity.org/bulletin/Dual%20Benefit/warner_gps_spoofing.html

KEYWORDS: Unmanned Aircraft System (UAS); Global Positioning System (GPS); Global Navigation System (GNS); Antijamming; Anti-spoofing; Electromagnetic Interference (EMI)

N112-096 TITLE: <u>On Demand Oil Supply</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

OBJECTIVE: Develop and validate a reliable and automatic on demand oil supply system.

DESCRIPTION: State-of-the-art oil pumps in aero-engines such as the JSF’s F-135, deliver a volumetric flow rate proportional to the rotor speed of the high-pressure engine core, which drives the pump via shafts and gear systems In aircraft & engines such as the F-35 & F-135 where the fuel and oil systems are used to cool a variety of engine and airframe systems, the undesirable oil heating accumulates and reduces the fuel’s heat-sink reserve at critical flight conditions. Maximum flow rates are set to meet requirements at maximum engine power settings. At power (speeds) less than maximum, the oil flow exceeds system requirements and as a result, parasitic losses generate additional heat due to the fact that the system circulates more oil than necessary. For some engine architectures, cruise and idle operation are critical and Thermal Management System (TMS) sizing conditions at which a reduction of these parasitic losses is crucially important in developing a light weight engine system.

Pumps that are capable of varying oil flow rate independent of shaft speed may then be able to deliver oil according to the true requirements. System should be designed and constructed for at least minimum engine service life which is 4000 +/-10 Engine Flight Hours (EFH), and minimum of 2 times the inspection Interval. The goal is to design a system that does not exceed the current pump weight of 27 pound with oil. A new system developed for a more optimized control depending on engine needs or variables could be in the form of direct-drive - variable displacement systems, variable speed – constant displacement systems, or combinations of these approaches. Additional considerations are the need for an automated feedback control system to adjust the oil pump output conditions over the entire operational envelop and total mission duration to insure proper lubrication system operating performance and system level reliability.

Weight and durability will be critical factors in the design of an automatic on demand oil supply system with a not to exceed oil flow rate of 30 gl per minute. To achieve optimum integration potential it is advised that the SBIR contractor contact and work closely with an engine manufacturer.

The Navy is not solely seeking an electrical solution. However, if one is proposed, the electrical power requirements should be defined using an electrical power source that meets the requirements of MIL-STD-704. An innovative solution is desired and all options will be considered.

PHASE I: Determine feasibility of developing an on demand oil pump supply system. Include part power oil flow requirements and robustness analyses in the study.

PHASE II: Define and develop prototype test plan and test rig. Develop and demonstrate prototype capability.

PHASE III: Integration into an OEM development program, where demonstration of durability, accuracy, reliability and repeatability can be verified.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial aircraft gas turbine engine, rotorcraft engines, and ground based gas turbine power generation.

REFERENCES:
1. Streifinger, H. (2010). Fuel/Oil Heat Management of Turbine Aero Engines – Future Requirements and Experience from the Past
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2. Black, S. J. (1986). X-29 Fuel/Auxiliary Oil Systems Thermal Management. AIAA 860913, doi: 10.4271/860913

3. Streifinger, H. (1998). Fuel/Oil System Thermal Management in Aircraft Turbine Engines. RTO Applied Vehicle Technology Panel Symposium RTO MP-8, 12-1-12-10. http://ftp.rta.nato.int/public/PubFullText/RTO/MP/RTO-MP-008/$MP-008-12.pdf
4. MIL-STD-704. MILITARY STANDARD: ELECTRIC POWER, AIRCRAFT, CHARACTERISTICS AND UTILIZATION OF (06 OCT 1959). http://www.everyspec.com/MIL-STD/MIL-STD+(0700+-+0799)/MIL_STD_704_1080/

KEYWORDS: oil; supply; oil pumps; volumetric flow rate; thermal management system; on-demand oil system

N112-097 TITLE: Lightweight Electromagnetic Interference (EMI) Shielding System for Aircraft Avionics

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-275, V-22 Osprey

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OBJECTIVE: Develop a novel EMI shielding system for aircraft electronic components using advanced lightweight materials that provide increased shielding.

DESCRIPTION: Advanced aircraft avionics and the potential hazard of artificially generated interference to disrupt electronics are prompting a need for improved EMI shielding materials that can reduce signal interference between electronic equipment. This need is even more critical due to the growing application of low-power and miniaturized electronics. Current EMI shielding materials include conventional metals or metal particles embedded in a matrix.

However, these materials are of considerable weight and are susceptible to corrosion. Therefore, lighter weight and more robust EMI shielding materials are critically needed for aircraft avionics.

The goal of this project is to develop next-generation EMI shielding materials that are lightweight and that will effectively shield electromagnetic radiation in various frequency regions. Recently, significant progress has been made in the area of nanotechnology, in particular, the use of carbon nanotube nanocomposites to achieve robust, lightweight EMI shielding materials for various applications, including avionics. Polymer-based nanocomposite EMI shielding materials that preserve or add EMI shielding efficacy can provide significant weight savings as well as resistance to corrosion and other environmental degradation.

PHASE I: Fabricate a polymer-based carbon nanotube nanocomposite EMI shielding material that exhibits high electrical conductivities. The fabrication process should be well defined and controlled. Initial characterization of nanocomposite electrical conductivities and structural properties should take place. The effect of processing conditions and weight percentage of carbon nanotubes incorporation should be examined.

PHASE II: Transition the fabricated EMI shielding material to an EMI shielding prototype material system. The fabrication process should be optimized and well defined, including optimizing nanotube loading and dispersion in the polymer. The prototype material system should undergo more detailed electrical conductivity and structural characterization. The composite fabrication process and weight percentage of carbon nanotubes should be optimized.

PHASE III: Implement a business case and partner with a DOD supply chain to commercialize the EMI shielding material system to technology readiness level 9.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Both military and commercial avionics can benefit from increased shielding of EMI that occurs naturally in the environment and that is artificially generated to disrupt electronics. Computers are driving more aspects of our daily lives in transportation as well as other sectors of our economy, making us more dependent on microprocessors and electronics in general, and increasing everyone's susceptibility to the risk of EMI.

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2. Yang, Y., Gupta, M. C., Dudley, K. L., & Lawrence, R. W. (2005). Conductive carbon nanofiber-polymer foam structures. Advanced Materials, 17(16), 1999-2003.

3. Fletcher, A., Gupta, M. C., Dudley, K. L., & Vedeler. E. (2010). Elastomer foam nanocomposites for electromagnetic dissipation and shielding applications. Composites Science and Technology, 70(6), 953-958.

KEYWORDS: lightweight electromagnetic interference shielding; electronic devices shielding; robust electromagnetic interference shielding; nanoparticles; improved electromagnetic interference shielding; electromagnetic radiation lightweight materials

N112-098 TITLE: Gas Turbine Engine Exhaust Jet Shear-layer Pressure Measurement System

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

OBJECTIVE: Design, develop, and demonstrate a jet shear-layer hydrodynamic pressure measurement system capable of detecting turbulent large-scale organized structures in full-scale military/commercial engine exhaust plumes.

DESCRIPTION: Laboratory scale supersonic jet noise experimental studies have demonstrated quantitatively that aft far-field noise is controlled by shear-layer large-scale turbulent structures in the form of convected pressure wave packets. Moreover, it has been shown that the wave packet characteristics are well represented by shear-layer instability waves. When the experimentally measured wave packets were projected to the far field, noise levels and spectra were well predicted suggesting that jet noise reduction might be achieved by controlling the spatial-temporal evolution of the shear layer. Confirmation of this shear-layer instability generated jet noise mechanism in full-scale engines is now needed as the next step towards developing advanced noise control strategies. Pursuing engine noise control strategies without such a diagnostic source confirmation would be premature. This is because laboratory nozzle studies have yet to simulate the high turbulence levels, Reynolds numbers, and temperatures typical of full-scale engines.

The system and associated data processing software should be capable of extracting the modal content of the convected hydrodynamic pressure fields during engine performance tests typically conducted at 20 feet (ft) above the ground. Analysis software must be capable of projecting the data to simultaneously acquired acoustic far-field microphones to confirm the noise contribution from organized turbulence structures. The three-dimensional sensor array must extract the flow field modal content for frequencies spanning one decade on either side of the spectral peak at aft jet radiation angles. The resulting calibrated frequency response range would be from approximately 50 Hertz (Hz) to 5 kiloHertz (kHz). The sensors should be located on surface(s) surrounding the spreading hot jet shear layer to ensure that the hydrodynamic pressure field is measured with fidelity. The sensor count should be limited to 160 covering an axial domain of 45-60 ft for a 3-ft diameter engine nozzle. Sensors may be fixed or continuously translated/rotated to discrete locations to minimize sensor count and to allow optimal positioning for reduced order models (e.g. wave packets) resolution requirements. Sound pressure levels of over 160 decibels (dB), hot exhaust flows, radiation heat transfer, and entrained flow over the sensors must be accounted for in selection of the sensors and the mechanical mounting schemes. There may be a need for thermal management on the sensors. Assembly of the system, which must reach engine center line locations on the order of 20 ft above the ground, should be achievable by four technicians in a week. If possible, the system should be capable of folding into a smaller size for outdoor storage on an airfield tarmac when not in use. Structural materials and mechanical/electronic components should be able to withstand rain and temperatures above 32 degrees Fahrenheit.

Near-field holographic array systems have recently been developed by various organizations. However, they are designed to measure the acoustic field at many diameters beyond the boundary of the jet shear-layer hydrodynamic pressure field. The existing holographic arrays are also limited to measuring the noise from stationary aircraft systems with installed engines at approximately 6-7 ft above the ground, rather than isolated engines at 20 ft above the ground at a test stand.

PHASE I: Determine the feasibility of developing a gas turbine engine exhaust jet shear-layer pressure measurement system. Design a concept for the mechanical hardware, drive systems, and instrumentation for the system control and sensors and formulate the software for real-time extraction of the wave packet modal information. Conduct scaled demonstration experiments where necessary to reduce risk.

PHASE II: Develop an integrated and functional jet shear-layer hydrodynamic pressure measurement array and demonstrate it on a military tactical aircraft isolated engine test stand on a piggyback basis. Provide operating procedures, calibration methods, and a real-time software package for detection of the organized structure wave packet modes. Demonstrate the system application via closure between 1) the convected wave packet data and existing instability model predictions and 2) projection of the wave packet data to the acoustic far field for direct comparison with the measured far-field spectrum.

PHASE III: Transition the developed jet shear-layer pressure measurement technology to an original equipment manufacturer (OEM) responsible for the propulsion system of a tactical/civil aircraft, and use it to design/implement "second generation" jet noise reduction hardware for current/future aircraft programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Both military and commercial gas turbine engine applications include jet noise source mechanism identification and identification of jet noise reduction concepts.

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1. Suzuki, T. and Colonius, T., “Instability Waves in a Subsonic Round Jet Detected using a Near-Field Phased Microphone Array,” J. Fluid Mech., Vol. 565, pp. 197-226, 2006.

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KEYWORDS: Jet Noise; Exhaust Noise; Turbulent Structure Noise; Shear-Layer Instability; Hydrodynamic Pressure Field; Wave Packets

N112-099 TITLE: Protection System for Tactical Vehicles During High-Speed External Transport

TECHNOLOGY AREAS: Air Platform, Battlespace

ACQUISITION PROGRAM: PMA 275, V-22 Osprey

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OBJECTIVE: Develop an innovative compact protection device or methodology that will enable aircraft to externally transport tactical vehicles at high speeds.

DESCRIPTION: Rugged tactical vehicles such as the High Mobility Multipurpose Wheeled Vehicle (HMMWV or Humvee), Interim Fast Attack Vehicle (IFAV), and Light Strike Vehicle (LSV) are widely used for military applications. These vehicles must often be transported across the globe quickly and at a moment's notice. Navy/Marine Corps rotary-wing aircraft such as the CH-53E and MV 22 were designed to carry these assets and effectively maneuver them into position over widely varying topography. When tactical vehicles are slung under helicopters and tilt-rotor aircraft they have simulated and demonstrated stability in excess of 180 knots, however when traveling in excess of 130 knots, their windshields and engine components, such as radiators, hoses, and wiring, are susceptible to damage from air loads. This limitation prevents the aircraft from traveling at optimum speeds and distances. As such, the ability to provide the Warfighter with vital assets to successfully engage the enemy, especially when time is of the essence, is severely curtailed.

During development of the V-22 a number of solutions, including Styrofoam forms, inflatable canvas bags and large cargo pods directly attached to the cargo hooks were considered to overcome limitations imposed on the aircraft by slung loads. However, all of these solutions imposed severe logistic (cost, transport and durability), storage (large footprints, rapid degradation) and time constraints (strapping, cinching and buckling before and after delivery) that negated any airspeed advantages.

Innovative, aerodynamic, lightweight yet rugged solutions are sought to protect tactical vehicles from damaging air loads incurred when transported externally on rotary-wing and tilt-rotor aircraft traveling at high speeds. Approaches that enable airspeeds approaching 200 knots and that fit within the limited space available aboard Naval shipping are desired.

To date, there has been no research into protecting slung load vehicles from air loads however, to address high wind conditions during hurricanes, new methodologies and materials, such as those referenced [1, 2, 3], have been developed to protect vulnerable building doors and windows and are, along with variations of them, considered baseline possibilities, but other innovative solutions will be considered as well. Innovative designs are needed to deal with the heavy air loads experienced by tactical vehicles when transported in excess of 130 knots.

PHASE I: Develop an innovative, low-cost, and compact means of protecting tactical vehicles while being transported externally on rotary-wing and tilt-rotor aircraft at high speeds and demonstrate the concept's feasibility.

PHASE II: Develop a prototype device of the concept devised in Phase I. Perform testing and evaluation to ensure that the prototype meets the proposed objectives.

PHASE III: Evaluate design enhancements and transition the system for production. Perform any required testing to certify the system for aircraft and vehicle use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The concepts developed in this SBIR could be transitioned for use on commercial and private vehicles, as well as other valuable assets of similar size, to protect against high-speed winds and the associated debris during use, transport, and storage. This concept could also increase the protection afforded by existing systems for protection of homes and commercial buildings from high winds during hurricanes.

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http://www.miamidade.gov/buildingcode/library/productcontrol/noa/06022103.pdf

2. Miami-Dade County Building Code Compliance Office Product Control Division, notice of acceptance no. 07-0315.02 for polycarbonate storm panel shutter.
http://www.miamidade.gov/buildingcode/library/productcontrol/noa/07031502.pdf

3. Miami-Dade County Building Code Compliance Office Product Control Division, notice of acceptance no. 08-1008.03 for polypropylene flexible wind abatement impact protection system.
http://www.miamidade.gov/buildingcode/library/productcontrol/noa/08100803.pdf

KEYWORDS: External Loads; External Transport; High Speed; Tactical Vehicle; Vehicle Protection; Windshield Protection

N112-100 TITLE: <u>Laser Removal of Composite Coatings and Damaged Areas on Aircraft</u>

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

ACQUISITION PROGRAM: PMA-275, V-22 Osprey

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

OBJECTIVE: Develop a laser-based method to safely and quickly remove material on the surface of composites without adversely affecting the structure.

DESCRIPTION: Modern military aircraft use composites for at least a third of their structures, and the V-22 in particular contains a number of advanced composite structures. As the aircraft age and are exposed to hostile environments, these composite (i.e., multilayer) coatings need to be repaired and replaced. The current procedure for removing composite coatings on aircraft such as the V-22 uses sandblasting or chemical solvents. The limitations of physical sandblasting include a lack of sensitivity (i.e., inability to remove layer by layer), remnants of foreign debris, and most importantly, the potential to damage the underlying composite material. Chemical solvents have the aforementioned limitations and can also be carcinogenic and require costly storage and disposal.

A novel approach to improved coating removal technology is needed that can also be used to precisely remove damaged material prior to repair. Compact laser technology has been used in other applications and industries to provide quick, economical, efficient, and environmentally friendly solutions. A need exists to apply this laser technology to the task of precisely removing the existing outer layers of composite coatings and damaged material in an economically, environmentally friendly way without affecting the composite material or structure. In addition to laser expertise, knowledge of V-22 coatings and composites should be demonstrated. Successful candidates will also propose a suitable vapor collection method and end-point detection method to accompany the laser-based technique.

PHASE I: Demonstrate the feasibility of using compact laser technology to remove composite coatings and materials from aircraft without affecting the underlying composite material. The study should also demonstrate the feasibility of a suitable vapor collection and sensor for end-point detection.

PHASE II: Optimize laser and process parameters and deliver a prototype system (laser, vapor collection, sensor) for NAVAIR V-22 program evaluation. System stability should be closely examined quantitatively and reported. Extensive coupon testing should be performed for controlled removal and for validating the preservation of underlying composite material.

PHASE III: Perform extensive testing and evaluation as well as final system optimization, manufacturing, and commercialization. A sound business case for technology transition and commercialization should also be prepared, identifying key members of the DoD supply chain.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Both military and commercial aviation are using composite materials to a greater extent. In some cases, composites represent a majority of the material that is used on board aircraft. Having a quick, economical, environmentally friendly way of removing surface material without affecting composite material properties is advantageous to life cycle cost and reduced man-hours for both military and commercial organizations.

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KEYWORDS: laser removal; coatings removal technology; damaged composite surfaces; stripping of material; safe disposition of vapor-removed material; laser technologies for coating removal

N112-101 TITLE: Integrated Data Registration for Networked Aircraft

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors

ACQUISITION PROGRAM: PMA-231, E-2C/D Hawkeye

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OBJECTIVE: Develop an integrated data registration capability for Navy aircraft that supports network synchronization of time and navigation sources as well as sensor alignment, taking into account the errors and biases associated with these sources.

DESCRIPTION: All tactical sensors have biases. Biases occur in the measurement dimensions (e.g., range, bearing, and elevation) as well as the assumed position and alignment of the aperture (e.g., navigation set position, lever arm from navigation set to aperture, and the orientation of the aperture face). The problems are compounded when operating in a networked environment in which the exchange of information using a common spatial reference and a common time reference is essential. If these biases are not sufficiently reduced, then a variety of tracking and engagement-related failures may occur, including less accurate tracking, failed engagements of hostile targets, and improperly identified targets.

A novel integrated data registration solution that accounts for the fundamental errors present in target or position reports received from multiple local sensor apertures or between local and remote units is needed to provide local sensor and navigation alignment to absolute DoD standards; improvements in tracking, correlation, and measurement-to-track association performance; and greater interoperability with legacy and other sensor networking systems. Proper data registration results in improved accuracy, which leads to improvements in warfighter effectiveness.

An Integrated Data Registration capability is needed that accounts for all factors to include aircraft altitude errors, to begin to implement a sensor network designed to work with different kinds of aircraft. Related schemes for correcting sensor bias have been implemented in L-16 using primitive algorithms. Cooperative Engagement Capability implemented a more modern approach from 1990s technology. Far more sophisticated algorithms were developed in laboratories for years and included in the Single Integrated Air Picture (SIAP), Integrated Architecture Behavior Model (IABM); unfortunately cancellation of the SIAP program prevented the technology from being validated as 'fleet ready.' The various algorithms are not being deployed for an open sensor network. A solution is needed for a tactical system which is subject to intermittent power failures, potential loss of GPS signal, unexpected sensor performance, etc. So, at this point, the modern science is all theoretical with no innovation

PHASE I: Develop an integrated data registration solution and then demonstrate the technical feasibility of its use on aircraft. Unclassified data would be provided for Phase I. The effort could propose one or more experiments to incorporate data registration algorithms in a Navy aircraft environment so that battlespace data can be used in nonheterogeneous networks based on precise World Geodetic System 1984 (WGS-84) alignment. This effort might also propose additional improvements that could facilitate integrated data registration.

PHASE II: Develop and demonstrate a working prototype that can accurately predict the range of time, navigation, and sensor errors from both fixed and variable sources. Bring the prototype into a neutral laboratory and measure performance using recorded Navy aircraft data.

PHASE III: Integrate the algorithms into applicable Navy Platforms

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Data registration algorithms could be used in any netted sensor framework; for example, if a group of radio telescopes across a great distance are being used to survey the same regions of space, with their data fused, these algorithms could be employed to account for variations in sensor and clock bias. Likewise, these algorithms could be used with geological mineral surveys with multiple recorder arrays to provide more precise data registration.

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2. Koyak, R. (2000). Joint Interoperability of Theater Missile Defense Systems: Extending the Scope of Testing. Retrieved from http://www.stormingmedia.us/30/3074/A307483.html

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KEYWORDS: gridlock; sensor bias; alignment; navigation errors; time synchronization; ellipsoid; covariance

N112-102 TITLE: Advanced Vacuum Bagging Technologies

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

OBJECTIVE: Develop and demonstrate a multi-use vacuum bagging system that can be used for the autoclave and vacuum-bag-only curing of medium to large composite aircraft structures.

DESCRIPTION: The current fabrication and application of single-use, nylon vacuum bags is labor intensive and failure prone due to operator, size and configuration dependent variables. Current reusable bagging technology is costly and does not lend itself to more complex geometry typical of 5th generation and beyond aircraft. The use of reusable rubber vacuum bags has been only marginally successful in reducing costs. High fabrication and maintenance costs and bag shrinkage have limited its broader use. Cost effective methods, such as, but not limited to, the use of disposable liquid application rubber technologies, would address many of those cost and producibility related issues.

The technology developed must be compatible with today's generation of epoxy and bismaleimide materials. The technology must be environmentally friendly, non-contaminating, and capable of 375 degrees fahrenheit service, and should lend itself to application at the prime contractor and major composite part supplier facilities. Interaction with an aircraft composite structure manufacturer to assist in the transitioning of the concept to production applications is encouraged.

PHASE I: Identify, develop and prove feasibility of concept for advanced vacuum bagging material and system. Complete a preliminary analysis of environmental, and health and safety factors, identifying potential risks.

PHASE II: Produce prototype system and materials based upon the results of Phase I. Initial evaluation of the system may be performed by manufacturing flat composite items. Select a full-size, medium-to-large, complex aviation composite structure and demonstrate the prototype system. Refine analysis of environmental and health and safety factors initiated in Phase I. Develop return on investment (ROI) and verify process is robust and capable for composite production environments; establish facilities requirements, process flow and environmental requirements.

PHASE III: Finalize and transition production-ready bagging system and materials suitable for use in aircraft production. Finalize all environmental and health and safety factors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology would have potential use in commercial aviation and wind power blade composite manufacturing.

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KEYWORDS: composites bagging; vacuum bag; spray on bag; roll on bag; rubber bag; re-usable composite bagging

N112-103 TITLE: Advanced Common Integrative, Intelligent, Customizable and Scalable Automated Logistics Environment (ALE) Framework

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

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

OBJECTIVE: Develop an advanced common integrative, intelligent ALE planning, development, technology, integration, and deployment framework solution to effectively support and sustain an increasing global military operations footprint.

DESCRIPTION: The importance of integrated logistics in being able to effectively support and sustain an increasing global military operations footprint and a high operations tempo cannot be over stated. Well planned, coordinated and integrated logistics operations, processes and activities are crucial to the success of ongoing and future military operations. The need for dynamic flexibility in operations and reliable resource deployment is essential in a growing global environment of uncertainty and shifting strategic and tactical paradigms. Integrated logistics planning, design, operations and execution are essential to making this possible. Additionally, with advanced aircraft, ship and ground systems becoming ever more "smart" and complex, these systems are becoming increasingly more dependent on continuous, comprehensive and integrated logistics sustainment support. With these challenges in mind, an advanced common integrative, intelligent, customizable and scalable ALE planning, development, technology, integration and deployment framework solution is needed that brings together the concepts and core principles of Focused Logistics, Integrated Logistics, Sense and Respond Logistics, the Automated Maintenance Environment (AME) and a common data environment.

The current state of ALE technology evolution is represented by an incomplete set of mostly stand-alone and proprietary logistics related systems, applications and disjointed databases. ALE development efforts to date have been disjointed, providing limited interoperability, integration or scalable customization options. Current efforts generally do not adequately support the broader mission, strategies and operations of NAVAIR, the Navy and DoD-wide. Ongoing ALE development programs are primarily focused on specific aircraft programs, mostly ignoring the broader enterprise and command and control level needs and opportunities. Existing ALE components do not integrate well. True interoperability across the enterprise is minimal.

The Navy has made significant investments in ALE component systems, application tools and their related functionality. This includes a number of existing ALE related system and software technologies, tools, and initiatives (for example NSIV, CAMEO, CABO). These tools provide standard IETM user interface viewer support, maintenance support, collaborative authoring and technical data sustainment, and apply web-based, service oriented and open architectures, and limited integration of a mix of COTS, GOTS and proprietary technologies. However, these technologies and tools alone do not provide a common integrative, intelligent ALE framework. These technologies and tools and others are components of a comprehensive ALE framework. Also, associated high data development, sustainment and management costs within an environment of declining resources represent a key pressure point. Data re-use and sharing opportunities across aircraft platforms developing similar data are minimal. This current technology environment does not support the Naval Air System Command's (NAVAIR), Navy's or DoD's open architecture, interoperability or net-enabled enterprise and flexible operations goals.

It is critical that innovative options for an advanced common integrative, intelligent ALE technology and integration framework be researched and (if feasible) developed that will bring together a unified set of customer-defined policies, standards, processes, workflow and combination of commercial off-the-shelf (COTS) and government owned technologies (GOTS). This desired ALE framework will provide the technology enablers from which a common integrated, intelligent ALE can be modeled, configured, implemented and used.

The primary common ALE framework enabling technology of interest is the intelligent ALE domain and component system/application integration orchestrator (the engine). The engine works transparently (to the user) with a dynamic integrated metadata environment manager, and a standard user interface viewer that becomes the interactive ALE gateway and dashboard for the end users. The ALE "orchestrator" engine would provide transparent dynamic interactive access to and adaptive coordination of ALE domains and component systems and application modules (both currently existing and future investments), including: ALE modeling and configuration, enhanced planning, what if scenario modeling, search, resource management, maintenance, automated workflow management, IETMs, interactive training, system health monitoring, diagnostics, prognostics, supply chain management, parts ordering, warehouse management and inventory control/tracking, common authoring environment, content management, data management and sustainment, and dynamic decision support.

There are technical risk challenges driven by inherent complexities, existing disparate systems and technologies, and breadth of domain functionality support that a common integrative, intelligent ALE represents. The successful result of this project would demonstrate a common intelligent, intuitive, and configurable ALE domain and component system and application integration "orchestrator", transparent to the user that dynamically integrates and coordinates the ALE domain and component functions, activities, and transactions through intelligent natural user interface options. In achieving this successful result, enabling technologies of interest to be researched and potentially developed and integrated within the ALE framework of the future include: innovative case-based and knowledge-based reasoning, self-learning, dynamic/adaptive algorithms, web-based dynamic services and cloud-based architecture, open source products, and natural user interface techniques and technologies that enable and support transparent dynamic user navigation and interaction through a standard interface. It would support the enterprise, operations, and expeditionary level process and tracking activities providing improved planning, common data access, management, sustainment and dynamic decision support.

PHASE I: Develop a concept model and determine the technical, operational, and cost feasibility of developing an advanced common integrative, intelligent ALE planning, development, technology, integration, and deployment framework solution.

PHASE II: Design, develop, and demonstrate a scaled prototype of the ALE framework solution. The demonstrated prototype should integrate at least three ALE component systems or applications. Show how the ALE framework can be used to support and deliver a tailored sustainable enterprise-wide, operational and platform specific ALE solution. Develop a cost/benefit/risk analysis for potentially moving forward to Phase III.

PHASE III: Develop a full-scale integrated ALE framework solution and transition it to a NAVAIR program such as the Joint Strike Fighter (JSF).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Any commercial operation that involves and/or manufactures, manages, maintains and trains on large, complex, high-value and potentially widely dispersed assets and products could benefit from this technology. Examples include commercial airlines, utility/power generation operations, the energy sector, and commercial shipping fleets.

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2. Cole, Dwayne, Standardized ALE Development, AIA/ATA/ASD S1000D Users Forum, Hilton Head, SC, 12-15 Oct 2009, http://public.s1000d.org/Downloads/Documents/2009%20User%20Forum%20Presentations/t2004%20Entire%20%20AME_ALE%20PANEL%20at%20S1000D%20Forums.pdf, pp. 31-36.

3. ONR program fact sheet, subject: Sense and Respond Logistics, Aug 2008, http://www.onr.navy.mil/en/Media-Center/Fact-Sheets/Sense-and-Response-Logistics.aspx

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KEYWORDS: Automated Logistics Environment (ALE); Focused Logistics; Integrated Logistics; Sense and Respond Logistics; Automated Maintenance Environment (AME); Common Data Environment

N112-104 TITLE: Compact Narrow-band Laser Sources for Atom-based Sensors

TECHNOLOGY AREAS: Sensors

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

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

OBJECTIVE: Develop a compact high power tunable laser source with output wavelength 780 nm, 795 nm or 852 nm (Rubidium D2, Rubidium D1 and Cesium D2 transitions respectively).

DESCRIPTION: Current semiconductor laser technology can provide for very small, compact lasers. However, for applications requiring narrow line widths, external cavities are often required, increasing the size and weight of the laser. Additionally, these external cavity lasers are of lower power (tens of milliwatts (mw)). Higher power diode lasers typically cannot be stabilized to very narrow line widths. Applications requiring higher laser power therefore require an amplifier, which often produces beams of poor mode quality, poor coupling efficiency into fiber optic cables and which increases the complexity of the final system [1, 2]. Atomic sensors ranging from atomic magnetometers [3, 4] to atom interferometer gyroscopes [5] and clocks [6] rely on these lasers to interrogate the atoms being used as sensors. For certain low power applications, existing lasers are adequate. For higher power applications, typically master-oscillator combinations need to be used.

Compact laser sources are sought that satisfy the following criteria. Note that all specifications must be met simultaneously. 1) Output power greater than 500 milliwatts threshold, 2 watts objective. 2) Continuous mode-hop free scanning operation 20 GHz threshold and 100 GHz objective. 3) Line width when not scanning less than 100 kHz threshold and less than 10 kHz objective. 4) Beam quality of M squared value 1.2 threshold and better than 1.1 objective. 5) Single polarization mode with unwanted mode suppression of 20 dB threshold and 30 dB objective. 6) The laser and associated electronics must fit into a 20 cm x 20 cm x 9 cm threshold and 5 cm x 5 cm x 5 cm objective volume. Although it is not required for this topic, it is anticipated that the combination of these criteria will lead to emission of 250 mw threshold and 1.25 watts objective laser light stabilized to an atomic line appropriate for atom interferometry from a single mode polarization maintaining fiber. Lasing on the rubidium D2 line (780.24 nm) is preferred, but other atomic lines of alkali species, i.e. sodium D2 (589 nm) or D1 (590 nm), rubidium D1 (795 nm) or cesium (852 nm), will be considered.

PHASE I: Determine feasibility of proposed laser source to achieve all parameters simultaneously. Define plan for the development and demonstration of the proposed laser system.

PHASE II: Develop, demonstrate and validate prototype laser system.

PHASE III: Complete final validation of the production laser system and transition system to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Atom interferometer sensors can be used to measure gravity and gravity gradients, and would be beneficial in the oil exploration and mine and tunnel detection fields. In addition, they could be used for rotation sensing, GPS-free navigation and precision time keeping. Successful technology developed would be useful for secure communication and high bandwidth communication.

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KEYWORDS: compact lasers; atom interferometers; atom gyroscopes; atomic magnetometers; atomic clocks, alkali vapor sensors

N112-105 TITLE: <u>Reduced-Cost Grinding and Polishing of Large Sapphire Windows</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

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OBJECTIVE: Develop methods of grinding and polishing to reduce the cost of a finished sapphire sensor window with dimensions of 12 x 18 x 0.25 inches by at least one-third of that of current windows.

DESCRIPTION: There is a need for precisely figured sapphire sensor windows with dimensions of 12 x 18 x 0.25 inches operating in the 1- to 5-micron wavelength range. The purpose of this topic is to demonstrate improved methods of grinding and polishing to reduce the cost of the finished window by at least one-third. The sapphire must have optical and mechanical properties at least as good as those of today’s commercially available material.

PHASE I: Develop improved methods of grinding and polishing sapphire to reduce the cost by at least one-third without degrading mechanical or optical properties. Demonstrate the selected method by grinding and polishing a 4- x 4- x 0.25-inch a-plane sapphire plate to obtain a root-mean-square transmitted wavefront error of one-tenth of a wavelength measured at 0.63 micron over a clear aperture extending to 0.01 inch from the perimeter of the plate. Estimate the cost of grinding and polishing 12- x 18- x 0.25-inch finished windows and define a path forward to produce such windows.

PHASE II: Continue to develop and optimize grinding and polishing procedures. Produce finished plates with geometries and tolerances to be provided by the government at the time the Phase II plan is written. Extract at least 10 disks from each of 2 finished plates to make mechanical test specimens with a diameter of 3 inches and thickness of 0.25 inch. Measure the ring-on-ring flexure strength with a load diameter of 1.25 inches. Estimate production costs for sapphire blanks and define a path forward to produce window blanks.

PHASE III: Scale up for commercial production of window blanks and transition into applicable platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a large market for bulletproof windows for armored vehicles if cost per unit area can be decreased.

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KEYWORDS: Sapphire Polishing; Optical Finishing; Polishing; Sapphire; Window; Electro-Optic Window

N112-106 TITLE: Self-Actuating Seals for Barrier-Fabric Protective Coveralls

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: SaaS Air Soldier, Layered Clothing Ensemble, ACAT II (US Army)

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

OBJECTIVE: Develop an innovative garment seal design or material that will allow nonconstricted fit and air exchange during routine ambient conditions yet will self-actuate upon immersion to exclude the influx of cold water.

DESCRIPTION: Current world operations expose our military to some of the deadliest environmental threats ever encountered in war: biological agents, chemical weapons, contaminated conditions, frigid seas, severe winds, and equatorial heat. Protective coveralls consisting of a barrier fabric with seals at the neck, wrists, and sometimes ankles are worn by our warfighters to repel these threats. There have been many advances in the technology of barrier fabrics, coatings, and laminates; yet, for the last 40 years or more, the seals have been (and still are) made of a constrictive rubber such as neoprene, latex, or butyl. Although these rubber materials are very effective at sealing out threats, they also seal in body heat, compress soft tissues to the point of impairment and/or pain, and impede blood flow.

One example of a barrier coverall with constrictive rubber seals (latex) is the U.S. Navy's CWU-86/P anti-exposure suit (and used by U.S. Army aviators), which is worn constantly during flight as a contingency against immersion hypothermia as a consequence of ditching or ejection in cold water. Numerous Fleet hazard reports have documented the cost of this constant-wear suit to the wearer's endurance. Because the seals are air/water tight and no auxiliary air exchange is provided, for example, the body heat buildup in the suit is considerable. Operators avoid wearing (or frankly refuse to wear) the suit for flights that traverse wide temperature conditions (e.g., hot desert to high-altitude mountain; hot ambient air over cold water, as in most north Pacific operations) even though wear is required by instruction. The neck seal is frequently reported as constricting blood flow to the hands, causing loss of dexterity and touch perception, and pressing the vocal chords against the windpipe, causing unintelligible speech as well as discomfort. Consequently, the failure rate of the seals is high, sometimes tearing during dressing, and sometimes creatively (and stealthily) modified by the wearer to allow blood flow, ventilation, and intelligible speech during preflight and in-flight. Total ownership costs are high as the spare part itself is not repairable, and replacement involves tedious maintenance and inspection. The Navy has long recognized these deficiencies; previous Navy and industry improvement efforts have included inflatable toroids, absorbent gel wraps, drawstrings, ratcheting ring clamps, baffles, and full head/neck hoods with see-through face enclosures. None, however, have been as effective or supportable as the necessarily tight and constricting latex and neoprene seals.

The goal of this topic is to develop an innovative, affordable, and supportable seal design or material that will allow nonconstricted fit and air exchange during routine ambient conditions yet will self-actuate upon immersion to exclude the influx of cold water. Specific requirements are to (a) limit influx of no more than 118 milliliter (ml) (1/2 C) water upon 30-foot (ft) immersion in turbulent 32 degrees Fahrenheit in surface salinities representative of seawater (32-35 parts per thousand (ppt)) and open baywater (10-17 ppt); (b) exclude water for 12 hours immersion with the neck area submerged in conditions of (a); (c) remain operable (a) and (b) after six months of operational wettings (e.g., rain, sweat, seaspray, leakage inspections); (d) allow air exchange through the neck opening in dry-suit applicable ambient cockpit conditions; (e) provide equivalent flame resistance to current materials; (f) remain nontoxic to skin; (g) resist mission and environmental contaminants (e.g., sand, petroleum, oil, lubricants, solar radiation, temperature extremes of negative 20 degrees Fahrenheit to positive 140 degrees Fahrenheit, mold, mildew, salt water; (h) install into the current dry suit; (i) tolerate multiple donning actions over bare head; (j) accommodate the head/neck dimensions of the central 95 percent of Navy flying population; (k) be compatible with the current Navy gear and equipment required to be worn with neck seals, such as flotation collars, coverall collars, mask, and helmets; (l) yield a service life of 2 years; (m) have a shelf life of 5 years; and (n) be maintainable by intermediate-level Navy personnel and support equipment.

PHASE I: Demonstrate a conceptual design of the garment seal. Verify that the concept can meet the stated requirements through analysis and limited laboratory demonstrations. Provide cost and reliability estimates.

PHASE II: Validate an operational prototype by demonstration on human subjects in controlled immersions. Demonstrate compliance with requirements. Provide a technical drawing and cost and reliability estimates.

PHASE III: Develop mass production for sustainment by defense supply and commercialization for the private sector. On average, defense procurement is 8,000 units per year.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This seal material could benefit other military, industrial, and recreational dry suits as well as industrial and recreational weather-protective garments. Depending on the actuating mechanism, the seal could be adapted for use with medical compression bandages, chemical biological protective coveralls, geotextiles, filtration mechanisms, and industrial gaskets.

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KEYWORDS: seals; garments; gaskets; immersion; biological; actuating

N112-107 TITLE: Advanced Bearing and Gear Steel Materials and Thermal Processing

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

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OBJECTIVE: Develop innovative materials, thermal processes, or a combination of both to improve the mechanical properties and corrosion resistance of carburizing grades of bearing and gear steels.

DESCRIPTION: Advanced case carburized bearing and gear steels have been shown to offer significant improvements in bearing performance, providing increased benefits to turbine machinery operating in a marine environment. However, conventional carburizing techniques have had limited success in meeting all required properties necessary for bearing and gear performance, particularly low pitting and corrosion resistance. Postprocessing techniques and coatings likewise have had limited success in improving the corrosion resistance of carburized bearings and gears. New bearing and gear steels, possibly optimized for alternate thermal processes such as plasma nitriding, may lead to a new generation of lighter weight, corrosion-resistant transmission components.

An innovative approach is needed to develop new steel materials and/or thermal processes that can lead to improved fatigue, pitting, and corrosion properties for high-temperature turbine engine applications in a marine environment. Such new bearing and gear materials in combination with new thermal processes have the potential to yield lighter weight and/or higher performance components for military gas turbine engines. Reduced machining and thermal processing costs may be an added benefit. Coordination with a major turbine engine manufacturer is strongly encouraged.

PHASE I: Determine the feasibility of developing an innovative material or thermal processing technology--or a combination of both--that will provide enhanced mechanical and corrosion properties compared to carburized 9310 or Pyrowear 675.

PHASE II: Develop and test the material or thermal process developed in Phase I and demonstrate a production-ready system that is capable of processing full-scale turbine engine bearings and gears.

PHASE III: Working with an engine manufacturer, transition the technology to produce optimized, full-scale turbine engine bearings and gears that provide enhanced mechanical and corrosion properties.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would benefit both commercial and military turbine engines by extending the useful life and performance of bearings and gears while reducing unscheduled maintenance and repairs.

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KEYWORDS: corrosion resistant steels; bearings; gears; steel thermal processing; carburizing; turbine engine

N112-108 TITLE: Innovative Power Generation Technologies for Thermal Battery Replacement

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

ACQUISITION PROGRAM: PMA-201, Conventional Strike Weapons

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OBJECTIVE: Develop innovative power generation technologies to replace the current thermal batteries used by the Fleet.

DESCRIPTION: Thermal batteries are the primary power source used to generate the energy necessary to actuate a variety of electric-initiator-based energetic devices, such as Cartridge Actuated Devices (CAD) and Propellant Actuated Devices (PAD). However, current state-of-the-art thermal batteries have several shortfalls. For example, they are sometimes unreliable, and, because their shelf life is limited, they are not ideal for applications that are deployed for a long time. Other disadvantages are that each battery is designed for a specific use and each component requiring electric initiation energy needs its own battery. So, in systems incorporating a variety of these components, more than one battery, with the size, shape, and capacity varying according to its use, is needed. This drawback can have a significantly negative impact in weapons in which weight and space are at a premium. Furthermore, thermal batteries do not have the capacity to provide the amount of power required to support missions involving high duty cycles at elevated temperatures. In addition, thermal batteries are expensive and difficult to procure because of the very limited supply base. They also present environmental hazards in their production, use, and disposal because they contain chemicals that the Occupational Safety and Health Administration has identified as harmful.

As such, a need exists to develop an innovative means to generate power that can be used in place of thermal batteries and that fills the cost, environmental, shelf life, and performance gaps that currently exist. Furthermore, the solution must provide the flexibility for multi-application use. Any solution must have the capability of providing 22 volts within 105 milliseconds at 200 degrees Fahrenheit and within 130 milliseconds at negative 65 degrees Fahrenheit and supply a continuous load of 0.95 ampere for at least 225 seconds. Current cutting-edge technologies such as piezoelectric, piezoceramic, and thermoelectric generators show some promise. Piezo-based energy harvesting or scavenging techniques that convert ambient conditions into electrical energy show potential, as well as being environmentally friendly. Possible options to harvest such energy include using piezoelectric, thermoelectric, radio frequency waves, and visible light photovoltaics. Piezoelectrics transduce the mechanical deformation of the crystals from natural vibrations or induced dynamic pressure changes into electrical charges. These charges could be collected and then stored for subsequent use to provide power. Because none of these approaches are sufficiently advanced to meet the aforementioned requirements, a novel and innovative means is required to either enhance these technologies or to develop a new method.

PHASE I: Determine and demonstrate the feasibility of developing an innovative power generation technology to replace thermal batteries that can meet the performance requirements state above.

PHASE II: Based on the findings of Phase I, identify the most promising approach and develop and test a prototype of the power generation technology.

PHASE III: Transition technology to the Fleet for CAD/PAD and other applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A potential market exists in both the consumer electronics area and commercial power supply applications, such as stand-alone electrical generators and/or supplemental electrical energy systems. This technology could directly support new commercial power supply applications in which there are physical size constraints that require a smaller self-contained unit.

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KEYWORDS: Thermal Battery; Piezoelectric; Piezoceramic; Thermoelectric Generator; Energy Harvesting; Energy Scavenging

N112-109 TITLE: Photonic Antennas

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

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

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OBJECTIVE: Develop a novel photo detection device that utilizes unique material techniques and performs as an "optical" antenna.

DESCRIPTION: Light Detection and Ranging (LIDAR) systems utilize photo detectors to receive the return light signal. Current state of the art detectors are based on various photon to electron conversion principles that, at best, have quantum efficiencies (QE) of 40 percent in the blue spectrum that we are interested in for oceanographic LIDAR applications. Since the conversion process is substantially less then unity, additional laser power is required from the transmitter to make up for the loss of signal on the detector. If a photo detector with near unity QE in the blue spectrum could be used, the LIDAR system performance would dramatically increase with no additional laser power. The spectrum of interest is 450 nanometers to 490 nanometers. The photo detector must also have an active area large enough to be usable in a practical LIDAR system. Active areas are typically on the order of 1 to 2 inches in diameter. Also, the bandwidth must be greater than 100 MHz and the noise factor must be less than 1.1. The effort should also address how the electrons will be transferred out of the device for use by the system. Removal of the generated electrons for use by the system must be addressed. Generated electrons are currently either removed from the device via an electronic amplifier or a vacuum amplification scheme.

PHASE I: Develop and prove feasibility of a conceptual design for a novel photo detector.

PHASE II: Produce and lab test prototype hardware based on Phase I work. All of the parameters listed in Phase I must be tested and met or exceeded by the prototype.

PHASE III: Transition the developed technology to appropriate platforms and systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Application of this technology to civilian cameras will greatly improve their low light level performance. A larger, broader application of this technology would be the efficient coupling of light into high index-materials, such as solar cells. Currently, commercial solar cells are less than 20 percent efficient.

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KEYWORDS: meta-material; optical antenna; photo detector; quantum efficiency; LIDAR; noise factor

N112-110 TITLE: <u>High-Temperature Sensor System for Turbine Clearance Measurement</u>

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

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

OBJECTIVE: Develop and validate a sensor system to measure turbine tip clearance in high-temperature environments.

DESCRIPTION: Turbine tip clearance is a critical parameter affecting the performance of propulsion engines. To operate at top efficiency, a turbine’s tip clearance must be minimized under the constraint of positive clearance to the turbine case. A turbine’s tip clearance varies throughout different operating conditions because of differential thermal expansion, manufacturing tolerances, stresses, creep, and erosion. Currently, the sensors that measure turbine tip clearance are not robust enough to withstand the high temperatures of the turbine environment. In addition, the present sensors suffer from deterioration and mechanical failure, often resulting in domestic object damage issues in the turbine.

The goal of this project is to develop and validate a production-quality sensor system that can be used in the harsh environment of propulsion engines to quantify turbine tip clearance of individual blades around the circumference of one or more turbine stages. This technology is intended to be installed in a fleet of aircraft for engine health management and not in a development test configuration. Involvement with an engine original equipment manufacturer (OEM) is strongly suggested. Accuracy and repeatability of a turbine tip clearance sensor system are of paramount importance. Turbine tip clearance can range from 0 to more than 0.125 inch. Clearance measurement accuracy must be 0.001 inch or better.

Environmental conditions in a gas turbine are challenging. Temperatures can range from 2500 degrees Fahrenheit to 4000 degrees Fahrenheit and static gas path pressures can range from ambient to approximately 30 atmospheres. Chemically, the turbine gas path constituents include air, intermediate species and products of hydrocarbon combustion, soot, calcium-magnesium alumino silicate (CMAS), and chloride and sulfate salts. Any sensor feature that is exposed to the gas path must be resistant both to chemical attack by these compounds and to deposition of the solids onto exposed surfaces. The sensor should have a service life of at least 10,000 operating hours in this environment and should have an unlimited shelf life. Innovation should be present in the design of the measurement system, and accuracy, reliability, and repeatability of the sensor measurement results must be demonstrated. In addition, durability will be considered a key parameter, as in any sensor system, as will a low propensity to generate domestic object damage.

In many applications, space limits accessibility to the turbine, and adding sensors to an existing instrumentation package may not be possible. Therefore, it would be beneficial if the turbine’s tip clearance sensor could acquire information in addition to clearance, such as temperature, pressure, tip timing, vibration, and so on. Quite often, the limiting factors in the application of a newly developed sensor are not related to the sensor itself but rather to the packaging and mounting of the sensor.

During the engine design phase, provisions for mounting sensors onto the turbine case can be provided with relative ease. However, after the engine has been fielded, a redesign of major engine modules to accommodate new sensors is rarely a justifiable exercise. An objective is to produce a sensor that can be retrofitted onto existing turbine hardware without major modifications. Also, the use of cooling and purge air would not be acceptable due to engine weight gain, efficiency loss, and other penalties. Weight of any aircraft-mounted system must be minimized to limit impact on aircraft performance and balance. The total weight of a production-representative turbine clearance measurement system should be less than 10 pounds (lb). Additionally, the system should consume less than 5 watts (W) of electrical power.

The sensor system must also be proven to perform robustly within the environment of an aircraft in order to be approved for service. Representative requirements include:

• Electromagnetic interference characteristics per MIL-STD-461E Elements CE102, CS114 (Navy aircraft internal criteria), CS115, CS116 (Navy aircraft level), RE102 (Navy aircraft level), RS103 (Navy aircraft internal level), and, depending on the design, CE106, CS103, CS104, and CS105
• Environmental performance per MIL-STD-810F with the following criteria:
o Minimum pressure 1 pounds per square inch absolute (psia)
o Minimum temperature negative 78 degrees Fahrenheit, maximum air temperature around signal conditioning electronics 250 degrees Fahrenheit
o Vibration: Levels for aircraft-mounted hardware per MIL-STD-810F Figure 514.5C-8 and for engine-mounted hardware per Figure 514.5C-16
o Acoustic noise to 150 decibels (dB)
o No nutritive materials that support fungus growth
o Immunity to salt fog, sand and dust, and fluids encountered in the vicinity of an engine
o Water proofness in the presence of spraying water
o Sustained acceleration of 15g
o Shock: Withstand a 48-inch fall
o Explosion proof

The sensor system must also be able to indicate a failure that causes the measurement outputs to exceed tolerance specifications. This characteristic can be accomplished through self-diagnostics or through design features that permit a connected diagnostic system to identify a fault within the tip clearance measurement system.

The turbine tip clearance measurement system must be compatible with aircraft electrical systems. Aircraft electrical power characteristics and compatibility requirements are defined in MIL-STD-704.

PHASE I: Develop and demonstrate the feasibility of a sensor that can measure turbine tip clearance in environments with temperature ranges on the order of 1800 °F, with a plan to extend the temperature range in Phase II.

PHASE II: Demonstrate the sensor system to the 2500 °F to 4000 °F temperature range. Run the sensor in an application that produces the typical pressure, temperature, and chemical environment (such as a rig) to enable reaching Technology Readiness Level 5.

PHASE III: Mature the sensor package and signal conditioning module, if applicable, to meet the service qualification requirements of electromagnetic interference characteristics, environmental criteria, weight limit, power consumption limit, and aircraft electrical power compatibility. Integrate the sensor system into an OEM development program where demonstration of durability, accuracy, reliability, and repeatability can be verified.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercialize the technology by integrating the developed sensor into multiple engine manufacturers' military engine development efforts to reduce engine development cycle time and cost by enabling turbine clearances to be understood and optimized to achieve improved engine fuel efficiency and durability in a more efficient manner. Also integrate into engine manufacturer's future turbine engines to attain improved engine fuel efficiency on future advanced military or commercial engine development programs or on upgrades to current fielded systems.

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KEYWORDS: sensor; gas turbine engine; clearance; high-temperature probes; turbine tip-clearance measurement system; size weight and power (SWAP)

N112-111 TITLE: Animation and Analysis of Shipboard Aircraft Recovery Using Ship's Geo-Referenced Data

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

ACQUISITION PROGRAM: PMA-209, Air Combat Electronics

OBJECTIVE: Develop an algorithm that compensates for and merges separately generated aircraft and ship motion data into a single stream/file that, when animated, accurately depicts the aircraft landing on the ship until after the arresting gear engages.

DESCRIPTION: With Global Positioning System (GPS) data becoming available on various military vehicle platforms, the role of animated planning/debriefing is on the rise. The ability to represent the geospatial relationship of moving platforms relative to terrain and to each other provides value in areas such as training, mission planning, and post-mission debriefing. With the availability of GPS, realistic animation of aircraft flight using real-time recorded data has become routine. Currently, land-based operations are depicted accurately from takeoff to landing with incredible fidelity. But, an as-yet untried extension to this concept, important due to the maritime nature of U.S. Navy operations, is to provide the same fidelity for operations in which landing occurs aboard a moving platform. Specifically desired is the depiction of an aircraft landing aboard a moving aircraft carrier until after the arresting gear engages. Doing so requires the integration of the ship's position and movement with those of the aircraft.

In concept, the challenge presented is more complicated than merely merging the ship's position with that of the aircraft at touchdown. The reason is that the ship's position does not necessarily represent the point of landing but rather the position of the GPS antenna on the ship's superstructure. Correctly compensating for this difference, which may seem insignificant when the two vehicles are at large distances from each other, is critical to the fidelity of the landing scene. Furthermore, the means of making this precise determination must be user friendly and enable the operator to correct for noise and errors in the data. Because the level of compensation required may not initially be known, the user must also have the capability of performing run time corrections. If the correct adjustments are not made, the animation will not accurately reflect the actual point at which the aircraft lands. As a consequence, the animation will be of little use for post-landing debriefings. Achieving those objectives requires the development of algorithms that will perform the appropriate steps to compensate for the differences in the instrumentation data currently being provided and the actual motion and position of the ship and aircraft. Therefore, accurate representation of vehicle geometry, position, and axial motion is a key element.

Any resultant software must accept time-stamped parametric data (format: <time><value>) of position and axial attitudes of both aircraft and ship, compensate for positional offsets and data errors, and allow for user input of corrections. The proposed method must produce a solution that merges the motion paths of both vehicles to accurately depict the embarked landing of the aircraft. An analysis of the input data, the observed errors, and recommendations for improvement in data specifications are also required.

The actual ship/aircraft information will be provided by the government as de-identified data in an open format such as CSV or XML. The output data must be demonstrated with animation software showing all of the complex facets of the entire landing scene. The vendor is responsible for providing all models, scenery, and hardware, but may also determine the animation hardware and software to be used. The host computer system must be compatible with PC/Microsoft Windows systems. The output data format must be open and nonproprietary and be exportable in <time><value> format using CSV, XML, or other open data conventions. Deliverables include a demonstration of a visualization session from data produced by the algorithm and of the ability of the algorithm to create an open exported data file on the host system. Other requirements include an analysis of input data quality, along with recommendations for improvement, and the accompanying source code of the algorithm.

PHASE I: Determine the feasibility of accurately representing high-fidelity ship/aircraft animation by using to-be-developed data-compensation algorithms and currently available PC animation technology. Define a plan for the development of the project.

PHASE II: Develop, demonstrate, and validate a prototype data-compensation algorithm and ship/aircraft animation process.

PHASE III: Build and demonstrate ship/aircraft animation data-compensation algorithm and software, analyze input data, and deliver a source code. Transition technology to applicable platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The system developed in this SBIR can be used for real-time monitoring and management of large shipping vessels in harbors throughout the world. In addition, the resultant technology can be applied to accurately represent sea hazards in shipping lanes. Other possible uses include depicting helicopters landing on commercial ships and oil rigs.

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KEYWORDS: Global Positioning System (GPS); Animation; Algorithm; Embarked Landing; Military Flight Operations Quality Assurance (MFOQA); Debriefing

N112-112 TITLE: Innovative Energy Absorbing Aerial Refueling (AR) Hose

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Electronics

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

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

OBJECTIVE: Develop and demonstrate an innovative aerial refueling (AR) hose that is capable of absorbing (without damage) the loads produced by a sine wave during a receiver engagement that was excessive or to a hose reel with poor response characteristics.

DESCRIPTION: Probe and drogue air-to-air refueling (AAR) involves extending 70 to 80 feet of hose to allow for receiver engagement. If the receiver engages too fast and/or the hose reel fails to keep tension on the hose, a sine wave will develop. This sine wave can produce overloads on the receiver aircraft probe with catastrophic consequences. AR hoses today are designed to meet the strength and construction requirements of MIL-H-4495; however, this specification does not give specific guidance on how to absorb energy. If the AR hose itself were able to absorb the energy of a sine wave, the AR operation would have a truly redundant system, greatly increasing system safety and availability. The number of receiver mishaps would be reduced by orders of magnitude, especially for our high risk receivers.

The critical issue is to determine how the hose can absorb energy but still provide enough control to sense receiver engagement and allow for proper hose reel response in normal conditions. The hose must be capable of absorbing the excess energy without transferring it back to the receiver or tanker aircraft. The hose must be a drop-in replacement for existing aerial refueling hoses and compatible with the hose reel systems in use today and meet the basic construction and structural integrity requirements of MIL-H-4495. Extensive modeling and simulation will be required to validate the dynamic response of the hose throughout the aerial refueling event.

PHASE I: Design, develop and demonstrate (via modeling and simulation) concepts for hose construction that provide for energy absorption. A validated hose reel model will be required that is capable of simulating hose reel response, hose dynamics, and receiver engagement. Develop coupon test methods for use in Phase II along with approaches for hose manufacture.

PHASE II: Produce prototype coupons for use in laboratory testing to verify the material properties and hose behaviors. Update the Phase I modeling and simulation results based on the coupon test results. Refine the hose construction techniques as a result of the coupon manufacture. Conduct full-scale testing with a full-scale prototype construction in a laboratory environment using the procedures developed in Phase I to verify the hose energy absorption characteristics. Develop Phase III flight testing objectives and methods. Verify tailored hose specification requirements via test/analysis.

PHASE III: Produce a production representative hose and certify it as “airworthy". Conduct flight testing in accordance with the objectives and methods developed in Phase II and transition the hose to the F-18E/F or KC-130 aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed technology would be applicable to all commercial aerial refueling companies.

REFERENCES:
1. MIL-H-4495, "Rubber Hose, Aerial Refueling" (hose design requirements).

2. ATP-56B, "NATO Air to Air Refueling Procedures Publication" (good reference to AAR procedures and equipment description).

3. JSSG-2001, "DoD Joint Services Specification Guide - Air Vehicle" (good reference for typical probe load requirements).

4. MIL-PRF-81975, "Couplings, Regulated, Aerial Pressure Refueling Type MA-2, Type MA-3 and Type MA-4" (coupling design requirements).

5. MIL-N-25161 - "Nozzle, Aerial Pressure Refueling, Type MA-2" (AR nozzle design requirements).

KEYWORDS: Aerial Refueling Hose; Sine Wave; Modeling; Simulation; Damping Layers; Rubber Hose

N112-113 TITLE: Low Profile, Very Wide Bandwidth Aircraft Communications Antennas Using Advanced Ground-Plane Techniques

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA 290; Maritime Patrol & Reconnaissance Aircraft

OBJECTIVE: Develop controlled-impedance ground planes with reduced weight and thickness, and apply them to low-profile aircraft communications antennas.

DESCRIPTION: Current and prior efforts have addressed all aspects of reducing the size of an aircraft communications antenna operating in the Very High Frequency (VHF) and Ultra High Frequency (UHF) bands, but while good progress has been made, maintenance of reasonable gain at very low profiles and small diameters, especially as operating frequency is lowered, remains a problem. These two performance measures (gain vs. profile/diameter) are inversely related, so an improvement in one generally means a loss in the other. Further reductions may be achievable in the amount of surface area required on a given aircraft, but only at the expense of gain. Overcoming these limits necessarily involves bringing another variable into play, and the only variable left to exploit is the ground plane itself. It is conceivable that the ground plane could be treated with some engineered material that would overcome these limitations. Recent advances in materials sciences have yielded several ideas that could be exploited to achieve these goals.

The need for low profile is related to the need for minimal aerodynamic drag, and it is generally accepted that the maximum height above the aircraft surface should be no more than one inch, less if practical. An antenna that is flush with the surface is most desirable, but is not required for this topic. These antennas require a 360-degree field of view in the azimuth plane and operate over a frequency range of 30 MHz to a minimum of 600 MHz, and gain performance at the horizon must be improved while reducing thickness and diameter below currently practical levels. Important specifications are vertical polarization in the horizontal plane, a lower frequency limit of 30 MHz or lower, an upper frequency limit of 600 MHz or higher, the ability to handle 100 Watts of input power at 100 percent duty cycle from a combination of several radio sets operated simultaneously, and a nominal voltage standing wave ratio (VSWR) of 1.5:1 or less (2:1 maximum). Weight and surface area consumed are always important considerations and should be minimized. It is assumed that several radios will share the single input port, but isolation between them should be handled by separate circuitry. Minimal hull penetration is allowed, but the proposed antenna should not require modification of the existing aircraft skin beyond penetrations for fasteners and the antenna feed port. It is envisioned that current and future aircraft ranging from helicopters to large transport category aircraft, and from low-speed craft to supersonic craft will utilize this technology and each platform on which it is to be employed will require specific adaptations.

PHASE I: Develop and determine the feasibility of advanced ground planes for antennas and select one or more candidate approaches likely to be able to satisfy the requirements. Conduct computational analyses showing the limits of performance for the selected approaches. Select the best approach and demonstrate by practical or computational modeling that the approach has the potential to meet performance requirements.

PHASE II: Refine the design selected in Phase I and fabricate a technology demonstration model. Show the performance of this model through laboratory measurements.

PHASE III: Develop an engineering model antenna for a specific Navy platform, and demonstrate performance with actual antenna pattern measurements on a ground plane that fairly represents the actual aircraft mounting location.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial aircraft experience many of the same difficulties as military aircraft. The developed technology would be very useful on commercial aircraft.

REFERENCES:
1. Kabiri, A., Yousefi, L. & Ramahi, O. M. (2010). On the Fundamental Limitations of Artificial Magnetic Materials, IEEE Transactions on Antennas and Propagation.
DOI: 10.1109/TAP.2010.2048845

2. Volakis, J.L., Chen, C.C. & Fujimoto, K. (2010). Small Antennas: Miniaturization Techniques & Applications, McGraw-Hill, 2010.

3. Brewitt-Taylor, C.R. (2007). Limitation On the Bandwidth of Artificial Perfect Magnetic Conductor Surfaces. Microwaves, Antennas & Propagation, Institute of Engineering and Technology (IET), 1(1),255-260. DOI: 10.1049/iet-map:20050309

4. Werner, D.H. & Werner, P.L. (2003, June). The Design Optimization of Miniature Low Profile Antennas Placed In Close Proximity to High-Impedance Surfaces. Antennas and Propagation Society International Symposium. Vol 1, pp 157-160. DOI: 10.1109/APS.2003.1217424

5. Yeo, J. & Mittra, R. (2001, July). Bandwidth Enhancement of Multiband Antennas Using Frequency Selective Surfaces for Ground Planes. Antennas and Propagation Society International Symposium, Vol 4, pp 366-369. DOI: 10.1109/APS.2001.959474

6. Orton, R.S. & Seddon, N.J. (2003, March) PMC As An Antenna Structural Component, Twelfth International Conference on Antennas and Propagation 2003 (ICAP 2003), Vol 2 pp 599-602. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01353715

KEYWORDS: antennas; wide-bandwidth antennas; low profile antennas; conformal antennas; controlled impedance ground-planes; affordability

N112-114 TITLE: Innovative Method for Aircraft Gross Weight and Center of Gravity Estimation

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-299, Multi-Mission Helo (H-60)

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

OBJECTIVE: Develop an innovative model for the estimation of the gross weight (GW) and center of gravity (CG) of aircraft under general conditions.

DESCRIPTION: An accurate software-based assessment of the GW and CG for both fixed- and rotary-wing aircraft is critical to establish aircraft fatigue and to estimate life expectancy because these properties greatly affect static and dynamic characteristics. Currently, information pertaining to these values must be recorded manually both on the ground and in flight, a time-consuming and painstaking process. For example, if cargo or stores are released/relocated/picked up during a flight, a log of what and when is required to make the appropriate calculations. The tasking involved imposes a significant burden on the squadron and technicians, as well as a high probability of introducing human error. Furthermore, under the current approach, if there is no instrumentation to indicate the fuel level, several assumptions must be made regarding the fuel burning rate. This situation often results in estimates that are overly conservative to ensure that the aircraft is not overloaded or overstressed.

Over the years, several different methods have been proposed to automatically estimate GW and CG. However, these technologies have various limitations. For example, some of them calculate only the GW or only the CG. In methods that do estimate both the GW and CG, the resultant data represent an idealization of the actual rotorcraft dynamics, so further work may be required to investigate the details of implementation challenges. In addition, the accuracy of the output depends on having accurate information that is readily available, and these approaches do not have the capability of making the necessary adjustments for degradations in performance.

As such, there is a need for a novel, innovative, and sophisticated computational method that overcomes the limitations of current state-of-the-art techniques. An innovative physics-based approach would improve the accuracy of CG and GW estimations for the entire mission duration for calculating airframe fatigue life expended. Such an approach would synthesize flight loads by determining the GW and CG in near real time using in-flight state parameter data from existing sensors provided by the on-board mission computer and Health Usage Monitoring System (HUMS). This approach will remove excessive conservatism in the weight estimate of the payloads and fuel burn rate and provide a much better accurate, near real-time CG and GW information for entire mission including in-flight cargo re-positioning and airdrops/pickups. Having a software-based tool that is able to compute GW and CG information simultaneously, quickly and accurately will enhance situational awareness, reduce the time and effort spent in logging the GW and CG information, improve the fidelity of the data, and increase efficiency. For rotorcraft applications, such a method should provide an estimate of GW and CG and have the ability to track them over the entire flight regime, including in-flight drop-offs and pickups, and must not rely on the data collected during a specific flight regime (for example, hover) to make an accurate determination. The method should also address rotorcraft variability and account for engine/torque/performance degradation over time. The recorded data could then be extracted to ensure GW and CG are known at all times during the flight.

PHASE I: Research and develop a novel software-based concept to estimate aircraft GW and CG and demonstrate the feasibility of this approach in a simulated environment.

PHASE II: Develop prototype demonstrators based on a set of realistic, operationally based scenarios and mission profiles of a Navy aircraft platform. Quantify the degree of uncertainty in the estimates.

PHASE III: Integrate prototype demonstrators with existing operations/applications/onboard tools to obtain real-time measurements of GW and CG.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The methods developed to establish GW and CG can be applied to any military or commercial aircraft. Application is broad, as commercial aircraft can take advantage of this information to better transfer luggage to meet flight envelopes.

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2. Idan, M., Iosilevskii, G., & Nazarov, S. (2004). In-flight weight and balance identification using neural networks. Journal of Aircraft, 41 (1), 137-143.

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KEYWORDS: Aircraft; Rotorcraft; Weight; Center of Gravity; Gross Weight; Automated Estimation

N112-115 TITLE: Durable Multispectral Sensor Window

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

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

OBJECTIVE: Produce an aircraft multispectral sensor window that can replace sapphire with a target cost that is less than two-thirds that of a finished sapphire window. The alternative material must meet requirements for strength, stiffness, and spectral transmission.

DESCRIPTION: There is a need for durable, precisely figured multispectral (1- to 5-micron wavelength) sensor windows with dimensions of approximately 30 x 46 x 6 cm (12 x 18 x 0.25 inches). Sapphire provides an expensive solution to the window requirement. The purpose of this topic is to demonstrate an alternate material that can produce finished windows at less than two-thirds the cost of sapphire. The alternative material must be strong and stiff enough to replace sapphire without being excessively thicker than sapphire. The alternative material must not sacrifice spectral transmission and must have low optical scatter.

The desired strength is at least 450 mega pascals (MPa), with a Weibull modulus of at least 5 when tested in ring-on-ring flexure with a 16-mm-diameter load ring. The desired Young's modulus is at least 300 giga pascals (GPa). Spectral absorption at wavelengths of 4 to 5 microns should not be greater than that of sapphire. Total integrated optical scatter for a thickness of 5 mm should not exceed 1 percent in the wavelength range of 1 to 5 microns and be preferably less than 0.5 percent. Refractive index homogeneity should not exceed 10 parts per million so that the window can be finished to a high degree of optical precision.

Off-the-shelf materials other than sapphire do not satisfy the requirements. A fine-grain spinel might be strong enough but is not likely to be stiff enough. Aluminum oxynitride has the desired mechanical properties but absorbs too much radiation near 5 microns. Experimental materials such as fine-grain yttrium aluminum garnet (YAG) or, possibly, nanograin composites might meet the requirements. Composite material might have too much optical scatter at short wavelengths.

PHASE I: Demonstrate on a coupon scale the optical and mechanical properties of a selected material that meets requirements for optical transmission, optical scatter, mechanical strength, and Young's modulus. Estimate the cost of producing finished 30- x 46- x 6-mm windows and define a path forward to produce such windows.

PHASE II: Produce finished windows of a practical size and geometry determined by mutual agreement with the government. Measure mechanical and optical properties of material taken from large panels. Properties to be measured will be determined by mutual agreement with the government. Estimate production costs for windows and define a path forward to produce such windows.

PHASE III: Scale up for commercial production of finished windows and transition technology to applicable platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a large market for bulletproof windows for armored vehicles if the cost per unit area can be decreased.

REFERENCES:
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2. Stefanik, T, Gentilman, R., & Hogan, P. (2007). "Nanocomposite optical ceramics for infrared windows and domes." Proceedings of SPIE 2007, 6545, 65450A.

KEYWORDS: Window; Sensor Window; Transparent Ceramic; Yttrium Aluminum Garnet; YAG; Nanocomposite Optical Ceramic

N112-116 TITLE: New AC+DC Generator to Reduce Weight/Increase Power Availability on the H-1Y/Z Aircraft

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-276, USMC Light/Attack Helicopter (H-1)

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OBJECTIVE: Develop and package an air cooled, dual-output capable generator that would supply both 5kVA (kilovolt-ampere) of three-phase/115V/400Hz alternating current (AC) and 400Amp direct current (DC) in accordance with MIL-PRF-21480.

DESCRIPTION: Currently, the UH-1Y and the AH-1Z aircraft both are fitted with two 400Amp DC generators. On the UH-1Y, there are two, single phase, 600VA inverters that supply AC power to the aircraft. On the AH-1Z, there are two, three phase, 1,800VA inverters that supply AC power. In both cases, future integrations and the need for commonality between the other major helicopter platforms (H-60/H-53/H-46/V-22) will require an electrical system that is AC based. Both aircraft are being loaded to a point where available AC power is being greatly diminished. The aircraft currently only have enough AC available to power the aircraft weapons pylons at a reduced capability. The inefficiency of converting DC to AC power should be taken into account. Successful development of this generator should allow for the removal of an inverter, and should alleviate the current issues of developing a higher capacity inverter, which adds a greater demand on the DC power system and increased weight. In addition, a corresponding Generator Control Unit (GCU)/Voltage Regulator would be required that has the capability to regulate both the AC and DC independently. All rectification and regulation must be housed within the current H-1 generator and voltage regulator form. The new generator system would replace the existing generator system and be capable of fitting onto the existing mounting of the H-1Y/Z combining gearbox. Selected candidates must demonstrate a thorough working knowledge of applicable military requirement documents (e.g.: MIL-G-21480 and MIL-G-6162). Selected candidates will make maximum use of computer modeling and simulation techniques.

PHASE I: Define generator design approach and develop implementation plan. Validate approach analytically or provide test data or bench top hardware that would validate approach.

PHASE II: Develop and demonstrate generator technology that can provide both 5,000VA AC as well as 400Amp DC, per MIL-STD-21480, that can be fitted to the H-1Y/Z aircraft. The package will be subjected to “proof of concept” testing at full qualification levels.

PHASE III: Package and integrate new generator for use in the H-1 aircraft. Unit(s) to be subjected to full qualification testing and flight test profiles.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology has commercial potential for any application that could utilize a dual output AC+DC generator. All aircraft use both AC and DC power so the technology could be used to scale to an indefinite number of output combinations.

REFERENCES:

1. MIL-PRF-21480B. Generator System, Electric Power, 400 Hertz, Alternating Current, Aircraft; General Specification for. https://assist.daps.dla.mil/docimages/A/0000/0001/4761/000005005682_000000216968_TBMSBOXLYO.PDF?CFID=31077496&CFTOKEN=89413022&jsessionid=5c30d1693aa2335f889a6e556a5327192043

2. MIL-DTL-6162C. Generators and Starter-Generators, Electrical Direct Current, Nominal 30 Volts, Aircraft General Specification For. http://www.everyspec.com/MIL-SPECS/MIL+SPECS+(MIL-DTL)/MIL-DTL-6162C_14521/

3. Supplemental information from TPOC, uploaded in SITIS 6/6/11

KEYWORDS: Generator; Generator Control Unit; Voltage Regulator; Electrical Power; Alternating Current; Direct Current

N112-117 TITLE: Optical Time Domain Reflectometer (OTDR) Module used to provide High Resolution between Short Distance Connections

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

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

OBJECTIVE: Develop, design and integrate a low cost plug-in module, which is compatible with the Optical Time Domain Reflectometer (OTDR) mainframe (including mechanical footprint, connector interface, and Graphical User Interface (GUI)).

DESCRIPTION: Bandwidth driven mission and vehicle system applications have levied performance requirements, which exceed copper based transmission system limits. Aerospace information networking infrastructure has progressively been transitioning to more reliable optical fiber wave-guides for sensor processing, analog radio frequency (RF) and digital communication. Maintenance and troubleshooting procedures rely on traditional telecommunication test equipment for fiber optic network operational restorations.

Infrastructure fault identification resolution requirements for breaks, fractures and high loss terminations/connections are gauged to locate and distinguish anomalies within meters. Avionic and information processing networks require the ability to spatially resolve multiple waveguide defects from source to detector with centimeter accuracy. Detection and identification is not limited to the optical waveguide anomalies found in the air vehicle infra-structure that interconnects Weapons Replaceable Assemblies (WRAs). Waveguide testing must go beyond the WRA interface and detect possible module to backplane faults or degradation, polymer waveguide failures, line replaceable module to optical transceiver faults and inline sensors (fiber gratings). Achieving these goals will require a combination of innovative design, research development and modeling solution sets, which will pull from fundamental concepts of Optical Backscatter Reflectometry (OBR), Photon-Counting OTDR (PC-OTDR), Low correlation OTDR (LC-OTDR), Pseudo Random Signal (PRS) Correlation (C-OTDR) and Optical Frequency Domain Reflectometry (OFDR) technology. Additional challenges will also require multiple trace characterization of S, C and L band optical wavelength performance of circuit card polymer waveguides and chip to chip parallel optics. Once a suitable solution has been validated and verified, further research and development is required in distilling packaging solutions to meet size, weight, and power requirements.

Airframe panel removal and reinstallation is time consuming and effects aircraft availability, especially on stealth platforms. Reducing maintenance time to repair by implementing reliable and accurate troubleshooting practices provides the warfighter with tools needed to accomplish their mission. To date, most cable breaks occur between the back of the terminus and 30 centimeters (cm) from the cable assembly connector end. A 1.0 cm or less resolution is required to determine if an end face is bad, verses a broken fiber at the back of a multi-termini connector. Resolution requirements are based on practical maintenance considerations. Lessons learned have shown measurement data has to identify spatial anomalies that lie within a range of less than 1.0 cm of each other. Link performance criteria include length measurements from 0.010 to 500 meters, one way loss range from 0.5 to 15 dB with an accuracy of less than 0.3 dB.

Aircraft technicians intend to use this device to troubleshoot distance to breaks, fractures, and voids along concatenated links of optical fiber harness assemblies at the terminus/connector ferrule end faces and at the cable entry ends of the terminus/connector. Additional applications include characterization of length, loss, splices, fiber bend attenuation along short segments, which comprise a fiber optic link. Design consideration should respect mainframe interface, operating environment and optical parameters of support equipment now being used by the fleet to troubleshoot, repair and maintain the existing fiber optic infra-structure deployed in the fleet. Current OTDR mainframe selected by and supplied in the National Stock System (NSN) is the JDSU Model 6000. Former OTDR mainframe was the Wavetek (now JDSU) Model 5200. Plug-in module(s) must be compatible with current (and also preferably former) NSN OTDR mainframe(s). Plug-in module compatibility with the OTDR mainframe must include mechanical footprint, connector interface, and Graphical User Interface (GUI). The operating conditions will be consistent with a Class 2 environment of MIL-PRF-28800 with some additional Class 1 requirements due to flight deck and fueled aircraft operation. Measurements need to be performed on single mode 9/125 micron cable, multimode 50/125 micron, 62.5/125 micron and 100/140 micron fiber optic cables. Measurement wavelength must be 1550 nm for single mode fiber and 1300 nm for multimode fiber. Measurements must be made within the parameters and accuracies specified for aircraft, shipboard, submarine and shore applications and for use in operational environments described in MIL-PRF-28800(F). Operating conditions will be consistent with a Class 2 environment with inclusion of additional Class 1 requirements due to flight deck and fueled aircraft operation. Target cost of purchasing a production version of the plug-in module should not exceed $3,000.

PHASE I: Design and demonstrate the feasibility of a low cost plug in module technology that is compatible with OTDR mainframes and meets aviation support equipment requirements. Model and simulate module performance and provide a breadboard plug-in module demonstration.

PHASE II: Design, construct and test plug in module prototype. Demonstrate that the prototype can achieve the plug-in module OTDR mainframe compatibility and high-resolution distance to fault requirements developed during Phase I. Meet entry criteria for Technology Readiness Level (TRL) 6 accreditation.

PHASE III: Prepare a working design for the operating environment requirements. Prepare and construct prototypes. Demonstrate that the finalized prototype can achieve the plug-in module OTDR mainframe compatibility, high resolution distance to fault requirements met during phase II, the operating environment requirements and entry criteria for Manufacturing Readiness Level (MRL) 6 accreditation. Finalize the design and complete final testing of prototypes. Advance to manufacturing and transition to the appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Current plug-in modules for OTDR mainframes are designed primarily for the telecommunications networks with relatively long distances between interconnections. Local Area Networks (LAN) and applications for fiber optic runs directly to the end user have small distances between interconnections and a need for performing a high resolution distance to fault measurement. This same test equipment need in the commercial sector will relegate the military market to a small portion of overall sales. The difference between commercial and military product is the operational environments (the military as described in MIL-PRF-28800).

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1. Chan, E.Y., Koshinz, D.G., Beranek, M.W. & Harres, D.N. (2006). Demonstration of a Gb/s transceiver with OTDR built-in-test (BIT) for avionics local area networks presented at the 25th Digital Avionics Systems Conference, Portland, OR. DOI: 10.1109/DASC.2006.313722

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KEYWORDS: Optical Time Domain Reflectometer (OTDR); High Resolution; One Way Loss; Optical Return Loss; Optical Backscatter Reflectometry (OBR);Optical Frequency Domain Reflectometry (OFDR)

N112-118 TITLE: Innovative Method for Real-Time Damage Alleviation

TECHNOLOGY AREAS: Air Platform, Sensors

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

OBJECTIVE: Develop a tool to adjust rotorcraft flight characteristics to mitigate damage levels on dynamic rotorcraft components.

DESCRIPTION: State-of-the-art structural health and usage monitoring systems (HUMS) provide the diagnostic and prognostic information used in scheduling maintenance actions. The ultimate advantage of this technology is the ability to reduce the cost and efforts associated with that effort. For example, parts are replaced only as needed based on the outputs from that tool. Additionally, potentially unsafe loadings on components are immediately identified. Using this information to make the proper adjustments to flight characteristics could alleviate or even prevent damage to vital aircraft components. However, no means currently exists to provide HUMS information to the control system or for it to make the necessary adjustments in flight control laws. Having this capability would have a significantly positive impact on mission readiness and substantially reduce repair and replacement costs.

Techniques have been devised that accurately model the dynamics of the rotorcraft under various flight conditions. As such, these tools can provide estimates of the loading sustained by dynamic components for use in fatigue analyses. In addition, algorithms have been generated that estimate loads in the rotating frame by using fixed frame measurements. This information is then used to make a real-time estimate regarding the remaining life expectancy of structural components for maintenance planning.

Advancements in fly-by-wire systems afford an excellent opportunity to integrate cutting-edge HUMS, modeling, algorithm, and sensor technology to enable the control system both to perceive when damage is occurring and to make the necessary adjustments to alleviate the severity in real time. The objective of this SBIR effort is to develop a means to achieve that functionality, which also must work in the background without direct involvement of the flight crew. The solution must not negatively affect the maneuverability, flight quality, handling characteristics, or structural integrity of the rotorcraft. Developing such an innovative and beyond-the-state-of-the-art concept entails enhancing all of the aforementioned techniques and seamlessly merging them to accurately interpret often complex interactions.

PHASE I: Develop a model/sensor-based concept for real-time and autonomous fatigue damage alleviation that can be incorporated directly into a fly-by-wire flight control system. Demonstrate the feasibility of the approach through simulations.

PHASE II: Fully develop the concept into a prototype system that can be implemented and demonstrated in a rotorcraft simulator.

PHASE III: Transition the technology to applicable rotorcraft platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology is applicable to civilian rotary-wing platforms, as well as fixed-wing aircraft.

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KEYWORDS: Structural Health; Usage Monitoring; Diagnostics; Prognostics; Fly-by-Wire System; Damage Alleviation

N112-119 TITLE: Improved Ship and Small Boat Classification Using Hybrid Synthetic Aperture Radar - Inverse Synthetic Aperture Radar (SAR-ISAR) Imaging

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA 265, F/A-18 Hornet Strike Fighter

OBJECTIVE: Develop innovative techniques to provide improved ship and small boat classification using hybrid synthetic aperture radar – inverse synthetic aperture radar (SAR-ISAR) imaging.

DESCRIPTION: ISAR is commonly employed to distinguish one class of ship from other possibly similar classes. It has traditionally been used to take advantage of the rotational motions of roll, pitch, and yaw induced on a ship by the sea. These motions can be substantial and thus provide a ready mechanism by which Doppler distributions across the target's structure can be consistently measured. The resulting two-dimensional image is a projection of the target's scattering centers onto a range versus Doppler grid, where the projection plane is defined as being parallel to the radar line-of-sight range vector and perpendicular to the effective axis of rotation of the target. Typically, the two most desirable image perspectives for ship classification are broadside profile and plan views. In practice, ships undergo a combination of roll, pitch, and yaw motions that yield a complex and continually changing multitude of visually unusual oblique projections.

In contrast to ISAR where we allow that the target itself is moving often with unknown velocities, SAR assumes the target scene is stationary, and calculates enhanced angular or cross-range resolution by analyzing subtle differences in range-rates due to the motion of the radar. From a classification perspective, supplementing ISAR imagery with target motion compensated SAR imagery can produce a product that is much easier for sensor operators to understand and subsequently, to be able to interpret them sufficiently to perform the classification task. The combination of simultaneously generating an ISAR broadside profile view and SAR plan view of a ship is very desirable. The challenge is to determine the basic kinematic and geometric characteristic in SAR imaging, the apparent and induced angles - yaw, pitch, and roll of the ship target during the observation time, to propose a linear frequency modulated SAR signal model, image reconstruction technique, and auto focusing procedure that can be implemented in real time.

PHASE I: Determine the technical feasibility of providing a hybrid SAR-ISAR ship and small boat imaging capability in real time. Develop a research, development, test and evaluation (RDT&E) plan addressing performance metrics, integration tasks, and human-system interface.

PHASE II: Design and demonstrate a prototype system in an operationally representative environment utilizing a Navy airborne radar system or suitable surrogate.

PHASE III: Transition the developed technology to appropriate platforms and the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The method can be utilized in both commercial SAR and ISAR systems as well as homeland security applications.

REFERENCES:
1. Tang Li-bo, Li Dao-jing, Hong Wen, and Cao Fang, “High Resolution SAR Imaging of Moving Ships,” Geoscience and Remote Sensing Symposium, 2005. IGARSS '05. 2005 IEEE International Proceedings, 25-29 July 2005, pp. 3329-3332.

2. A.D. Lazarov and Ch.N. Minchev, “SAR Ship Target Imaging by Induced Complementary Movement,” Recent Advances in Space Technologies, 2009. RAST '09. 4th International Conference on, 11-13 June 2009, pp. 441-446.

KEYWORDS: Synthetic Aperture Radar; Inverse Synthetic Aperture Radar; Target Classification; Ship Classification; Multi-Mode Radar; Small Boat Classification

N112-120 TITLE: Pitting Corrosion Sensor and Tracker

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

OBJECTIVE: Develop a sensor and tracking system that will detect and track corrosion between two metallic surfaces.

DESCRIPTION: Many of the corrosion inspection methods currently employed in the field to inspect magnesium housings involve disassembling the components and performing a visual inspection. The man-hour effort can be extensive, resulting in long time spans between inspections. Occasionally, the protective coatings become compromised during the disassembly process, and the damage remains undetected. As a result, the next disassembly inspection may reveal severe corrosion, failing the parts and exposing a potential safety hazard.

Corroded parts that do not fail the established damage limits are blended and returned to service. Those that do fail are replaced or repaired. Repair options for holes include installing bushings; oversizing bushings; rebuilding hole walls with epoxy compounds; or simply blending the corrosion and then treating, priming, and painting the exposed metal. Repair options for flat surfaces include machining surfaces flat and installing a shim to return the surfaces to their blueprint condition, filling blended and dimpled surfaces with epoxy, or leaving the surfaces with blended divots and scooped out material. These repairs can form water entrapment or intrusion areas that result in corrosion that may fail the part at the next scheduled visual inspection. These corrosion-prone areas are normally where flight controls and gearbox mount feet attach, and the load path through these locations is critical for aircraft safety.

The problem to be solved is to find a better inspection system for magnesium housings that will detect corrosion more efficiently and effectively. One way to do this is to develop an innovative sensor system consisting of sensors and a portable, handheld unit. Inspections should occur at opportune times when the aircraft is not flying, and the sensors should receive power only from the handheld unit. The sensors can be permanently attached to the portable unit or permanently mounted on the housings either in the form of gaskets between the mating surfaces or secured by the installation of structural bolts that hold the surfaces together. If the sensors are attached to the portable unit, inspection would involve the sensors being temporarily installed or swept across the corrosion-prone areas and then removed to prevent a foreign object damage safety risk. If the sensors are mounted on the housings, inspection would involve plugging the portable unit into the sensors.

The sensors should detect corrosion pitting in 0.005-inch depth increments starting from 0.005-inch deep to 0.100 inch or greater. Each surface should have its baseline stored in memory for tracking and trending purposes. The sensors should identify the location of pitting within a 1.00-inch area of where the pitting is occurring. The sensors should also account for any previous repairs described above and determine if the previously blended uneven surfaces, bond-lines, or bushing-housing interfaces are developing any corrosion-induced voids. The sensors should determine the compressive loads between the surfaces to ensure that the bolts have proper preload, or they should determine the bolt preload. If the sensors will be permanently mounted on the housings, they should have a robust design to detect fretting-induced corrosion.

The sensors must be capable of determining the pressure between mating surfaces within 10 percent accuracy, or they must detect bolt preload within 10 percent accuracy. If the sensors are in the form of a gasket, the sensors must be hardened to withstand 0.0015 inch of fretting movement amplitude under a steady 1,000 psi pressure for 1,000 cycles. This requirement will demonstrate the sensors' robustness and potential longevity for in-field service. If the sensors will be permanently mounted on the housings, it must be demonstrated that the corrosion conditions that cause the various depths of pitting on the magnesium should not also cause the sensors to fail.

Test to corrosion failure (0.100 deep) of the sandwiched materials is required to refine the sensors, to demonstrate the ability to calibrate the corrosion depths via sensor feedback, and to validate the ability of the sensors to accurately quantify the current health state and predict the remaining useful life of the parts.

PHASE I: Design, develop, and demonstrate proof-of-concept sensors and associated state awareness sensor algorithms that are capable of making corrosion activity determinations for magnesium housings and of mapping where this corrosion is occurring within 1.00 inch of accuracy. Demonstrate that the sensors can detect 2,500 psi of pressure between magnesium and aluminum mating surfaces with 20% accuracy, or that they can measure the 16,500 lbs of bolt preload that holds these surfaces together with 20% accuracy.

PHASE II: Increase the corrosion pitting detection resolution to demonstrate detection of corrosion depths at 0.005 inch, 0.010 inch, 0.015 inch, 0.020 inch, etc. to 0.100 inch deep. Increase the sensors' ability to determine bolt preload by determining pressures between mating surfaces in 500 psi increments starting at 500 psi up to 2,500 psi, or by determining bolt preload in 3,000 lb increments starting at 3,000 lbs up to 18,000 lbs. The sensors must be capable of determining the pressure between mating surfaces within 10% accuracy, or they must detect bolt preload within 10% accuracy. If the sensors are in the form of a gasket, the sensors must be hardened to withstand 0.0015 inch of fretting movement amplitude under a steady 1,000-psi pressure for 1,000 cycles. This requirement will demonstrate the sensors' robustness and potential longevity for in-field service. If the sensors will be permanently mounted on the housings, it must be demonstrated that the corrosion conditions that cause the various depths of pitting on the magnesium should not also cause the sensors to fail.

PHASE III: Conduct the necessary qualification testing and finalize the sensors for transition to both military and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The corrosion sensor system developed under this topic would significantly enhance the state of the art for commercial aviation. The technology is directly transferable to military and commercial gearbox, airframe, maritime, and many other applications.

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KEYWORDS: aircraft maintenance performance; propulsion; drive systems; corrosion; sensors; inspection

N112-121 TITLE: Experimental and Analytical Techniques for the Validation of Complex Gas Turbine Engine Rotor Systems

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

OBJECTIVE: Develop a low-cost, high cycle fatigue experimental and analytical capability to evaluate complex gas turbine engine rotor and airfoil systems for the purpose of component and design tool validation.

DESCRIPTION: As advanced aircraft engines continue the trend to improved thrust-to-weight, propulsion system development and validation engineers continue to wrestle with complex structural dynamics and turbine engine high cycle fatigue. Whereas much activity has been devoted to the development of advanced design tools and component technologies, advanced low-cost rotor spin test and data analysis techniques beyond the current state-of-the-art are now needed to validate both these new tools and technologies.

High cycle fatigue (HCF) is still a major factor that negatively impacts safety, operability, and readiness, while at the same time substantially increasing maintenance costs. The HCF failure of compression and turbine system components is still a major contributor to the HCF events experienced in both development and fielded weapon systems. Although much has been done over the last several years to mitigate HCF though the development, validation and transition of new physics-based HCF tools and testing protocols, escapes to the fleet or changes in operational use can result in unexpected HCF fractures of fan, compressor and turbine airfoils.

Blade to blade variations in turbine engine rotors leads to the well documented phenomenon of mistuning. Mistuning can cause an amplification of resonant response by up to 400 percent of one or more airfoils in any given stage. Mistuning has been identified as a primary factor in HCF failures, and there has been significant progress in using vibration data from bench tests to identify the properties of mistuned Integrally Bladed Rotors (IBR). This process requires that high quality frequency response data be measured for one or more points on each blade. The resulting information is then used to develop a fundamental understanding of the IBR's vibratory response that can be used to mitigate the risk of HCF. This topic is focused on developing a comparable experimental and analytical capability for measuring the complex response of bladed disks under rotating conditions and using the information to develop a fundamental understanding of the bladed disk's vibratory response.

A key challenge for this proposed effort is to develop a system that can both readily excite the rotor system in a manner that simulates the engine environment and measure the relatively small airfoil dynamic responses while rotating at engine-like conditions. While traditional approaches to measure full-wheel responses have employed non-contacting stress measurement systems (NSMS) that rely on measures of blade time of arrival to infer deflection and strain, these systems have significant limitations. Improved experimental capabilities are needed to reduce HCF risk in engine development programs and fielded systems, particularly for modes in the frequency range from 5 kHz to 15 kHz, although modes of both lower and higher frequency are of interest. Proposed solutions must recognize the complex system structural dynamics of compressor integrally bladed rotors and damped turbine blades. In addition, the system must provide a means for measuring vibratory responses of all airfoils within a stage at multiple airfoil locations. Although a full airfoil measurement is preferred to enable HCF mode identification, the measurement locations should be readily changed to enhance mode identification techniques. Demonstration of the capability will be required at engine relevant forcing levels given engine relevant Q's (approximately 100 to 500), temperatures (up to 1200 degrees), and rotor speeds (up to 25,000 rpm).

Proposals should also address how the measurement system may be transitioned to development rigs or engines as part of an advanced instrumentation package for development endings and/or as part of an integrated health management system for fielded systems, recognizing airfoil line of sight through a case structure may be limited to the tip section only. To that end, upfront coordination with turbine engine original equipment manufacturers (OEMs) to identify potential rig/engine demonstration opportunities is recommended but not required. Proposed solutions should consist of advanced instrumentation, airfoil forcing systems, rotor speed control systems, and a data analysis system that uses the information to develop a fundamental understanding of the bladed disk's vibratory response.

PHASE I: Design, develop and demonstrate technical feasibility of a system to meet the requirements listed above.

PHASE II: Validate through testing of prototype systems, including the system excitation and airfoil measurement techniques, and new data analysis and analytical capabilities at engine relevant conditions.

PHASE III: Demonstrate a fully functional analytical system on a relevant rig/engine platform if available or if the opportunity exists. Transition validated system to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Non-contacting measurement techniques, such as laser vibrometry or holography, and rapid test article turnaround would improve the economics and viability of experimental component validation. It is expected that this experimental capability would have broad applicability to military and civilian turbine engine applications.

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2. Feiner, D. M. & Griffin, J. H.(2005). Exploring the Use of FMM ID for Engine Health Monitoring. Proceedings of NATO AVT-121 Symposium on Evaluation, Control and Prevention of High Cycle Fatigue in Gas Turbine Engines, Granada, Spain.

KEYWORDS: blisk; mistuning; integrally bladed rotors; Joint Strike Fighter (JSF) propulsion; gas turbine engine; high cycle fatigue

N112-122 TITLE: Embedded Single Mode Wave Guides for High Data Rate Processing

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: F-35 Joint Strike Fighter

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

OBJECTIVE: Develop and evaluate methods of integrating single mode waveguides in printed circuit boards (PCB) and backplanes for optical communications.

DESCRIPTION: Traditional avionic networks have evolved by using and combining a myriad of digital parallel and serial buses, analog switches and digital to analog signal processor architectures to route critical information among/between onboard decision islands. All of this has been accomplished by pushing the boundaries of electrical integrated circuit technology. Both the physical and electronic limits of PCB performance have been reached, and in order to increase communication bandwidth/throughput, industry must start exploring and deploying optical based technologies to eliminate the bottlenecks of copper based systems. Benefits derived from using photonic waveguides can be found in size, weight and power (SWaP), radiated and conducted electromagnetic immunity, elimination or reduction of ground plane complexity, board to board interface pin reduction, and increase in communication reliability (lower bit error rates), Built in Test (BIT) functionality and technology insertion resilience.

One approach to meeting this need for greater processing bandwidth is emerging polymer based slab waveguide technology. Compared to copper traces, polymer optical waveguides allow for greater bandwidth, reduce signal loss and thermal loads, less material intensive, and are not susceptible to electromagnetic interference [2]. In addition, photonic waveguides can be utilized in stand applications or inserted into multi-layer hybrid copper circuit card assemblies (CCA). Production methodologies use similar lithography applications and can be integrated into existing copper CCA manufacturing processes.

Current integrated polymer based waveguide PCB research is focused on supporting multi-mode optical applications [1]. However, multi-mode waveguides have bandwidth limitations due to modal dispersion [3]. Single-mode waveguides have numerous potential advantages over multi-mode waveguides. Namely, single-mode waveguides allow for larger bandwidth density per layer, provide improved aspect ratios, require less material, and weigh less.. Innovative methods to integrate single-mode waveguides are needed to realize their potential. Commonly used optical and datacom communications wavelengths are found in the 1530-1565 nm range. Cost, reliability and ease of manufacturing drive wave division multiplexing (WDM) and dense WDM solutions to choose electro-optic transceivers form this band of the light spectrum. Developing and evaluating methods of integrating single-mode waveguides within (PCBs) at these regimes, will maximize the potential of the waveguides embedded in printed circuit boards, while opening the door to transferring methods for other communications and datacom regimes.

PHASE I: Determine the feasibility of integrating single mode optical waveguides and PCBs. Develop comparative lists of possible materials, and fabrication methods. Perform computational analysis of optical performance of single mode waveguides which include: cross-section shape, minimum radius, cross talk, maximum bandwidth.

PHASE II: Develop validate and demonstrate single mode fibers fabricated in a laboratory setting or in small batches in a pilot fabrication facility. Integrate with a transceiver on a functional printed circuit board, test, and evaluate.

PHASE III: Build a flight-test capable printed circuit board and integrate with a military test system, and evaluate. Assess the potential for operational capability. Work closely with aerospace contractors to integrate with existing technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for private sector commercialization is strong. Fabrication and test processes developed under DoD sponsorship will be quickly applied in commercial computer and digital communications industries, and quite likely in advanced cell phones.

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KEYWORDS: Waveguides; Backplanes; Photonics; Printed Wiring Boards; Fly-By-Light; SWaP

N112-123 TITLE: Conformal Packaging and Installation Techniques for In Situ Sensors in Extreme Environments

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

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

OBJECTIVE: Develop a packaging methodology and associated installation techniques for encapsulating and mounting passive sensors that are capable of measuring and transmitting wide-bandwidth structural health monitoring data at service temperatures ranging from negative 60 degrees Celsius up to positive 600 degrees Celsius.

DESCRIPTION: Structural testing or structural health monitoring of aerospace components commonly involves installing sensors and wiring them to a data collection system. For example, strain and shear are sensed using this technique. However, wired sensors are generally limited to temperate environments and stationary structures. New types of miniaturized wireless sensors are being developed to address these deficiencies, but conformal, high-temperature packaging and installation methods are not yet available to support these emerging sensors. As the sensor technology evolves to meet the requirements of the environment, new packaging materials and in situ installation methods are needed to facilitate application of these new sensing capabilities in harsh environments.

This topic seeks novel concepts for packaging and installing conformal sensors for in situ measurement of structural health monitoring data in extreme environments at temperatures ranging from negative 60 degrees Celsius up to positive 600 degrees Celsius and accelerations levels up to 56600 g. The packaging should be easily installed, requiring no permanent changes to the engine component or surface on which it is installed. The packaged sensor must be sufficiently small and conformal in order to avoid disrupting aerodynamic flows.

PHASE I: Determine the technical feasibility and identify viable approaches for packaging conformal, high-temperature sensors and installing them in harsh environments. Feasibility must be addressed for operating temperature, high acceleration levels, low mass, aerodynamics, ease of installation, and variable sensor size.

PHASE II: Fabricate and demonstrate operation of a number of sensor packages and install them on a high-speed, high-temperature aerospace component. The operating environment should include temperatures up to 600 degrees Celsius and acceleration forces up to 56600 g.

PHASE III: Integrate into an OEM development program, where demonstration of durability, accuracy, reliability, and repeatability can be verified.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Although the conformal high-temperature packages are being developed for use in aerospace applications, this technology could be used in a wide variety of industrial testing and structural health monitoring applications.

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1. Arms, S. W., Townsend, C. P., Galbreath, J. H., & Newhard, A. T. (2004, July). Wireless strain sensing networks. Paper presented at the 2nd European Workshop on Structural Health Monitoring, Munich, Germany.

2. Hagerty, J. A., & Popovic, Z. (2001). An experimental and theoretical characterization of a broadband arbitrarily-polarized rectenna array. IEEE MTT-S Digest, 1855-1858. Retrieved from http://nemes.colorado.edu/microwave/papers/2001/ims_jh_01.pdf

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KEYWORDS: strain sensor; wireless sensor; passive sensor; conformal sensor; high temperature sensor; structural health monitoring

N112-124 TITLE: 3 Dimensional (3D) Braiding of Non-Uniform Solid Cross-Sections

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35, Joint Strike Fighter

OBJECTIVE: Develop an innovative technology for performing a 3-dimensional (3D) braid with a solid non-uniform cross-section.

DESCRIPTION: 3D braided composites are made by consolidating a braided fibrous preform with a resin. 3D braids are difficult to manufacture when the cross-section of the preform is solid (not hollow) but not uniform. Most braiding strategies use a fixed number of yarns or bobbins throughout the braiding process, making it difficult to introduce or subtract yarn during the process. The prevalent industry practice is to include inserts in the preform and overbraid over it. However, such techniques result in a weak interface that is prone to damage and failure during service. The goal of this project is to develop an innovative solution that will allow easy manufacture of braided preforms in which the cross-section can be varied in a controlled fashion.

PHASE I: Demonstrate the feasibility of braiding a 3D preform with a solid non-uniform cross-section in which the cross-section can be varied in a controlled fashion.

PHASE II: Based on the recommended approach in Phase I, fabricate a 3D braided component prototype using a production-scalable process.

PHASE III: Transition the approach to platforms that will benefit from the developed 3D braided composite technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Braided structures are widely used in aerospace, automotive, and biomedical applications. Examples of 3D braided composites include mechanical linkages and composite fasteners.

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KEYWORDS: textile composite; composites; braiding; non-uniform cross-section; fasteners; connecting rods

N112-125 TITLE: Fiber Optic Refractive Index Matching Material

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Electronics

ACQUISITION PROGRAM: PMA-265, F/A-18 Hornet Strike Fighter

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OBJECTIVE: Develop a fiber optic refractive index matching material for use in aerospace platform fiber optic mechanical splices that has a long shelf life and enables a durable and ultra-low optical loss fiber optic mechanical splice.

DESCRIPTION: Fiber optic mechanical splice loss performance typically ranges between 0.1 dB and 1 dB depending on fiber optic cleave quality, splice alignment tolerances, and index matching material environmental performance. Curable fiber optic index matching material used to secure and index match fiber optic cores in mechanical splices has limited shelf life at both room and elevated temperatures. Shelf life is particularly problematic in applications where no refrigeration or humidity control is available during shipping and storage of the curable index matching material prior to splicing. High power optical signals running through fiber optic mechanical splices can result in ignition of refractive index matching material. Significant index matching material optical, environmental and shelf life improvements are needed for mechanical splicing onboard military aerospace platforms. New index matching materials are needed to improve the shelf life performance of mechanical splices based on light cured index matching materials.

PHASE I: Model and simulate index matching material design. Demonstrate feasibility of the design for low-optical loss and wide operating temperature fiber optic mechanical splices operating at 850 nm and 1550 nm wavelengths. Demonstrate long shelf life refractive index matching materials via accelerated aging/highly accelerated life testing and mechanical splicing. Deliver uncured index matching material for additional testing.

PHASE II: Optimize refractive index matching materials for use in mechanical splices. Design, build and test mechanical splices based on the proposed index matching material. Build and test mechanical splices based on new index matching material and test the performance of the splices per established fiber optic splice qualification test regimen. Deliver ten prototype fiber optic splices for testing. Deliver representative uncured index matching material field kits.

PHASE III: Transition technology to appropriate platforms and production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The medical, industrial welding and telecommunications industry would benefit from better splices.

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KEYWORDS: Fiber Optic Splice; Refractive Index Matching; Shelf Life; Low Optical Loss; Low Toxicity; Environmental Stability

N112-126 TITLE: Master Clock Vibration-Isolation Technology Improvements for Aircraft Avionics

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA-272, Advanced Tactical Aircraft Protection Systems

OBJECTIVE: Develop a vibration-isolation schema that greatly improves by several magnitudes the performance of the 10-megahertz (MHz) master clock in aircraft avionics.

DESCRIPTION: Every digital receiver system that serves signal intelligence (SIGINT), electronics intelligence (ELINT), and communications intelligence (COMINT) has a crystal oscillator as a reference source (master clock). Also, every aviation platform has platform-induced vibration that adds random phase noise to these crystal oscillators, thereby increasing phase noise by as much as 45 decibels (dB) and degrading overall system performance. When receiving electronic signals of interest during collection events, aircraft experience vibration-induced phase noise that increases the noise floor creating the potential for failure to detect signals that are under the platform's noise floor. Further, the more vibration-induced phase noise there is, the smaller the platform stand-off range is, or the closer to the source the detection platform has to be.

In order to decrease the noise floor and increase the stand-off range of aviation platforms (UAVs included) that receive and gather electronic information, a novel approach to reducing the platform-induced vibration in the crystal oscillator is needed. Creating a novel vibration-isolation solution will reap overall system performance benefits throughout all avionics on the aircraft that use master clock reference signals, including radars, jammers, countermeasures, and so on.

PHASE I: Develop novel solutions to increase the vibration isolation of the crystal oscillator in legacy aircraft avionics. Provide both white paper theory and modeling and simulation as to the benefit of the proposed vibration-isolation schema. This modeling and simulation should show significant performance improvements of legacy avionics based on the crystal oscillator's improved vibration isolation.

PHASE II: Develop a prototype vibration-isolation solution and conduct platform-specified vibration analysis, demonstrating reduced vibration and increased receiver sensitivities. Vibration testing will include three aircraft-type vibration tables prescribed by the technical point of contact (TPOC) at the beginning of Phase II.

PHASE III: Transition the approach to legacy systems and other platforms that will benefit from the developed vibration-isolation schema.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Every aircraft, military and commercial, has vibrations that affect the reference crystal oscillator (master clock), creating a degradation in the system's performance. Advances in vibration isolation for crystal oscillator applications will result in system improvements.

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KEYWORDS: crystal oscillator; vibration isolation; master clock; electronic warfare; decibel; vibration noise reduction

N112-127 TITLE: Backup Shipboard Landing System for Vertical Takeoff and Landing Unmanned Air Vehicles

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-266, Navy & Marine Corps Tactical Multi-Mission UAS

OBJECTIVE: Develop a backup shipboard landing system for unmanned air vehicles that does not require specialized ship-mounted components.

DESCRIPTION: The Fire Scout Vertical Takeoff and Landing Tactical Unmanned Air Vehicle (VTUAV) is currently dependent on a single ship-mounted, radar-based landing system that is susceptible to component failures. Such a failure would require the air vehicle to divert from the intended host platform to another radar-landing-system-equipped ship or land-based facility. If an acceptably equipped alternate ship or land facility is out of range or unavailable, a multimillion dollar asset would have to be ditched at sea.

A backup landing capability would permit safe landing of the air vehicle on board the ship despite a failure of the VTUAV's primary landing system. The backup landing system must be radio independent as a key issue is lack of antenna/radio frequency spectrum. Proposals should assume that although regular ultrahigh frequency (UHF) communication between the ship and VTUAV is functioning, the global positioning system (GPS) is down. From the preplanned Marshall holding pattern and without the use of the radio frequency spectrum, the backup landing system must enable the Fire Scout to fly a final approach and land itself on the helicopter flight deck on a moving ship. This means that the backup system will have to be able to locate the landing pad, orient itself properly, and descend onto the deck using its own sensors and controls.

PHASE I: Develop a design for a backup landing system for landing unmanned air vehicles safely on the helicopter flight deck of moving ships. Provide a concept plan for demonstrating simulated VTUAV landing performance via a shore-based flight test of the integrated system and any unique/special test equipment needs.

PHASE II: Develop and demonstrate a prototype of the innovations developed in Phase I in a relevant environment.

PHASE III: Transition the system developed in Phase II to the Fire Scout and develop commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The backup landing system developed could readily be transitioned to any emergency landing system or assisted landing system for a commercial, piloted helicopter. It could also be used as a guidance system for any autonomous vehicle.

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KEYWORDS: autonomous landing system; vertical takeoff and landing; helicopters; Fire Scout; unmanned aerial system; shipboard landing; precision relative navigation

N112-128 TITLE: Alternative Energy Harvesting for Small Watercraft

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Cross Platform Systems Development, (CPSD).

OBJECTIVE: Develop a device that harvests the energy collected from various sea condition wave motion and/or solar radiation and uses that energy to power and/or extend the range of a lightweight unmanned watercraft without operator intervention.

DESCRIPTION: Technological advancements in alternative energy systems have significantly reduced the need to power a lightweight watercraft (thirty-three (33) feet or less) or its onboard equipment systems solely by petroleum and battery based energy sources. Creating a device that can absorb the abundant amounts of alternative energy being generated by sea waves and/or solar radiation to extend the range or increase the loitering capabilities of a lightweight watercraft can help reduce the total ownership cost for many vessels in the Navy’s fleet. Additionally, the invention of this device would help extend the mission range of these vessels for the warfighter and reduce the operational cost associated with the manned resupply of fuel for these vessels. This energy harvesting device must be able to create and/or store enough energy to support the deployment of an eight (8) ton unmanned watercraft to its mission location and its loitering on station anywhere from six (6) months to a year. While the vessel is loitering this device must also be capable of supplying power, at a minimum, in the range of 600 to 700 watts to support the operation of onboard vessel systems such as; navigation lights, communication equipment, satellite equipment, and radar equipment. Once the mission has been successfully completed the newly created energy harvesting system must have the power to support the return of the lightweight watercraft to its base without the significant intervention of an operator.

Many of the lightweight watercraft in operation today utilize a petroleum based system to power their internal power plants and a secondary electrical power supply to operate onboard devices such as, radar or other pieces of mission critical support equipment. All of these power supply systems require manned intervention to ensure they are full or completely charged prior to the craft beginning its mission. Once these fuels have been consumed the craft must return to some type of re-supply location to be re-fueled regardless of the current status of its mission. Lightweight watercrafts do not currently have an effective method of autonomously resupplying themselves with power to continue their missions for extended periods of time. There is a need for a new innovative product that can harvest alternative energy sources from sea waves and/or solar power to autonomously resupply the systems of the vessel.

The development of a device that consistently harvests sea wave and/or solar energy given various craft speeds and/or environmental conditions such as: water temperature, wind speed, wave height and atmospheric conditions will be technologically difficult to achieve. A device that can distribute power as required to the on-board systems of the watercraft in a reliable, safe and timely manner will be essential to the successful completion of this innovative research investigation. The performance of the system cannot become degraded by exposure to salt or fresh water systems, various sea conditions or extreme temperature variations.

PHASE I: Develop a concept for a device that can safely and consistently harvest sea wave and/or solar energy created by a lightweight unmanned watercraft given various craft speeds and/or environmental conditions such as; water temperature, wind speed, wave height or atmospheric. Once the energy is harvested this device must also store and accurately redistribute this power to the watercraft as needed.

PHASE II: Using the concept developed in Phase I, create a physical "proof of concept" prototype model of the energy harvesting device and demonstrate the consistent capture, storage and accurate distribution of power from the device.

PHASE III: Using the system developed in Phase II conduct trials on a lightweight vessel to demonstrate that the harvesting system can power and/or extend the range of the vessel. Correct any shortcomings identified during the vessel T & E. Develop operational and repair training instructions. Generate full-scale manufacturing, fleet introduction and fielding and training as required.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of a watercraft using this innovative energy source has private sector applications in the areas of the commercial oil industry, maritime/offshore security industry, commercial boating/yachting industry, commercial marine battery industry and humanitarian organizations.

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KEYWORDS: Alternative Energy, Solar Powered, Wave Energy Harvesting, Extended Range Vessel, Autonomous Refueling, Unmanned

N112-129 TITLE: Crystallization of Energetic Materials with Limited Solubility

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO IWS 3: Naval Gunnery (5-inch 155mm AGS), Standard Missile-6, ESSM

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

OBJECTIVE: Develop enabling technologies that can be used to crystallize energetic materials with low solubility in industrial solvents into various desirable forms for use in propellant and explosives formulations. The technology developed should be applicable to a variety of materials as well as offer scalability and low-cost manufacturing options.

DESCRIPTION: Particle size and morphology of energetic materials are critical factors for processing as well as sensitivity and performance of energetic formulations. The ability to produce energetic materials in varying particle size and morphologies is critical to evaluating these properties in formulations. There is a need to develop technology that can produce quantities (multi-gram and multi-kilogram) of energetic materials in varying particle size and morphologies. This may be accomplished through models, technology development, and later combining these technologies to achieve these goals. For example, the ability to enhance solubility of materials can be modeled using minimal experimental data. This information can be combined with technologies such as sonocrystallization to yield desired particle size and morphology of a specific material.

PHASE I: Prepare a concept for a crystallizer for low solubility materials (i.e., low solubility would include materials such as Triaminotrinitrobenzene). The materials will be modeled to identify solubility and predicted morphologies. Conduct preliminary proof-of-concept experiments that successfully test and evaluate the conversion of low solubility materials of one particle size and morphology to a different particle size and morphology.

PHASE II: Configure a crystallization apparatus to assess the process (es) on various insoluble candidate materials. These materials will be selected based on Phase I results. The resulting materials will be provided as deliverable and made available for evaluation in formulations by the sponsoring activity. Up to 25 grams of each material will be made available. Phase II will include a conceptual design of a pilot scaled crystallizer capability of producing a desired material at a rate of 10 metric tons per year.

PHASE III: The technology will transition to PEO IWS 3 in Phase III based on the success of Phase II experiments. PEO IWS 3 has a number of programs (i.e., Naval gunnery, SM-6, ESSM) that would benefit from the use of these materials. Depending on the energetic material technology introduced and pursued, the transition could be any or all of the following: a propellant solution with missile rocket motor applicability; high explosive solution with blast fragmentation and/or shaped charge warhead applicability for both missiles and projectiles; or explosive with warhead booster applicability. The small business would participate in the transition of the technology by supporting the energetic requirements for production level application, which may include propellant and/or explosive mix procedures, loading and curing determination, and establishing performance parameters, as required.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The private sector (pharmaceuticals, agricultural materials, food processing) typically uses high shear wet milling as a unit operation to obtain final particle size or form. This unit operation is typically costly but does control the desired products' particle size. If the proposed technology is developed appropriately, it could be transitioned for problematic materials in these industries where high shear wet milling is not applicable. Industry could also use this technology as a back-up to high shear wet milling or other mechanical grinding methods.

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KEYWORDS: crystallization, solubility, morphology, particle size, energetic, explosive

N112-130 TITLE: Pulse Compressor for Long Stretch Factor in High-Energy Ultrafast Fiber Lasers at Eye-Safer Wavelengths

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PMS 405, Directed Energy & Electric Weapon Systems Program Office, ACAT N/A

OBJECTIVE: Develop and demonstrate a low loss ultrafast laser pulse compressor capable of compressing greater than (>)3 ns stretched pulses down to less than (<)500 fs in high energy (>1 mJ) fiber-optic chirped pulse amplification (CPA) systems at eye-safer wavelengths.

DESCRIPTION: Ultrafast lasers offer a variety of potential applications of interest to the Navy in the fields of sensing, diagnostics and distance interrogation as well as with weapons potential. At the pulse energy and average power levels of interest, current state-of-the-art pulse compressors are limited in compression factor due to physical size constraints, alignment sensitivities, and/or high optical losses. These limitations impede the scaling of fiber-optic CPA system pulse energy and greatly restrict the deployment of practical ultrafast lasers.

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

Scaling the pulse energy from chirped-pulse fiber amplifiers to the millijoule level at high average power has been limited by the nonlinear effects in fiber that are detrimental to the amplified pulse quality. Self-phase modulation and other nonlinearities limit the minimum pulse durations achievable by pulse compression following the amplification stage. A primary technique for postponing these issues is to increase the linear pulse temporal stretch factor from <1 ns to 3 ns or greater. The proportional decrease in pulse peak irradiance for a given pulse energy enables a likewise proportional increase in the achievable amplified pulse energy for the system. Compressing >3 ns pulses to <500 fs using the incumbent Treacy geometry is not feasible in a compact, deployable package owing to the required diffraction grating size, the long optical path length, and the high losses imposed by conventional multi-pass schemes.

The compressor must have compact size (<1000 cm3 volume), high efficiency (>75% transmission), no degradation of spatial mode quality, and dispersion properties compatible with fiber-optic pulse stretchers used in CPA systems. The compressor must operate at high laser pulse energy (>>1 mJ) and high average power (>25 W) without distortion to the laser or damage to the compressor elements. The compressor must be demonstrated in an end-to-end ultrafast fiber laser system at eye-safer wavelengths with pulse output: >1 mJ energy, <500 fs temporal full width at half maximum (FWHM), and negligible pulse pedestal (>95% integrated energy within the 10 ps centroid).

PHASE I: Conduct research, design, and analysis on the pulse compressor architecture that enables long stretch factor (>3 ns), high efficiency (>75% transmission), and high energy (>1 mJ) in a compact, robust form factor. Prove feasibility of device fabrication based on design architecture and materials evaluation. The Phase I effort should include modeling and simulation results supporting pulse compression performance claims. The effort should also produce a draft testing methodology that can be used to demonstrate performance of the end-to-end fiber-based CPA system proposed for the Phase II effort.

PHASE II: Develop a prototype long stretch factor (>3 ns) pulse compressor based on the technology advances and methods identified in Phase I. Demonstrate the required optical performance in an end-to-end fiber-based CPA system with output energy >1 mJ, pulse width <500 fs, and eye-safer center wavelength, e.g. 1.55 µm.

PHASE III: Develop a long stretch factor pulse compressor capable of mass production for a variety of civilian and military uses. The final system may be expected to be “hardened” for field use, depending on mission needs.

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

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KEYWORDS: Ultrafast Lasers; Chirped Pulse Amplification; High-energy fiber amplification; High peak power pulses; Compact ultrafast fiber amplifiers; Eye-safer fiber amplifiers

N112-131 TITLE: Data Fusion for USW Common Tactical Picture

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: Program Executive Office, Integrated Warfare Systems (PEO IWS) 5E

OBJECTIVE: The objective of this research topic is to develop a real-time decision-aid that can compute multi-sensor threat assessment analysis for USW decision support systems and aid the user in the decision-making process.

DESCRIPTION: The Navy USW community has a significant need for decision support tools that support the operator in making decisions about fusing multiple targets and managing uncertainty in the challenging environment of undersea warfare. Current fusion engines focus on automated processes that combine contacts into tracks. The operator is presented with the results of the fusion process with no understanding of why some tracks were combined while others were not. Without knowledge of the process behind the fusion the operator is unable to accurately assess the outcome of the fusion process. These black box systems reduce the operator’s situation awareness (SA) by reducing their knowledge of the tracks in their area. The fusion system should include the operator in the decisions and give them a method to continually identify confidence and uncertainty in the information being used in the fusion process.

After many years of research, the vast majority of work in data fusion has focused primarily at Level 0 and 1 of the JDL fusion model, which deals primarily with the characteristics of single objects (Ref 1,2) such as track fusion. Although there is significant interest and need for computer models incorporating fusion at the higher levels of the JDL model (to include object meaning and relationships, mission impact and projected future states), currently there is very little work that has accomplished this objective (Ref 3).

Endsley’s model of SA provides a foundation for developing computer models that include these higher levels of data fusion (Ref 4,5). This work provides insight into the characteristics that computational models of SA would need to embody, and provides tools and methodologies that can be utilized to develop fusion engines and algorithms that focus on the higher levels of data fusion by mimicking the human processes of perception, comprehension, and projection (Ref 6). Principled processes for information presentation also provide guidance on how to present the results of this data fusion to the operator in a manner that allows for data checking and verification, to insure that the operator understands the confidence and reliability of the fused information (Ref 7,8).

The goal of this research program is to develop a decision aiding tool that effectively fuses track and other pertinent information into needed assessments of enemy threats and presents the data fusion results to the user. It should also provide confidence and uncertainty information to the user. This tool should not only combine relevant contact information together into meaningful tracks, but it should also allow the user to assess the data fusion process. The tool should provide:

1. Perception. Enabling technologies should be capable of assimilating, filtering, and displaying relevant info to the user. This includes being able to compute relevance, confidence, and uncertainty about each track.

2. Comprehension. Enabling technologies should be capable of integrating low-level information into higher cognitive "bits of information" to reduce information clutter, but still provide access to low-level data for the user. Enabling technologies should be capable of quantifying threat assessment and ranking existing threats across multiple goals, and displaying it to the user in a way that allows users to understand the reliability of the assessments.
3. Projection. This includes projecting future locations and threat characteristics of the fused track at future points in time based on past data points, track capabilities, and other intel on the situation.

PHASE I: Provide a preliminary concept for a decision support tool that can support SA and decision-making for fusing multiple contacts into tracks. Identify information requirements and algorithmic approaches that will be used to compute track fusion, threat assessment, and threat projection. Develop prototype UI concepts that will allow the operator to assess the fusion outputs and modify as needed.

PHASE II: Develop a prototype of the decision support tool. Determine feasibility and assess performance of this preliminary model for a test case. Essential human performance metrics should be included for assessing efficacy of the tool. An integration plan should be provided to detail how the prototype will be integrated within existing Navy systems.

PHASE III: The firm shall work with IWS 5 to transition the decision support tool to USW Decision Support acquisition programs. The decision support tool development methods and algorithms should also have transition potential to other branches of the military.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: 1. Training for operators of systems requiring cognitive situational awareness such as Air traffic Control. 2. Training for professionals with complex cognitive decisions using decision aids for information seeking such as Medical Doctors making diagnosis and course of treatment decisions.

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KEYWORDS: Anti-Submarine Warfare; Situational Awareness; Undersea Warfare; data fusion; adaptive user interface; threat assessment

N112-132 TITLE: Automated Networked Torpedo Defense

TECHNOLOGY AREAS: Information Systems, Electronics

ACQUISITION PROGRAM: Program Executive Office, Integrated Warfare Systems (PEO IWS) 5E

OBJECTIVE: Investigate and develop automated and autonomous networked torpedo detection, classification, and localization information fusion algorithms to support coordinated and networked Torpedo Defense using relevant data from ship self-defense systems with torpedo detection, classification and localization (TDCL) capability. These information fusion algorithms will receive relevant data from all networked platforms with TDCL capability. From this data, the information fusion algorithms will generate alerts concerning possible torpedoes, in order to reduce risk to friendly units and optimize counter-fire.

DESCRIPTION: Future naval platforms (e.g., DDG, CV, LCS) will have self-defense systems that can detect, classify, and localize torpedoes. Recent advances in torpedo defense have focused on generating a Torpedo Picture on each platform of interest using that platform's relatively small number of sensors. In an environment with multiple platforms, it should be possible to improve overall military utility by creating a networked Torpedo Picture. The aim of this project will be to evaluate candidate information fusion algorithms technologies that will perform automated and autonomous networked torpedo detection, classification, and localization. Operationally critical performance metrics to be improved by transitioning these algorithms into the fleet will include reduced risk from torpedoes and reduced operator workload.

PHASE I: Develop and assess feasibility of automated and autonomous networked torpedo detection, classification, and localization information fusion algorithms that utilize best-available information fusion techniques and are suitable for transition into Navy systems such as the Undersea Warfare Decision Support System (USW-DSS) or the Aircraft Carrier Tactical Support Center (CV-TSC). Emphasis will be placed on future military utility (i.e., producing effective tools that reduce fleet vulnerability to torpedoes).

PHASE II: Consistent with the Navy Advanced Processor Build (APB) process, fully develop prototype automated and autonomous networked torpedo detection, classification, and localization information fusion algorithms to evaluate their operation and ability to effectively provide automated and autonomous counter-fire recommendations and alerts.

PHASE III: Embed and demonstrate the Phase II automated and autonomous torpedo detection, classification, and localization algorithms within a prototype ASW command and control system such as USW-DSS or CV-TSC. Demonstrate and report on performance during at-sea trials.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This networked alerting technology could be applicable to a wide range of civilian applications of autonomy and automation including the use of unmanned systems for homeland defense, automation of building, facility, and port security, search and rescue, and other first responder applications.

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KEYWORDS: torpedo defense; information fusion; detection; classification; localization

N112-133 TITLE: Innovative Approach to Automatically Detect Ground Faults in Shipboard Control System

TECHNOLOGY AREAS: Information Systems, Electronics

ACQUISITION PROGRAM: PMS 400D, DDG 51 New Construction Program

OBJECTIVE: Development of an innovative, advanced fault detection/isolation/coordination methodology to increase the operational efficiency, robustness and reliability of the Machinery Control System (MCS).

DESCRIPTION: The Navy wishes to mitigate the amount of time a ship is inoperable or at a reduced operating capability due to the execution of the MCS fault detection, mitigation, isolation and repair process. This “downtime” is variable and is a simple function of when the troubleshooting effort begins and how quickly the troubleshooter is able to find the fault(s) within the system. The MCS design is based on an ungrounded or floating ground power supply design. There is no direct connection between the console circuits and hull ground. The design specifications require that the signal wires and their associated shields be isolated from the ship’s hull by more than 250K Ohms to ensure accuracy of the monitored signal. This configuration provides improved signal fidelity, resistance against EMI problems and against damage to electronic components as a result of stray voltages. However, it has become apparent that grounds to ship’s hull can introduce stray voltages and EMI in the MCS system, and cause the MCS circuits to vary in voltage relative to ground. Additionally, the presence of faults in the MCS system can result in the generation of inaccurate system information as well as a higher component failure which, in turn, can lead to equipment shutdowns and periods of system inoperability.

In general, the Navy machinery control system consists of five consoles that have roughly a total of 5500 control and monitoring signals directly wired to control points and sensors. The signal and return lines are typically two or three twisted wires with a shield. The signal shield is tied to the signal return at the MCS console. Many signal sets (50 or more) are cabled together and connected to the MCS console with an overall cable shield to reject EMI. This cable shield is tied to ships ground. The signal shield is isolated from the cable shield, and ship ground, to provide for a clean signal. Each signal set may have many termination points as it traverses from the console to the control point, through shipboard junction boxes. Individual signal returns and shields maintain continuity through the junction boxes. The cable shields are tied to ground at each junction point. If the signal return becomes grounded, signal value accuracy is affected, and un-commanded system operation may occur due to corrupted signal.

Currently, the Navy’s fault isolation detection process consists of taking the console off-line and, using a handheld analog meter, the user measures the resistance between the power supply return and ship’s hull. When less than 250K Ohms is measured, the user performs a manual trial and error method to locate the ground fault(s). This process usually starts at the console where the ground has been indicated and will continue cable by cable downstream of the console until the fault is identified. This is a very laborious and time consuming process and can lead to the introduction of additional grounds, additional component failures, and breaking pins due to removing and re-attaching the ribbon cables and the cannon plugs. Though another widely used method in the commercial industry to locate ground faults by injecting signals into the system. This is not considered a viable solution due to concerns of a potentially adverse impact on the operation of the MCS Control System.

This topic seeks to explore the development of an innovative, fault detection/isolation/coordination methodology and the associated technology(ies) to provide ship’s force with the ability to quickly and accurately identify a grounded condition as well as the ability to localize the affected cable(s) and/ or components. Specifically, proposed concepts should address the ability to detect and determine the location of the ground (including signal returns and signal shields connected to ship's hull), multiple simultaneous grounds, between the MCS system and ship's hull with attention to signal cables, sensor cables, and components, such as relays, sensors, transducers, contact closures, and other floating ground components. The proposed concept should be able to function while the system is in operation, with a noninvasive, nonintrusive approach, and should be able to provide fault indication and location of problems, such as: intermittent fault conditions, multiple faults on the same phase and/or inverted ground faults. An innovative, easy to implement concept that requires little training and utilizes minimal ship's force to execute is of particular interest. The increased mission capability and potential savings on the materials and manpower associated with the development of this capability could be significant. Proposed concepts should employ open architecture principles and be able to interface with the currently used MCS and Integrated Condition Assessment Systems used onboard naval ships. It is envisioned that a key technical challenge is going to be in the development of a non-intrusive, detection and localization process that provides real-time or near real-time detection.

PHASE I: Demonstrate the feasibility of improved, innovative, fault detection/isolation/coordination methodology and the associated technology(ies) to provide ship's force with the ability to quickly and accurately identify a grounded condition and localize the affected cable(s). Establish performance goals and metrics to analyze the viability of the proposed solution. Develop a test and evaluation plan to contain discrete milestones for product development to be utilized for verify performance and suitability.

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

PHASE III: Construct a full-scale prototype based on the Phase II results for testing in a shipboard environment. Working with government and industry, install onboard a selected DDG 51 class ship and conduct extended shipboard testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A means of quickly detecting a fault can dramatically improve the life of the system components that are subjected to large stresses during the fault periods. This method of fault detection may be applied to any system utilizing a floating ground.

REFERENCES:
1. C. Wood and P. Clark. FADES: An Expert System for Fault Analysis and Diagnosis. TIRM 87-024, Turing Institute, 1987.

2. Baldwin T., F. Renovich, Jr., L. F. Saunders, and D. Lubkeman; Fault Locating in Ungrounded and High Resistance Grounded Systems; IEEE Transaction on Industry Applications, Vol. 37, No. 4, July/August 2001; pp. 1152-1160.

3. Bascom III E. C., D.W. Von Dollen, H.W. Ng, "Computerized underground cable fault location expertise," Proceedings of the IEEE Power Engineering Society Transmission and Distribution Conference, Chicago, IL, USA, Apr. 10–15, 1994.

4. MIL-STD-1310 "Standard Practice For Shipboard Bonding, Grounding and other Techniques for Electromagnetic Compatibility and Safety" section 5.1.2.1.4 - (https://assist.daps.dla.mil/quicksearch/)

5. MIL-SPEC-901D," Shock Tests, High Impact Shipboard Equipment, Machinery, and Systems" - (https://assist.daps.dla.mil/quicksearch/)

6. MCS/Engine Controller Grounding Failures, Ships Force & IMA Manhours.

KEYWORDS: MCS; ICAS: Ground Fault Detection; Fault Isolation; Ungrounded Systems

N112-134 TITLE: In-Line Fiber Optic Signal Quality Fixture

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 317, LPD 17 Program

OBJECTIVE: Develop an in-line signal quality fixture to provide shipboard personnel with a 24/7 condition status of the entire fiber optic network plant throughout the life of the ship. Additionally, the fixture should enable shipyard fiber optic technicians with the ability to detect, isolate, and troubleshoot conventional or air-blown fiber optic cable installations during the shipboard cable installation tests and inspection phase of the Shipyard Industrial Test Period.

DESCRIPTION: Communication transmission systems and networks continue to evolve towards higher data rates, increased wavelength density, longer transmission distances and more intelligence. Additionally, dense wavelength division multiplexing (DWDM) and all-optical networks (AON) such as the Ship-wide Area Network (SWAN) on the LPD 17 Class demands a monitoring fixture to assure quality of service (QoS). Higher degree of self-control, intelligence and optimization for functions within next generation networks require new monitoring schemes to be developed and deployed. Currently, on board naval ships there are a wide range of optical network technologies: 10 Gigabit Ethernet (GigE), 10 Gigabit SONET, OCx ATM, etc. All these system use or are projected to use air-blown fiber optic (ABFO) cabling. While methods and installation practices of Fiber Optics (FO) in a shipyard environment has improved considerably over the years, experience has shown that ABFO cables will develop tiny breaks or cracks that, if not detected during the testing period, will continue to propagate. Breaks or cracks are typically found in areas such as bends in the cableways, as a result of initial connectorization, subsequent removal and reconnecting, cinching up the cableways and installing and pulling copper cable within the same cableways. As the Navy continues to move into the FO environment, it is beginning to see thousand of man hours being spent troubleshooting initial ABFO or standard FO installations. Degradation of FO connections have been experienced merely by opening, moving, or disconnecting FO connectors, thus become unknown or questionable entities. Though portable FO testers are available to test the fiber cable in a shipyard environment, there is no apparatus that is capable of being installed in the shipboard FO network as part of the monitoring system 24/7. The development of an in-line FO fixture will drastically reduce essential troubleshooting hours required to install and verify fiber optic cables and over time will reduce time spent troubleshooting broken or unknown fiber connectivity. An in-line monitoring fixture is a key enabler for self-control of next generation networks.

This topic seeks to explore innovative approach(es) to the development of an in-line signal quality fixture to enable users to detect, isolate and troubleshoot conventional FO or ABFO cable installations. The development of an in-line FO fixture will drastically reduce essential troubleshooting hours required to install and verify fiber optic cables and over time will reduce time spent troubleshooting broken or unknown fiber connectivity. An in-line monitoring fixture is a key enabler for self-control of next generation networks. Proposed concepts should be able to be permanently rack mountable as well as portable, easy to use and cost-effective to deploy in both shipyards and in the fleet. The proposed concepts will need to be capable of monitoring a variety of metrics – Loss of Signal, Bit Errors, Optical Power Levels, Laser Current, Voltage Output, and Bandwidth in a real-time status.

PHASE I: Demonstrate the feasibility of the development of an in-line signal quality fixture(s) to provide shipboard personnel with a 24/7 condition status of the entire FO network plant throughout the life of the ship as well as enabling shipyard FO technicians with the ability to detecte, isolatate, and troubleshoot conventional FO or AFBO cable installations. Establish performance goals and provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Develop, demonstrate and fabricate a prototype as identified in Phase I. In a laboratory environment, demonstrate that the prototype product meets the performance goals established during Phase I. Provide a detailed plan for software and/or hardware certification, validation, and method of implementation into a future ship test and/or design environment. Prepare cost estimates, logistics data packages, and interface documents for use in both forward fit and retrofit ship programs.

PHASE III: Utilizing the technology developed during Phase I and II, work with Navy and industry to certify and implement for use on existing and future naval and commercial shipbuilding environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This in-line fixture could be employed in any fiber optic environment involving complex network systems and interfaces.

REFERENCES:

1. Fiber Optic Cable Topology Installation Standard Methods for Naval Ships Mil-Std-2042B

2. Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Mil-Std-810F

3. Telecommunications Industry Association (TIA) standard test FOTP-95.

KEYWORDS: Fiber optics; air blown fiber; signal quality; test and evaluation; troubleshooting

N112-135 TITLE: High Friction, Conforming Boat Capture and Transfer System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 500, DDG 1000 Program, ACAT 1

OBJECTIVE: Development of an innovative approach and associated energy absorbing technologies to enable safe capture and retrieval of Rigid Hull Inflatable Boats (RHIBs) of varying geometries while entering ship-based boat bays while under power.

DESCRIPTION: The DDG 1000 stern launch and retrieval system must be capable of safely retrieving RHIB boats with a 10 knot speed relative to the forward speed of the ship. Safe capture and retrieval of boats of varying geometries presently requires direct and often abrupt contact with the boats' hulls before the boat is transferred into the boat bay. The ability to safely retrieve boats under these conditions requires the ability to account for unpredictable dynamic forces while arresting the forward momentum of boats entering the boat bay. The currently planned boat capture and transfer system utilizes pneumatic tires with relatively high inflation pressures and a small, contact patch area which could result in high stress levels in the boat hulls and does not account for forces into the boat hulls above a 1g load condition in any direction.

This topic seeks an innovative approach to the capture and retrieval of manned and unmanned vessels in a manner that will minimize the applied force as seen by the vessel during the boat handling process. While RHIBs are of a current interest the system proposed must be flexible enough to allow for the handling of future technology innovations in the areas of unmanned vehicles. Once contact with the hull is established, proposed energy absorbing, high-friction material solution(s) must be capable of preventing a 21,000 pound vessel from sliding back into the water at a nominal ramp capture angle of 10 degrees and to allow for forward transfer further into the boat bay. Technologies/Concepts developed under this effort must account for dynamic conditions above 1 x gravity (1g) loading condition, absorbing energy in three axial directions. Use of alternative, hull surface-conforming, energy absorbing, material solutions are encouraged in the area perceived to be a key technical challenge in the execution of this topic: at the 10 degree ramp angle where one would expect to see a high, normal, contact force between the vessel and the capture contact surface. Proposed concepts can be in the form of an innovative interface to the existing system or an entirely new approach that fits within the hull-form trade space. Proposed concepts should be able to operate in a maritime environment and meet performance requirements as indentified in the references while covered in salt or fresh water and under widely varying water and air temperatures (arctic to tropical up to a sea state 5 condition. Proposed concepts must provide a minimum Factor of Safety of 2.0 at all points of contact, conform to hull geometries and shapes and provide a high capture force on a 10 degree ramp incline. Additionally, any system or solution proposed must have low acquisition and lifecycle costs, be mechanically simple, and provide for safe ship operations in a variety of shipboard conditions including high ship speeds and up to sea states 5. Open architecture design principles are strongly encouraged.

PHASE I: Demonstrate the feasibility of the development of an innovative approach and associated energy absorbing technologies to enable safe capture and retrieval of Rigid Hull Inflatable Boats (RHIBs) of varying geometries while entering ship-based boat bays while under power. As applicable, demonstrate the effectiveness of the solution with modeling and simulation and engineering analysis. Establish performance goals and provide a Phase II development approach and schedule that contains discrete milestones for product development

PHASE II: Develop, demonstrate and fabricate a prototype as identified in Phase I. In a laboratory environment, demonstrate that the prototype product meets the performance goals established during Phase I. Of particular interest is the demonstration of the prototype's ability to launch, recover and secure a variety of boat size in simulated shipboard conditions. Provide a detailed plan for software and/or hardware certification, validation, and method of implementation into a future ship test and/or design environment. Prepare cost estimates, logistics data packages, and interface documents for use in both forward fit and retrofit ship programs.

PHASE III: Working with the Navy and Industry as applicable, prepare installation plans to modify the existing boat handling system aboard DDG 1000 to test the system's effectiveness at-sea during sea trials. Conduct shipboard testing to evaluate performance in the Navy environment and develop plans for shipboard certification and application. Develop transition plans for shipboard and commercial uses of the system developed.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology applies and could be used on commercial vessels conducting stern-ramp recovery operations e.g. research vessels, commercial cargo roll-on/roll-off Ships, etc.

REFERENCES:
1. Destroyers - DDG; http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=900&ct=4

2. DDG 1000 Launch and Recovery Boat Handling Information Sheet - Available Upon Request

3. SeaFrame Carderock Publication 2009 Volume 5 Issue 1 (Reference page 11-12); http://www.navsea.navy.mil/nswc/carderock/seaframe/issues/SEAFRAME-Vol5-Iss1.pdf>

KEYWORDS: boat handling; boat retrieval; boat capture; launch and recovery; RHIB

N112-136 TITLE: <u>Environmentally Acceptable Conversion Coating for Un-Coated Aluminum Alloys</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 501, Littoral Combat Ship Program, ACAT I

OBJECTIVE: Development of an advanced, environmentally acceptable, conversion coating system that can be inexpensively applied to un-coated, marine-grade, aluminum alloys.

DESCRIPTION: Currently, all ships in the United States Navy are painted with Low Solar Absorbance (LSA), haze gray topcoats. While LSA paints have shown themselves to help reduce the amount of solar energy absorbed by the ship structure, cost and weight constraints have limited the use of these products on new, aluminum ships and structures. For example, the superstructure on the LCS-1, the entire LCS-2, and the HSV freeboard/superstructures are unpainted. This unpainted aluminum has been abrasive blasted to reduce the "shiny" appearance of mill-finished aluminum. However, the blasted surface is rough and could readily trap dirt, exhaust gasses, and rust particles. An un-coated aluminum surface, as compared with an LSA-coated Navy ship will: increase the energy load on the ship's air conditioning plant; increase the rate at which aluminum is aged resulting in decreased toughness as well as increased cracking over time; increase the amount of time or effort that maintenance personnel or sailors have to spend to clean-up the appearance of the ship for events like change or command or port calls. Present methods for the pre-treatment, such as anodizing or the use of chromate conversion coatings, are tank-based and are neither compatible nor realistic or cost-effective to implement in a shipyard/shipbuilding environment. Both these methods also require the shipyard/shipbuilder to employ environmental management plans including the ability to provide waste treatment and require personnel to be outfitted in protective gear during the coating process.

This topic seeks an innovative approach to the development of coating or surface treatment for un-coated, marine-grade, aluminum alloys that will retard corrosion and staining while providing some LSA properties such that coated/treated aluminum would be cooler than untreated aluminum when exposed to sunlight. The primary technical challenge is that conventional paint systems are too expensive and too heavy for aluminum ships and as such the desired corrosion-control and LSA performance normally achieved by over 6-mils of paint must be achieved with a material that is far less costly to apply and that forms a far thinner layer. For the purposes of this proposal, the layer should be less than 1-mil thick. Of particular interest is the method of application and the ability to apply the coating/treatment using current shipyard coating application processes like brushing, spraying, or rolling the material on the surface. Coatings/treatments that can be readily applied by sailors and waterborne maintenance teams would be preferred over systems that have to be applied in a controlled, industrial setting. Specifically, solutions are sought which would:

1. Be compatible with un-coated aluminum alloy surfaces with a minimal level of surface preparation (i.e., the material will not require an abrasive blasted or power-tool cleaned surface).
2. Remove rust staining and create a uniform gray oxide color on otherwise unpainted aluminum surfaces.
3. Leave a residual film on the aluminum surface that shall inhibit corrosion as well as inhibit the absorption of solar radiation. There is no requirement on film thickness and in fact, a thinner, lighter film would be preferred over the 6-9 mil thicknesses for conventional paint systems.
4. Be environmentally acceptable products and shall not contain hazardous heavy metals (e.g., hexavalent chromium, cadmium, lead, etc.), have less than 250 grams/liter of volatile organic compounds, and that could be approved for use by sailors from barges or boats in Navy ports like Pearl Harbor, HI and/or San Diego, CA. As such the product should not be strongly acidic or alkaline, should not include carcinogenic or mutagenic materials in the formula and should not have a flash point below 100F.

PHASE I: Demonstrate the feasibility of an innovative approach to develop a coating system for un-coated, marine-grade, aluminum alloys that will retard corrosion and staining while providing the LSA properties with respect to thermal protection. Establish performance goals and provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Develop, demonstrate and fabricate a prototype as identified in Phase I. In a laboratory environment, demonstrate that the prototype product meets the performance goals established during Phase I. Provide a detailed plan for validation testing of the prototype product using established processes for judging the appearance of corrosion on surfaces and measuring radiant heat transfer and method of implementation into a future ship test and/or design environment. Prepare cost estimates, logistics data packages, and interface documents for use in both forward fit and retrofit ship programs.

PHASE III: During Phase III, materials/processes validated in Phase II shall be scaled up to allow field application to a LCS. For example, enough product should be developed to coat a minimum of 50,000 square feet of surface on an actual LCS. The surface treated would be from the boot-top to the top of the superstructure.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The approach would be applicable to all marine applications for aluminum alloys including: Boats & Craft; Masts, booms, and other topside hardware; Aluminum decking and structures used in a seacoast environment. The Commercial industry would benefit from the new technology because industry could leverage the cost and weight savings associated with not having to paint aluminum parts used in the marine environment.

REFERENCES:

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

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

3. Bushfield, Harold Sr., et al, "Marine Aluminum Plate ASTM Standard Specification B 928 and the Events Leading to Its Adoption". Presented at the October 2003 Meeting of the Society of Naval Architects and Marine Engineers, San Francisco, California.

4. Bovard, FS, "Sensitization and Environmental Cracking of 5xxx Aluminum Marine Sheet and Plate Alloys," Corrosion in Marine and Saltwater Environments II: Proceedings of the Electrochemical Society, ed. DA Shifler, 2004, pp. 232-243.

KEYWORDS: conversion coating; aluminum; low solar absroption; heat; environmentally acceptable

N112-137 TITLE: Active Motion-Compensation Technology for Roll-On/Roll-Off Cargo Vessel Discharge to Floating Platforms

TECHNOLOGY AREAS: Ground/Sea Vehicles, Battlespace

ACQUISITION PROGRAM: PMS 385, CAPT Sutton

OBJECTIVE: The goal of this topic is to develop an innovative approach and the associated technologies to permit deployment and vehicle transfer across a commercial Roll-on/Roll-off (Ro/Ro) ship stern ramp to a floating platform in up to a sea state 5 environment. Proposed concept(s) should not require modifications to the ramp structure, but rather rely on a separate, active system driven by sensed motions to isolate the ramp from the environment.

DESCRIPTION: The military transportation system includes the use of commercial Ro/Ro ships for cargo and vehicle stowage as well as transport and delivery – particularly when participating in disaster relief or humanitarian assistance operations. Ramps are currently used as a means to bridge the gap between an independently floating vessel and a floating platform or barge to facilitate the transfer of cargo. Commercial Ro/Ro ship ramps are designed for operations in calm water environments, no greater than sea state 3. If a protected harbor is not accessible, the Ro/Ro ship may have to discharge cargo over its ramp to a floating platform in an open water environment which would increase the probability of encountering sea states of 3 or more. Additionally, both the vessel and the platform will have pitch, heave and roll characteristics that will likely be different from each other creating relative motions between the two ends of the ramp. The motions will also impart accelerations to the vehicle driving across the ramp. In order to successfully discharge the ship's cargo, a vehicle operator must be able to safely drive a vehicle out of the Ro/Ro ship, across its stern cargo ramp, and onto the platform. With the Ro/Ro ship and the platform exposed to waves, the relative motion will cause the ramp to heave and torque in a more extreme manner than would typically be seen in a protected harbor environment. Use of the current state-of-the-art would severely restrict cargo movement operations in order to comply with the requirement for use in lower sea-states. Use of the state-of-the art in higher sea-states would likely cause damage to the ramp structure and its attachment to the ship as well as create unsafe conditions for personnel transiting the ramp in vehicles.

This topic seeks an innovative approach and associated technologies to develop a ramp interface or a coupling mechanism concept that uses an active system approach to compensate for the induced motions (linear and rotational) and forces while vehicles are being transferred from a vessel to a platform during in up to sea state 5 conditions. Implementation of the proposed concept (s) should not require modifications to either ship or ramp structures and should employ open architecture design principles to maximize adaptability and flexibility of use. An anticipated technical challenge will be in the ability to employ a motion sensing and structural monitoring coupled to an actuation concept to isolate the ramp from the motion environment and assure operating loads are within allowable limits. The emphasis should be on sensing and actuation systems architecture and development of algorithms for determining the safe operating load on the structure in the dynamic environment and in relation to its rated capacity. For purposes of focusing proposals in this topic area, the Large Medium Speed Roll-on/roll-off (LMSR) and its existing stern ramp for will be the baseline. Detailed information about the LMSR can be found in Ref (4). The ramp on the LMSR is 100 feet long with a clear driveway that is 16 feet wide. It has a truss structure along its two long sides to provide vertical plane bending stiffness. The ramp has a design load of 80 tons and is rated for operations in up to sea state 3. The weight of the ramp itself is 100 tons. It is hinged at the ship end to allow the ramp to pitch and slew relative to the stern of the vessel. With other vessels, such as commercial Ro/Ro ships the height of the ramp at the transom could vary over a range from 8 feet to 16 feet above the waterline. The ramp applies significant vertical loads on the platform deck and point loads get very large at the ramp corners when the vessels have significantly different motions induced by the seaway. The maximum weight supported by the foot is half the ramp weight plus the maximum gross vehicle weight. Proposed concepts should allow for the torsion associated with the relative motions between the ends of the ramp while also providing adequate strength and stiffness.

PHASE I: Develop an innovative approach and associated technologies for a ramp interface concept that will compensate for motions (linear and rotational) and forces while vehicles are being transferred from a vessel to a waiting platform during in up to sea state 5 conditions. Assess feasibility and establish performance goals. As part of this task the contractor should estimate the size of all major components that make up the conceptual design along with an explanation of how the system operates. As practicable, modeling and simulation to include animations of the dynamic aspects of the concept are encouraged. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Develop, fabricate and demonstrate a proof-of-concept system as identified in Phase I. In a laboratory environment, demonstrate that the system concept can meet the performance goals established during Phase I. As applicable, provide a preliminary detailed design package including supporting calculations, a plan for software and/or hardware certification, validation, and method of implementation into a future ship test and/or design environment. Prepare cost estimates, and interface documents for use in both forward fit and retrofit ship programs.

PHASE III: If the Phase II effort is deemed appropriate for demonstration, the contractor will be tasked to prepare a detail design and build, install and demonstrate a full scale system that would permit transfer of vehicles from a Government provided Ro/Ro ship to a Government provided platform in up to sea state 5 conditions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial Ro/Ro ships can utilize this technology to broaden their ability to offload in port locations marginally protected from the sea.

REFERENCES:
1. http://en.wikipedia.org/wiki/Roll-on/roll-off

2. "Guide for Certification of Stern, Bow and Sideport Ramps and Moveable Platforms (Decks)," ABS Guide for Certification of Lifting Appliances, Chapter 6.

3. http://www.globalsecurity.org/military/systems/ship/inls.htm

4. http://www.msc.navy.mil/factsheet/lmsr.asp

5. Improved Navy Lighterage System - Roll-on/ Roll-off Discharge Facility (INLS-RRDF)

KEYWORDS: Dynamic interface; Vehicle transfer; Relative ship motions; Ramp structures; Ro/Ro; RRDF

N112-138 TITLE: Watercraft Wave Energy Prediction Model

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Cross Platform Systems Development (CPSD)

OBJECTIVE: Develop and correlate a parametric analysis prediction modeling tool that can accurately calculate the amount of energy generated when a lightweight watercraft displacement or planing hull absorbs the wave energy from various sea conditions and vessel travel speeds.

DESCRIPTION: Technological advancements in watercraft designs have created shock absorption and wave damping systems that can absorb significant amounts of energy that is being transferred by the waves to the pontoons or hull of the vessel. This energy represents a significant opportunity for the support / augmentation of existing onboard electrical power supplies once accurately modeled. The creation of a device to capture this energy opportunity will be proposed as the subject of a separate Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) topic at a later date. The development of a parametric analysis modeling tool would have a significant positive impact on the total ownership cost of a vessel once the model is capable of accurately describing the amount of energy imparted on the pontoons/hull of a lightweight vessel. A successfully developed parametric analysis tool would have the ability to model various pontoon/hull alternatives and energy input configurations to safely optimize the amount of energy that can be created by the interaction of these systems at various sea conditions and vessel travel speeds. This knowledge would help reduce the amount of electrical energy and/or fuel consumed, increase the utilization of alternative energy sources and improve the operational range of the craft. Ultimately having a parametric modeling tool such as this would help reduce vessel development costs by reducing the quantity of physical models required for validation.

Many of the lightweight watercrafts in operation today were created based on techniques that have been passed down over the years. There is a need to identify new ways of accurately modeling sources of alternative energy for lightweight vessels and to quickly translate these models into transitional physical vessels the warfighter can use in more nontraditional mission deployment areas. The need to develop a parametric model that can quickly and inexpensively validate various vessel concepts would help facilitate the validation of an alternative energy source that would autonomously resupply the vessel's electrical systems.

The creation of the parametric analysis tool and its successful correlation to the measurements taken from a physical scale model will result in a virtual tool that allows for the optimization of a system capable of creating enough electrical energy to support and /or extend the operational range of an onboard electrical system. A parametric analysis tools that can accurately model the effects of these various sea conditions and vessel speeds on the pontoon/hull of a craft is not readily available. The knowledge of which energy inputs to monitor that most accurately represent all of the variables that can affect the vessel and the proper placement of energy recording sensors on the vessel will be technologically difficult to determine. However, the development of such knowledge would create a system that helps to lower the development cost of lightweight vessels. This will in turn help reduce the time and total ownership cost associated with the development of lightweight vessels for the Navy.

PHASE I: Develop a concept and determine the feasibility of a parametric analysis prediction modeling tool that can accurately calculate the amount of energy generated when a lightweight, not to exceed thirty-three feet, watercraft displacement or planing hull absorbs the wave energy from various sea conditions and vessel travel speeds. Identify the energy inputs that affect the hull such as sea conditions and vessel speed inputs that must be collected to accurately represent the various energy forces on the planing or displacement hull. Then develop the computer based parametric model identified.

PHASE II: Create a physical scale model of a lightweight vessel to validate the parametric analytical model developed in Phase I. Create a sensor plan to identify the type of sensors required to collect the energy force input data, the correct placement of the sensors on the physical scale model and the method to accurately record the input data from that model. Evaluate the physical model, collect the energy input data, and create an energy input file. Using the energy input file validate the computer based parametric model and update that model as needed to establish an accurate correlation between the parametric model and the energy forces as recorded on the physical scale model.

PHASE III: Expand the parametric model's ability to be used on other similar hull forms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of a parametric model capable of accurately predicting the amount of energy created by sea wave energy would support advancements in the commercial marine battery suppliers industry and could revolutionize how the commercial boating and yachting industries design power supply systems.

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2. Sea Surface Simulation in Large Coastal Region for Maritime Simulators – Yongjin Li, Yicheng Yin, Helong Shen Xinyu Zhang Lab of Maritime Simulation & Control, Dalian Maritime Univ., Dalian, China - http://ieeexplore.ieee.org/Xplore/login.jsp?url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F5437555%2F5437594%2F05437953.pdf%3Farnumber%3D5437953&authDecision=-203

3. Technology White Paper on Ocean Current Energy Potential on U.S. Outer Continental Shelf – Minerals Management Service Renewable Energy and Alternative Use Program U.S. Dept. of the Interior - http://ocsenergy.anl.gov/guide/current/index.cfm

4. National Renewable Energy Laboratory (NREL) Scoping Meeting Presentation: Renewable Energy Technologies for Use on the Outer Continental Shelf - http://ocsenergy.anl.gov/guide/current/index.cfm

KEYWORDS: Alternative Energy; Wave Energy Absorption; Nautical Parametric Analysis Tool; Wave Energy

N112-139 TITLE: Radar/EW Aperture Cold Plate Innovation for Increased Thermal Performance

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: IWS 2.0 Developing Radar and EW Systems

OBJECTIVE: Develop and evaluated innovative affordable aperture level cold plate thermal management concepts to handle thermal dissipation from high power Electronic Warfare (EW)/Radars implementing Gallium Nitride(GaN) Power Amplifiers (PAs) and associated electronics.

DESCRIPTION: Aperture level thermal management for high power Navy solid state Electronic Warfare (EW)//Radars largely utilizes fluid flow within cold plates that interface with edge-cooled naval RF electronic assemblies in order to remove increasing amounts of thermal dissipation from Wide Bandgap RF electronics subassemblies containing multiple GaN power amplifiers. This increasing level of thermal dissipation for high power shipboard EW/Radars must be accomplished while interfacing with existing shipboard heat removal systems. Traditional cold plate technologies exhibit limited thermal performance and significant manufacturing cost. Existing approaches have relatively high thermal flow and hydraulic flow resistance and there is a limited supplier base for manufacturing these large cold plates. This topic seeks innovative modular cold plate design/manufacturing approaches with significantly improved performance that will be scalable, more affordable, and capable of higher power density. These approaches will provide improved efficiency and higher manufacturing yields as well as maintain or improve system level reliability and maintainability. Proposed technologies will demonstrate scalability to accommodate different aperture sizes. The selected technologies will improve system performance (2-3X reduced thermal resistance and a 3-4X reduction in hydraulic resistance relative to current cold plate technologies utilized in EW/Radar Systems), system level reliability and maintainability will be maintained or improved over existing systems and efficiency improved by 5% while reducing the electronics operating junction temperatures by 10-20 Degrees C. The selected technologies will also incorporate improved manufacturing technologies to reduce development, acquisition, and life-cycle costs.

PHASE I: Develop concepts and assess feasibility of proposed thermal management technology through modeling and empirical evaluations of key manufacturing and design features. Technical feasibility analysis will be conducted to determine whether the technology concept(s) will meet the stated topic performance objectives and transition potential.

PHASE II: Based on Phase I results, develop and evaluate prototype modular cold plate assemblies. Evaluation will affirm (1) the cold plate assembly addresses the mechanical and thermal objectives of the topic and (2) the assembly is compatible with high power operational shipboard solid state EW/Radar, and (3) that it will satisfy shipboard reliable and maintainable long-term operation within an operational shipboard solid state EW/Radar.

PHASE III: Refine the phase II prototype as necessary and incorporate into a shipboard solid-state high-power aperture design that is intended for integration and demonstration within an operating IWS 2.0 radar system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed cold plate technologies will have technological applicability to many commercial and military avionics radars, all commercial radar applications, and all marine radar applications.

REFERENCES: 1. T. Kuppan (February 2000). Heat Exchanger Design Handbook (1st Edition ed.). CRC Press. ISBN 0-8247-9787-6.

2. Sadik Kakac and Hongtan Liu (March 2002). Heat Exchangers: Selection, Rating and Thermal Design (2nd Edition ed.). CRC Press. ISBN 0-8493-0902-6.

3. http://www.aavidthermalloy.com/technical/papers/pdfs/water.pdf

4. Incropera, F. P., and Dewitt, D. P., "Fundamentals of Heat and Mass Transfer," 3rd Edition, Wiley Publishing, pp. 496-502.

KEYWORDS: Cold Plate, Aperture, Power Amplifier, Transmit/ Receive, GaN, Thermal Management, Radar, EW

N112-140 TITLE: Atmospheric Aerosol Mitigation for High Energy Laser Propagation

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMS 405

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

OBJECTIVE: The principle objective of this effort should improve the overall optical transmission of directed energy (DE) systems operating in a maritime or equivalent environment.

DESCRIPTION: Optical transmission of High Energy Laser (HEL) systems in the Near Infra Red (NIR) optical bandwidth typically suffer from absorption and scattering losses due to water vapor content found in maritime environments. This results in reduced transmission efficiency between the source (laser) and the target (threat) which results in reduced range of defense for ship based systems. Current optical (electromagnetic) technologies exist which if employed in a novel manner may mitigate the absorption/scattering behavior of aerosol content within the beam path of the HEL thereby permitting engagement of targets (threats) at greater distances from platforms (ships). Previous attempts using the HEL beam to "burn" through maritime absorption/scattering environments have resulted with little success in optical transmission improvement due to thermal lensing of the HEL beam. The application of novel principles utilizing either continuous wave (CW) through ultra short pulse (USP) technologies or a combination of said technologies to mitigate the impact of aerosol laden beam paths is desired employing either current technologies or near term development of emerging technologies to achieve substantial improvement in NIR transmission of HEL beams in maritime environments.

PHASE I: Initial work should include model development of typical maritime aerosols and their impact on absorption and scattering at 1070 nm laser energy. The model should further incorporate HEL energy levels with average power of 100 kilowatts (KW) and energy densities of 1 KW/cm2. Techniques for mitigating absorption/scattering impact of aerosols identified in the proposal should be incorporated in the model and demonstrated theoretically as a proof of concept. Identify and design a test instrument for field testing the theoretical concept and mitigation strategy for reducing the impact of absorption and scattering on HEL 1070 nm radiation. The mitigation strategy should be able to handle a beam path that is dynamic; i.e., work in concert with a swept beam and one that has varying elevation angles.

PHASE II: During this phase a prototype system employing hardware and software elements will be completed and subsequently tested in a laboratory environment followed by subsequent testing in a maritime environment. The maritime environment should represent those which Navy vessels would encounter in littoral and open sea conditions with emphasis on high moisture laden atmospheric conditions. Validation of the device must be completed using representative HEL systems or equivalent thereof. Absorption and scattering losses due to water vapor/aerosol content in the beam path should be reduced by at least a factor of two (2) when tested in the wavelength regime of 1050 - 1080 nanometers. Both static testing and dynamic testing of the system will be used to determine the overall success of the technique employed for mitigation of absorption/scattering losses due to aerosols composed of water vapor.

PHASE III: During this phase the small business will oversee and manage the transition of this device to the field and coordinate the efforts with appropriate warfare technology centers such as the Naval Surface Warfare Center - Dahlgren Division. The small business will be responsible for implementing new technologies as they become available towards improved effectiveness of the capability. Device integration with HEL systems should be accomplished by coordinating the mission needs of the warfare center and the technology readiness of the device so as to marry the technologies together minimizing disruption in system advancement. Device production and integration with HEL systems will be driven by available power associated with the integrated HEL system, space requirements, and ship command and control systems. This technology should have value for all services particularly those that are planning to deploy and/or experiment with HEL systems thereby creating opportunity for diversified use within the defense and atmospheric studies community.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology should provide improved signal to noise ratios when employed with Lidar applications due to reduced optical transmission losses for probe wavelengths. In effect, sensing range of Lidar and similar devices should be extended and the resolving power of said devices should be increased as well. The ability to increase sensitivity related to atmospheric probing, be it through Lidar or related optical sensing capabilities, should directly impact the community and services which study environmental effects and impacts of in situ gases and chemistry not normally associated with local environments.

REFERENCES:
1. Handbook of Geophysics.

2. Clouds, Aerosol, and Precipitation in the Marine Boundary Layer - U.S. Department of Energy’s Atmospheric Radiation Measurement (ARM) Climate Research Facility.

3. High Power Laser Propagation - Gebhardt, F. G., Applied Optics, vol. 15, June 1976, p. 1479-1493.

KEYWORDS: laser; aerosol; absorption; scattering; near infrared; high energy laser

N112-141 TITLE: Advancing Performance Diagnostics to Support Decision Superiority

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: ACAT IV Battle Force Tactical Training

OBJECTIVE: Optimize cognitive performance diagnostic process. Advance instructor and performer in-the-loop machine learning capabilities to support cognitive performance complexities not served in current or planned instructor-led or fielded technology aids for training debriefings. Success will be measured by improved standardization in assessing cognitive performance measures and results (increased adaptive knowledge; increasew in situational recognition and assessment, self-knowledge leading to decrease in decision/judgement errors, improved learning curves to acquire expertise, improved training transfer).

DESCRIPTION: This innovative prototype effort will reorient the integrated performance diagnostic capability to improve and expand the debriefing heuristic. The research effort will establish approaches that extend existing debrief methods for cooperative systems to guide and support facilitator-led and metacognitive level self-assessment debriefs required for the cognitively dynamic and demanding environments. Group and individual performance diagnostics required for individual and team debriefs are presently one of the weakest areas of training, resulting in systemic lost opportunities for performance understanding, feedback and improvement which mirrors other domains [2]. The Navy's standards and metrics for used for unit and individual feedback are primarily focused on task completion and do not generally reflect required cognitive levels or interoperability requirements of performance [3]; therefore, debrief capability and transfer of learning is severely restricted.

While it is recognized that post-training exercise debriefs are the period where much learning can take place, all-too-often post-exercise debriefs fail to be conducted at all or fail to produce desired timely, accurate cognitive-level diagnostic feedback (e.g., interpreting the pattern of data to arrive at a conclusion) [4] or ultimately the desired behavior, skill, attitudinal modifications that support optimal performance. Reasons include failure to facilitate the session appropriately, lack of time, failure to stimulate the trainees to verbalize their experiences, as well as failure to have captured the most relevant variables at sufficient precision to infuse the training feedback/self-assessment with the appropriate level of cognitive and technical content. Training feedback is also problematic when based solely on human observations. Because observations can have a subjective basis, inter-rater reliability becomes an issue in maintaining standardization of evaluation and ability to track training trends. This is exactly the problem we are hoping to avoid; the machine learning approach helps in two ways here: (a) Since performance metrics designed at a gross level that does not provide accompanying cognitive diagnostics, it would be very useful for the crew and instructors to have some form of automated diagnosis backed up with concrete onscreen metrics to inform the performer (s) how close one is to an “optimal” action/decision and (b) with this difference measurement, the objective feedback can then inform people why it's working and not just that it is working.

Despite the computational advances of machine learning, their application is not without risk. The risks include: (a) Feeding the Model with Data; by their nature, machine learning models are very “data hungry,” requiring considerable amounts of input, particularly if the model contains a number of predictor variables. (b) Picking the right Model; selecting the right model entails a mix of trial-and-error and expert judgment. (c) Model Convergence and Degree of Fit; depending on the patterns in the data, it may take a given model thousands of iterations to achieve a final solution. Once achieved, the modeler must make a decision concerning the degree to which the best-fitting model has done an adequate job of predicting the outcome measures. There is no hard and fast rule in this area, so the modeler’s experience with previous machine learning environments will be crucial, (d) Updating the Model; requirements for model updating and re-running a given algorithm as new case data are obtained. Also, the modeler must be aware of the impact of new system input variables on his/her model and whether there is a viable need for refitting the data with a revised model.[5]

PHASE I: The research team will identify and create a framework of cohesive cognitive skills that underlie effective "real time" situational awareness and decision-making. These same sources of information will then be used to determine the diagnostic and debrief requirements most deficient in the present cadre of instructors, and in general, debriefing practices. Phase I will conclude with development of a feasibility concept design for the most promising metacognitive measures and diagnostic feedback for improving performance.

PHASE II: The outcome of this phase is the development or adaption of methodologies and technologies that support the most promising performance diagnostic and debriefing strategies identified in Phase I. The impacts of these metacognitive training interventions will be formally evaluated in a field setting, and the results will be used to fine-tune the recommended diagnostic models to advance positive training impacts. Plans for practical implementation of the interventions on a larger scale will be provided as part of the Phase II deliverable.

PHASE III: Training exercises will provide a realistic path to test, evaluate, certify and transition of adaptive and dynamic instructional processes that center on explanation-based learning with diagnostic models is needed to supplement and extend active transfer of learning to the Fleet for an improved training capability to better dynamically identify and support aligned metacognitive training and sustainment of proficiencies.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: While the training community is presently proficient at identifying performance deficiencies and even deficiencies in process, those doing the evaluating are frequently not as effective at identifying underlying performance issues and communicating identified cognitive weaknesses as they are at identifying the shortcomings in the first place. This applies across training environments and any performance assessment and improvement effort. A validated integrated training methodology and technology package with demonstrated ability to enhance training feedback through metacognitive performance diagnostics and debriefing has applicability across the Services and beyond. The need for better individual and team performance diagnostics and debriefs has been established in such diverse fields as commercial aviation, nuclear control rooms, emergency medical teams, and firefighting units. Virtually any industry for which situational awareness, decision making and/or interoperability coordination plays a major role will benefit from meta cognitive-focused improvements in training facilitation and diagnostic capabilities/feedback methodologies.

REFERENCES:
1. Sheppard, J. W. (1992). Explanation-Based learning with Diagnostic Models, ARINC Research Corporation, Annapolis, MD.

2. Dismukes, R., K., Jobe, K.K., & McDonnell, L.K. (1997). LOFT debriefings: An analysis of instructor techniques and crew participation. NASA Technical Memorandum 110442, Ames Research Center: Moffett Field.

3. Spiker, Alan (2009) Interviews with 101st Soldiers at Fort Campbell, Anacapa Sciences, Santa Barbara, CA.

4. Yamamori, H. & Mito, T. (1993). Keeping CRM is keeping the flight safe. In E.L. Wiener, B.G. Kanki, and R.L. Helmreich (Eds), Cockpit resource management. New York: Academic Press.

5. Weiss, S.M. & Zhang, T. (2003). Performance analysis and evaluation. In N. Ye (ed), The handbook of data mining. Mahway, NJ: LEA.

KEYWORDS: Metacognitive debriefing; explanation based learning; cognitive performance measures; instructional methodology; active transfer

N112-142 TITLE: Advanced Structural Development for Naval Hovercraft Ramps

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 377J, LCAC and SSC Programs

OBJECTIVE: To develop durable, lightweight bow and stern ramps that will improve payload lift capacity and reduce corrosion, weight, and life-cycle costs for LCAC or SSC.

DESCRIPTION: The Landing Craft Air Cushion (LCAC) vehicle, which is a Navy hovercraft, has welded aluminum bow and stern ramps to provide roll-through capability for loading and unloading equipment and personnel. The ramps are heavy and prone to damage due to the uniquely harsh environment in which the LCAC operates. This environment includes exposure to salt, sand, sediment, seawater spray as well as machinery oils from offloaded equipment.

This topic seeks innovative, advanced materials and structural concepts to provide a lightweight ramp alternative that is resistant to the environment challenges inherent in the operating arena while handling large loads up to 74.5 tons (149,000 lbs). Addressing these challenges will increase the ruggedness and durability of these ramps which in turn will reduce life-cycle and maintenance costs. A reduction in weight while maintaining the structural integrity will allow for an increase in the payload lift capacity of the vessel. The current ramps are hydraulically operated. The proposed design must be able to interface with the existing attachment points and pulley system. The proposed structure shall conform to current ramp size and stowage constraints. During technology development and fleet integration, testing will be conducted that will include functionality demonstrations and roll-on/roll-off trials of various Marine Corps vehicles including the Abrams M1A1 tank. This includes the most severe load case of a cantilever arrangement where the ramp is supported on only one corner. If successfully developed, proposed concepts could have application to the Ship to Shore Connector (SSC) Program.

PHASE I: Demonstrate the feasibility of the application of innovative, advanced materials and structural concepts to provide a lightweight ramp alternative that is resistant to the environment challenges inherent in the LCAC and SSC operating arena while handling large loads up to 74.5 tons (149,000 lbs). Establish performance goals and provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Develop, demonstrate and fabricate a prototype panel and subsection as identified in Phase I. In a laboratory environment, demonstrate that the prototype product meets the performance goals established during Phase I. Provide a detailed plan for hardware certification, validation, and method of implementation. Prepare cost estimates, logistics data packages, and interface documents for use in both forward fit and retrofit ship programs.

PHASE III: Utilizing the technology developed during Phase I and II, transition the prototype design into a production design, for procurement and possible implementation into the LCAC or SSC acquisition. As applicable, the small business will work with the Navy or Industry to transition the technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial ferries and cargo ships that load and unload vehicles and heavy equipment would benefit from the design and technology development of durable, lightweight ramps. Trucks which use ramps for loading, such as moving or delivery trucks, would also benefit from the durability and weight savings this technology could provide.

REFERENCES:
1. http://www.fas.org/man/dod-101/sys/ship/lcac.htm

2. (Deleted 5/19/11: Not available for public release at this time.)

3. Information from TPOC providing a summary of project goals, current ramp characteristics, technical issues, typical questions and answers, and other information to clarify SBIR Topic N112-142.

KEYWORDS: Landing Craft Air Cushion; LCAC; Lightweight; Advanced Materials; Cargo ramp; Ship to Shore Connector

N112-143 TITLE: Development of an Articulating Thermal Sensing Manikin System to Predict Burn Injury in a Flame-filled Environment

TECHNOLOGY AREAS: Materials/Processes, Human Systems

ACQUISITION PROGRAM: Defense Logistics Agency (DLA)/Navy Exchange Service Command (NEXCOM)

OBJECTIVE: To develop an articulating, thermal sensing full body manikin and associated variable speed traversing system for use in a full scale flame/thermal chamber. The resulting manikin system will be used to test personal protective ensembles under a wide array of flash fire scenarios producing burn injury prediction data and ultimately lead to enhanced protective garments for shipboard use and beyond. The manikin shall include the current complement of 123 sensors positioned throughout the body plus additional sensors to allow data collection from the head, hands, fingers and feet.

DESCRIPTION: The Navy Clothing and Textile Research Facility possesses a rigid manikin and a unique full scale fire testing chamber capable of replicating flame and thermal threats common to confined spaces such as compartment fires found aboard ship. However, recent information suggests that clothing protection is not fully characterized using existing rigid stationary manikins since stresses imparted to the fabric resulting from body movements (e.g. at the knees, elbows or across the back) are not captured and therefore offer an incomplete picture of protection to the body. Even with the best protective garments these stresses combined with a flame/thermal challenge contribute to fabric “break open”, exposing the skin and resulting in significant burn injury. By leveraging advancements in robotic technology we seek to develop a light weight, smoothly operating articulated manikin, capable of simulating sitting, standing, walking, jogging and running motions to simulate those stresses while withstanding repeated exposures (approximately 500 uses; each lasting for approximately 25 seconds, with a 30 minute reset time between uses) to high heat scenarios up to 3 cal/cm2/sec (126kw/m2) heat flux for up to 20 seconds. The resulting manikin shall have the ability to manually position the fingers and thumbs to facilitate the donning and doffing of gloves and to also incorporate data collection devices into both the palm and back of the hand, plus each finger. It is desired to have the hands, feet and head removable to facilitate donning and doffing of garments without having to cut and compromise garments. The manikin shall also possess a totally free range of motion in the arms and legs to facilitate donning and doffing of clothing. The resulting prototype manikin shall utilize commercially available components to the fullest extent. The prototype shall replicate a full sized human, with a target size of 40 medium regular. The articulated mechanism shall be capable of repeated removal and installation (if necessary) without failure to the manikin or the mechanism. Internal articulating mechanisms shall not interfere with other components such as thermal sensors, thermocouples and associated connections. The completed prototype manikin shall be designed to minimize weight with a target weight of not to exceed 75 pounds and to facilitate rapid donning and doffing of garments without compromising the durability of the manikin or its components, and shall include a power cable (if necessary) capable of repeated use in the same operating conditions as the manikin. The completed manikin shall be designed with remote data acquisition capabilities and with remote on/off switch capability.

Potential approaches for articulating the manikin and conveying it through the chamber could include the use of pneumatic, hydraulic, cabled, geared, belt driven concepts, but other creative solutions shall be explored to achieve the goals of the project. Alternative concepts are encouraged which would optimally result in a free standing untethered manikin so as not to be encumbered by the existing traversing system and data collection cabling.

PHASE I: Conceptualize multiple design approaches and establish a hierarchy of considerations balanced against technological limitations. The two best candidate solutions will be selected from the analysis. Best candidate concepts will be fabricated into a pre-prototype demonstration model and/or demonstrated via comprehensive computer aided design modeling taking all requirements into account. Design limitations shall be identified and sound engineering solutions presented for incorporation into the best candidate leading to Phase II development.

PHASE II: Based upon the success demonstrated in Phase I, a fully functioning articulated manikin system capable of data collection in the operating environment shall be manufactured and delivered. The developer will support the testing and evaluation of the manikin’s ability to replicate human motion and to repeatedly collect accurate data without evidence of degradation to the manikin, components or its mechanism. Deliverables will include the manikin, associated drawings, identification of all materials and components including consumable items necessary for repair or replacement, if applicable to the design.

PHASE III: A fully functioning and validated articulated manikin resulting from Phase II is expected to transform the current state of the art for the assessment of flame retardant garment systems and will ultimately impact personnel protection. During Phase III, and in conjunction with the industry partner, final testing to prove the manikin’s ability to yield high fidelity data as well as to determine the system’s equivalence to established test protocols is expected. Also, it is imperative that studies in the flame filled chamber will be conducted to validate compatibility with existing data collection hardware and software thereby assuring the proper functioning of the entire system prior to pursuing interest from an acknowledged International Standards organization.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In addition to Naval personnel, all military users, first responders, academia and the private sector will benefit from this initiative. Given the existing threat levels worldwide, user communities as well as research and development organizations are interested in the evolution of flame retardant materials and rely upon accurate methods to quantify protection, and as a result, realistic methodologies to characterize protection at the system level such as this are highly desired.

REFERENCES:

1. ASTM F1930 Standard Test Method for Evaluation of Flame Resistance Clothing for Protection against Flash Fire Simulations Using an Instrumented Manikin, Volume 11.03 ASTM

2. (Reference removed because it is not publicly available at this time.)

3: Additional Weblinks from TPOC for Topic N112-143 (posted in SITIS 5/25/11).
http://www.wpi.edu/Pubs/ETD/Available/etd-0625102-153152/unrestricted/Fay.pdf
http://www.wpi.edu/Pubs/ETD/Available/etd-0427103-233516/unrestricted/awoodward.pdf
http://www.wpi.edu/Pubs/ETD/Available/etd-0503104-154856/unrestricted/JSipeThesis.pdf

KEYWORDS: Articulating manikin; instrumented manikin; traversing manikin; flash fire testing; burn injury predictions; personal protection ensemble

N112-144 TITLE: Low-Drag Infrared Dome

TECHNOLOGY AREAS: Materials/Processes, Weapons

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OBJECTIVE: Produce a precisely figured, polished, ogive-shaped, infrared-transmitting dome from a durable optical material.

DESCRIPTION: Future high-speed missiles require aerodynamic infrared domes that reduce drag and have greater ability to withstand aerothermal heating. By exchanging a conventional hemispheric dome for a pointed dome, drag is reduced and aero heating is reduced on most of the surface of the dome. Decreased drag enables a combination of increased speed, range, and payload. The aerodynamic shape also increases the ability of the dome to fly through rain and particles in the atmosphere without damage.

In the past, infrared domes have had a hemispheric shape because this shape introduces minimal optical distortion and is easy to fabricate. The DARPA Conformal Optics program completed in 2000 demonstrated methods to correct distortions introduced by aerodynamic shapes. Several NAVAIR SBIR topics advanced the state of the art in fabrication and metrology of ogive domes made of infrared-transparent, polycrystalline alumina. To this point, aerodynamic domes meeting optical tolerances have not been produced.

This new SBIR topic builds on previous efforts and will produce optically precise, ogive-shaped domes from polycrystalline alumina or other durable materials. The dome will have an approximate tangent ogive shape with a base diameter near 125 mm, a height near 175 mm, and a wall thickness near 3 mm. Drawings will be provided by the Government during the contract. The desired root-mean-square transmitted wavefront error is less than one third of an optical wavelength measured at 0.633 mm. It is expected that contractors will consider using magnetorheological finishing techniques for final finishing. The tip of the ceramic dome will eventually be replaced by a more durable material and need not be optically finished. The ceramic dome material might be polycrystalline alumina or another hard ceramic selected in consultation with the Government.

Proposals may address all the requirements of this solicitation or may address individual aspects of grinding, polishing, final finishing, and metrology of domes.

PHASE I: Use the best available metrology and best available finishing methods to produce a precisely figured ogive dome made of BK7 glass or other material selected in consultation with the Government. A dome drawing will be provided by the Government at the beginning of the contract. The purpose of Phase I is to demonstrate the contractor’s capability for precise fabrication and to identify areas that need the most work in Phase II.

PHASE II: In year 1, produce a BK7 glass or ceramic ogive dome with a root-mean-square transmitted wavefront error less than one half of an optical wavelength measured at 0.633 mm. Refine the methods in year 2 to produce a dome with a root-mean-square transmitted wavefront error less than one third of an optical wavelength measured at 0.633 mm.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Methods for grinding, polishing, and measuring non-hemispheric shapes can be applied to aspheric lenses that simplify the design of a wide variety of optical products.

REFERENCES:
1. M. V. Parish and M. R. Pascucci, "Polycrystalline Alumina for Aerodynamic IR Domes and Windows," Proc. SPIE 2009, Volume 7302, p 730205.

2. W. P. Kuhn, M. B. Dubin, R. S. LeCompte, and H. P. Durazo "Measurement Results for Time-Delayed Source Interferometers for Windows, Hemispheric Domes, and Tangent Ogives," Proc. SPIE 2009, Volume 7302, p 73020R.

3. S. DeFisher, M. Bechtold, D. Mohring, ands. Bambrick "An InnovativeNon-ContactMeasurement Solution for Asphere, Deep Parabolic, and Ogive Radome Geometries," Proc. SPIE 2009, Volume 7302, 73020S.

4. D. W. Diehl, C. J. Dichman, and C. T. Cotton, "Low-Coherence Surface Metrology Using a Multiple-Beam Optical Probe," Proc. SPIE 2009, Volume 7302, p 73020T.

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6. B. Hallock and A. B. Shorey, "Technologies for Precision Manufacture of Current and Future Windows and Domes," Proc. SPIE 2009, Volume 7302, p 7302V.

KEYWORDS: infrared dome; ogive dome; missile dome; optical finishing; optical metrology; metrology

N112-145 TITLE: Infrared-Transparent, Electrically Conductive Coating

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

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

OBJECTIVE: Demonstrate an infrared-transparent, electrically conductive coating for electromagnetic shielding of sensor windows and domes. Transmission should be at least 90% in the 3-5 micron wavelength region. Sheet resistance should be less than 10 ohms per square. The coating must be chemically stable in the atmosphere and in sunlight. It is desirable that the coating be able to operate at temperatures of at least 600C and be resistant to erosion by rain and solid particles in the atmosphere.

DESCRIPTION: Electromagnetic shielding of electro-optic sensor electronics in military systems is currently provided by electrically conductive metal grids applied to the sensor window or dome. Grids provide excellent electrical shielding, but compromise the optical system through geometric blockage, diffraction, and undesired reflection of light. In addition, grids are difficult to deposit on curved shapes. Grids are poorly resistant to erosion damage by rain and particle impact on the external surface of a window or dome. A continuous thin-film coating that has both electrical conductivity and optical transparency could provide adequate electromagnetic shielding and superior optical performance. The conductive layer must be part of an anti-reflection stack of layers to maximize optical transmission. For external coatings, the outer layers of the anti-reflection stack must also provide erosion resistance.

Physics draws a fine line between electrical conductivity and infrared transparency of a continuous thin-film coating. Increasing electrical carrier mobility while decreasing carrier concentrations provides the possibility of obtaining adequate electrical conductivity while pushing optical absorption to the longest possible wavelengths. Increased effective mass of the charge carriers in p-type semiconductors also increases the wavelength for the onset of infrared absorption.

PHASE I: Demonstrate an infrared-transparent, electrically conductive coating with strong potential to achieve less than 10% absorption in the 3-5 micron wavelength region and a sheet resistance less than 10 ohms per square. The coating should be deposited on 25-mm-diameter disks of an infrared-transparent substrate such as spinel to allow infrared optical properties to be measured.

PHASE II: Optimize the coating for minimum optical absorption and maximum electrical conductivity. Design and demonstrate an anti-reflection layer structure to provide >90% transmittance in the 3-5 micron wavelength region. If possible, incorporate hard layers in the anti-reflection stack to provide erosion resistance. Conduct sand and rain erosion testing of the coating if it is designed to be on an external surface. Demonstrate stability of the coating in the atmosphere and in sunlight.

PHASE III: Demonstrate commercial production capability for coating windows and domes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Optically transparent, electrically conductive coatings could become components of photovoltaic cells.

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3. F. A. Benko and F.P. Koffyberg, "Opto-electronic Properties of p- and n- Type Delafossite CuFeO2," J. Phys. Chem. Solids 1987Volume 48, p. 431.

4. M. Joseph, H. Tabata, and J. Kawai, J. "p-Type Electrical Conduction in ZnO Thin Films by Ga and N Codoping," Jpn. J. Appl. Phys. Part 2: Lett.1999, Volume 38, p. L1205.

KEYWORDS: conductive optical coating; optical coating; electrically conductive coating; coating; sensor window

N112-146 TITLE: Fabrication of Corrective Optics for Aerodynamic Domes

TECHNOLOGY AREAS: Materials/Processes, Weapons

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

OBJECTIVE: Demonstrate the grinding, polishing, final finishing, and metrology of corrective infrared-transmitting optics for use with aerodynamic domes such as a tangent ogive.

DESCRIPTION: Infrared-transmitting domes with a shape such as a tangent ogive have the potential to reduce the drag of a missile. Decreased drag enables a combination of increased speed, range, and payload. An aerodynamic dome shape distorts the image of a scene viewed through the dome. It is envisioned that refractive corrector elements will be required between the dome and an infrared imaging seeker.

A corrector element for a tangent ogive dome could be a bilaterally symmetric arch with aspheric terms. Candidate materials include Cleartran® zinc sulfide, spinel, and chalcogenide glasses. For an ogive dome with a base diameter of 125 mm and a height of 175 mm, the arch might have a base dimension of approximately 100 mm and a height of 125 mm. Correctors can be modeled with splines, conics, even and odd ordered polynomial aspheres, superconic, Zernike polynomials, anamorphic aspheres, and toroids. Fabrication challenges include the need to transfer a design representation into a form that a computer numerically controlled machine can accurately create, and the need to grind, polish, and measure the physical form.

Designs for correctors to be fabricated will be provided by the Government at the time of contract awards. Proposals may address all the requirements of this solicitation or may address individual aspects of grinding, polishing, final finishing, and metrology of domes.

PHASE I: Demonstrate techniques of grinding, polishing, final finishing, and measuring a corrector element. Techniques should ultimately apply to a full arch, but, in Phase I, work may be done on a half arch terminated at the vertex of the arch. A material such as glass or fused silica with dimensions on the order of 50 x 125 mm would be suitable for this demonstration. A goal for optical figure is 0.5 wavelength peak-to-valley deviation at 633 nm over the entire clear aperture of the part. Plan a clear path to fabricate a full arch in Phase II.

PHASE II: Demonstrate grinding, polishing, final finishing and metrology of full-size corrector arches with designs provided by the Government. Steps should lead from glass or fused silica to infrared-transparent materials such as Cleartran®, spinel, or chalcogenide glass. The final optical figure should be within 0.5 wavelength peak-to-valley deviation at 633 nm over the entire clear aperture of the part.

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

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

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1. P. A. Trotta, “Precision Conformal Optics Technology Program,” Proc. SPIE 2001, Volume 4375, p. 96

2. D. J. Knapp, J.P. Mills, R. G. Hegg, P. A. Trotta, and C. B. Smith, “Conformal Optics Risk Reduction Demonstration,” Proc. SPIE 2001, Volume 4375, p. 154.

KEYWORDS: corrector optics; optical fabrication; metrology; optical finishing; aerodynamic dome; infrared imager

N112-147 TITLE: <u>Person-Portable Micro-Hydropower System</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: OASN(EI&E) - Energy (Non-ACAT)

OBJECTIVE: Develop a person-portable micro-hydropower system to provide electrical power in support of humanitarian assistance and disaster relief operations, as well as provide power for remote locations and forward operating bases.

DESCRIPTION: Humanitarian assistance and disaster relief (HADR) operations, forward operating bases, and remote camps and communities require electrical power. The use of traditional petroleum fueled generator in these sistuations is often problematic due to costly or limited fuel availability. Where flowing water (rivers, streams, creeks, etc) is available, hydropower provides a simple, cost-effective, sustainable energy solution. While the technology exists to provide small, hydropower systems for use in civil and military applications, complete systems are not necessarily optimized for easy transport, setup, and use in remote locations. Therefore, this topic seeks innovative micro-hypower designs and technologies that possess the following characteristics: (1) person-portable tansportable as component modules in packages weighing no more than 80 pounds; (2) rapid setup (<1 day, 1 man) of components and complete hydropower system using manual tools; (3) effective operation in widest range of water flow categories; (4) maintenance-free operation regardless of water-borne debris and variation in water flow; (5)minimal environmental impact on water source and associated lands; and (6) minimal capital and operational costs. The system should be capable of providing a minimum of 500W of continuous electric power, peak system power up to 10kW (<60 seconds), and sustained power of 2kW for up to two hours. Power output could be direct current (DC) or alternating current (AC) conditioned to power off-grid equipment of facilities, or be connected into a micro-grid. The system should contain all the parts and assemblies required to construct and operate the micro-hydropower systems, to include all electrical and water handling components needed to handle water inlet and outlet flows. A methodology to determine whether the flow and/or head requirements are present in any particular application is required. The methodology must be easy to use in the field in a remote location.

PHASE I: Design a person-portable micro-hydropower system. Develop a methodology for determining whether the sufficient head and/or flow is available to meet the system's requirements, and incorporate this into a dynamic system computer model to predict overall system performance under various water flow/head conditions. Demonstrate innovative technological improvements in system assembly, weight reduction, or component operation in a laboratory environment.

PHASE II: Develop a complete person-portable micro-hydropower system and demonstrate the complete system in a realistic environment. Conduct testing to provde feasibility over extended operating conditions, including varying flow/head conditions. Using measured data, determine the overall system and sub-system efficiencies and validate the dynamic computer model. Prepare a system analysis with recommended improvements.

PHASE III: Develop and install a complete person-portable micro-hydropower system package for use in a remote access location.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system would have application to both remote civilian and military off-frid applications where flowing water is present. It would be used in humanitarian assistance and disaster relief operations by non-governmental organizations, military, and civilian governments.

REFERENCES:
1. http://hydropower.inel.gov/hydrofacts/index.shtml

2. http://www.hydro.org/hydrofacts//factsheets.php

3. http://www.eere.energy.gov/basics/renewable_energy/hydropower_resources.html

4. http://www.builditsolar.com/projects/hydro/canadamicrohydroguide.pdf

KEYWORDS: hydropower: hydro-electricity; hydro-turbines; penstock; flume; flow-rate

N112-148 TITLE: Versatile Shallow Water Anchoring/ Securing Technology

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Seabase FNC

OBJECTIVE: Develop an automated system for shallow water anchoring/ securing suitable for use in all bottom conditions encountered by U.S. Navy (USN) craft. Furthermore, it is desirable that one system meet the requirements of all anchoring and securing needs rather than requiring a ship or craft to carry multiple anchoring/ securing systems to meet the varying bottom conditions. It is also desirable that the proposed solution works with the shortest possible scope of anchor line.

DESCRIPTION: Anchoring a large structure such as a floating pier along a shoreline is a time consuming and labor intensive procedure. Training and experience is required for personnel to anticipate a dangerous anchoring situation. Failure of anchoring hardware or failure on the part of the crew to exercise the proper judgment to avoid such a situation usually results in a costly property and life threatening incident. This is particularly true in shallow water conditions near shore. Therefore, an innovative solution is needed to develop a semi-autonomous or even fully autonomous anchoring system that:
- reduces the number of personnel required in the anchoring process,
- reduces the number of bottom-condition-specific components,
- reduces the amount of training required for those involved in the anchoring process and,
- removes the liklihood of error while at the same time speeds the process of anchoring and securing.

The current state of the art for automated mooring systems deals more with vessel mooring to a pier rather than anchoring.

Shallow water anchoring and securing systems have evolved very little over the past century, with developments often involving modifications of the shapes of previously-known anchors. The basic features of modern anchors have been in use for over 2,000 years. As such, most systems involve a large weight with some configuration of one or more flukes, hooks and cups. Common types of modern anchors used in shallow water environments include the stockless, the lightweight and the mushroom. Each of these types of anchors is generally preferred over the other types based on the bottom conditions. For example, the fluted anchors are preferred for hard bottom conditions, such as rock and coral, whereas the mushroom anchor is preferred for use in soft bottom conditions, such as sand, silt or mud. Smaller vessels that may encounter both hard and soft bottom conditions must carry two or more types of anchor devices. Use of an improper anchor may result in failure to secure the vessel in place, resulting in significant risk to the vessel and its crew. Additionally, environmental damage, such as to coral, may also occur as a result of anchoring when the large weight of the anchor impacts the coral or other waterborne natural formations. The ecological impact of the proposed automated or semi-automated system (s) shall be minimal.

In recent years, a number of different types of materials, compounds, and compositions of matter have been developed, many of which have found applications in fields other than anchoring technology but could provide a significant technological advantage in anchoring technology.

To achieve semi-autonomous or fully autonomous anchoring capability, the proposer is encouraged to make use of developments in robotics as well as other technologies that potentially may be applied to anchoring. Both sensing technology to assist in the characterization of the bottom condition and to select the placement of anchors as well as remote actuation technologies to set the system in place with minimal involvement of personnel are seen as enablers for anchoring system automation and to achieve the desired result of an anchoring technology suitable for use in both soft and hard bottom conditions. Part of the function of the automated system shall be to assess the wave and current conditions to determine the number of anchors and relative positioning required to safely anchor a selected vessel or structure in the environment.

Besides automation, proposers can explore non-traditional anchoring mechanisms such as a bio-mimetic surface adhesion approach.

Key factors to be addressed include degree of automation and methods proposed, environmental damage, need for multiple anchors, material weight, deployment and retrieval time, deployment and retrieval system complexity (chain, cable etc.), compatibility with shortened scope configurations, maintainability and cost. The desired solution should provide increased versatility of the anchoring or securing device while reducing the personnel and labor-hours required as well as the other disadvantages of historical anchors.

PHASE I: Develop an innovative concept for semi-automated or fully automated shallow water anchoring technology and assess feasibility of the concept in terms of holding strength, deployability, retrievability, endurance, longevity, and environmental impact.

PHASE II: Establish performance parameters through experiments and prototype fabrication of anchor/ securing technologies. The proposer should provide "technology off-ramps" where valuable concepts could proceed into full developments even though the primary, overall concept is not successful or desirable for some reason.

PHASE III: Demonstrate anchor/ securing technologies in an operational environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Applicable to private and commercial vessels and near-shore facilities.

REFERENCES:
1. Standard Safety (2008). Anchoring, Special Edition, downloaded 13 November 2010 at: http://www.standard-club.com/docs/StandardSafety-Oct08.pdf

2. European Patent EP1-873-052-B1 entitled Automatic Mooring System, downloaded 13 November 2010 at: http://www.freepatentsonline.com/EP1873052.html

3. Northwestern University (2007). Synthetic Adhesive Mimics Sticking Powers Of Gecko And Mussel. Science Daily, 18 July 2007, downloaded 13 November 2010 at: http://www.sciencedaily.com/releases/2007/07/070718140750.htm

4. U.S. Commission on Ocean Policy (2004). An Ocean Blueprint for the 21st Century - Final Report of the U.S. Commission on Ocean Policy. Chapter 21, PRESERVING CORAL REEFS AND OTHER CORAL COMMUNITIES, 20 September 2004, downloaded 13 November 2010 at: http://www.oceancommission.gov/documents/full_color_rpt/welcome.html

5. Cutler, T. (2002). The Bluejacket's manual, United States Naval Institute, Naval Institute Press, Annapolis, MD, pp. 314 and 424

KEYWORDS: Automtion;Anchor; Bottom conditions; Shallow water; Mooring; Floating Structures

N112-149 TITLE: Advanced Carbon Nanotube Forms for Composite Structural Applications

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: None

OBJECTIVE: To develop new carbon nanotube structural products that are amenable for seamless integration with existing structural composites manufacturing methods and that will provide significant increases in through thickness strength of laminated composite structures. The ultimate goal is to enhance the performance and endurance of structural composites by introducing small amounts of CNTs in to critical areas, with relative ease and minimal cost impact.

DESCRIPTION: By now it has been amply demonstrated that carbon nanotubes (CNTs) can produce polymer (epoxy, vinyl ester and others) nano-composite materials with mechanical properties (in-plane and out-of-plane) that are significantly better than those of the best aerospace grade carbon fiber reinforced material, albeit at relative small sizes due to the large CNT cost when used at high concentrations. On the other extreme, very small concentrations of CNTs, acting as a secondary reinforcement phase and placed at the appropriate location, have been shown to significantly enhance some of the mechanical properties of structural composites with a minimum cost impact. This topic seeks to develop new cost effective CNT forms (for example pre-preg tapes, pre-preg mats, sprays, or other advanced concepts) that can be applied to well defined hot spots and are amenable with existing PMC manufacturing processes. The intent is not to apply these new forms throughout the entire composite structure, but only in localized areas that could benefit from additional out of plane reinforcement such as around fastener holes, ply drop-offs and other mentioned previously.

Special interest will be placed on those teams that can manufacture and process CNTs since it is well know that the best performance of these materials is achieved when the quality of the CNT is appropriately controlled (such as number of CNT walls, the number of defects on the surface of the CNT, the length of the CNTs, functionalization of the CNTs, resin compatibility, dispersion of the CNTs and other properties).

PHASE I: Develop at least one new carbon nanotubes (CNT) form. Demonstrate how it is applied during a manufacturing trial and characterize its structural performance under an open hole compression test (OHC). Optimize the CNT form (CNTs length, form thickness, length and width, processing parameters and other form parameters) in terms of OHC strength and/or interlaminar shear strength.

PHASE II: Expand on that CNT form to include other sizes and configurations. Investigate scale-up options and start developing manufacturing and commercialization plans. In coordination with Navy engineers, a target demonstration application will be identified and executed.

PHASE III: In coordination with Navy engineers, a target demonstration will be performed on a representative structural article and resulting test data evaluated to a baseline configuration. The manufacturing processes also will be further optimized.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial aviation and shipping industry would benefit significantly from a product of this nature as well. The same problems are experienced in our Naval platforms (ships, subs and aircraft) also occur in commercial counterparts. For example, impact related delaminations, dis-bonds, fastener hole damage, and heat/moisture induced delaminations are common to all In Service composite structures.

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2. "Joining prepreg composite interfaces with aligned carbon nanotubes", Enrique J. Garcia, Brian L. Wardle*, A. John Hart; Composites: Part A 39 (2008) 1065-1070

3. "Functionalization of Carbon Nanotube Buckypaper for High-Performance Composites Applications," Jianwen Bao, Qunfeng Cheng, Xianping Wang, Richard Liang, Chuck Zhang, Ben Wang, High Performance Material Institute (HPMI), Department of Industrial and Manufacturing Engineering.

KEYWORDS: Carbon Nanotubes, CNT, Composite Materials, Composite Patches, Peel strength, interlaminar shear strength

N112-150 TITLE: Through the Sensor Active Sonar Enhancement

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PEO IWS Surface Advanced Capability Build (ACB)

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OBJECTIVE: To develop robust and efficient techniques which utilize in situ sonar data to estimate parameters that effect temporal changes in the local range- and depth-dependent probability of detection versus probability of false alarm (PD/PFA) for improved performance prediction and potentially target recognition in active sonar systems.

DESCRIPTION: Mid-frequency (MF) active sonar performance prediction accuracy depends critically on the estimate of the range-dependent sound speed profile (SSP) and a variety of often unpredictable sources of reverberation and clutter. Through visual analysis and integration of sonar returns, trained operators and analysts are able to infer qualitative changes in reverberation, clutter, and the SSP and estimate the impacts on PD/PFA. Rapid automated quantification of these changes that could be folded back into sonar performance predications would support enhanced tactical decisions and could also support estimates of the temporal coherence and uncertainty associated with the predictions. Ideally, the automated analysis products would also serve to improve the recognition differential of the operators.

PHASE I: Utilizing unclassified mono-static and bi-static sonar data provided under the PH I contract, analyze and develop techniques to be used to estimate key parameters in sonar performance prediction for the given data and propose concepts for extending the methods to a wider variety of systems and scenarios. The effort may include model-based trials and development in addition to the data analysis.

PHASE II: Expand testing to include operational sonar data and conduct proof-of-concept demonstrations and tests of methods developed under the PH I program. Refine the methodology, develop metrics, and complete system verification and validation demonstration and testing. Develop a system employment concept of operations. SECRET clearance will be required for Phase II.

PHASE III: Deploy the prototype parameter estimation system on a Navy operational platform, support the at-sea testing, identify operational constraints and obtain end user feedback which can be used to improve the overall tool prior to transition under the ACB process. SECRET clearance will be required for Phase III.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Direct system application is limited, but the concepts may be leveraged to enhance other efforts that rely on sound propagation in the ocean: the commercial fishery, oil and gas exploration (seismic), and marine construction industries. In many cases environmental compliance and determination of risk to protected marine mammals from their activities is necessary, and ncreasingly these endeavors will have to rely on active sonar systems to monitor the area for marine mamnals in order to effectively employ mitigation measures (e.g. cease operations when marine mammals enter an exlcusion zone).

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[3] Backus, G. E., and J. F. Gilbert, Numerical Applications of a Formalism for Geophysical Inverse Problems, Geophys. J. R. Astron. Soc., 13, 247–276, 1967.

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[5] Taroudakis, M.I. and Makrakis, G.N. Editors, Inverse Problems in Underwater Acoustics, Springer-Verlag, 2001

[6] Sambridge, M. and Mosegaard, K., Monte Carlo Methods in Geophysical Inverse Problems, Reviews of Geophysics, 40, 3, September 2002.

KEYWORDS: Sonar, Acoustic Performance Prediction, Estimation, Inversion, Simulation, Acoustical Oceanography

N112-151 TITLE: Multifunctional Laser Systems for Ultracold Matter Applications

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

ACQUISITION PROGRAM: PMA264 Advanced Avionics Development P-3

OBJECTIVE: The attainment of Bose-Einstein condensation (BEC) in experimental physics laboratories in 1995 heralded a new era in ultracold atomic physics, which has led to laboratory-scale demonstrations of new frequency standards and sensors of transformational sensitivity. A critical step on the path to BEC was the emergence in the 1980s of semiconductor diode lasers, which greatly simplified the number and operational complexity of lasers needed for the many steps of cooling, initialization and readout of atoms. Transition of this laboratory science to Naval applications today requires (1) shrinking the ultracold atomic physics package and (2) reducing again the operational complexity of the associated laser systems. The first of these objectives is being addressed by a previous SBIR topic that is now in Phase II. The second is the subject of this topic.

The broad goal of this topic is to reduce the barriers to entry of scientists and engineers into the study of ultracold matter, thus facilitating the wide-ranging practical experimentation needed to transition ultracold science to Naval applications. In weighing the relative merits of particular approaches, proposers should consider which of them best address this goal. The particular objective of this topic is the development of a single laser module, with a compact power supply and control electronics, which can perform all of the laser functions required to cool and condense a gas vapor from initial ambient conditions down into the quantum degenerate regime (typically colder than 100 nanokelvin at a density of 10^13 atoms/cc, depending on the gas).

DESCRIPTION: To do this, existing laboratory laser systems for ultracold matter typically need to provide light at some 10 different wavelengths to a gas cell, during a cooling cycle that takes about the same number of discrete operations over a period of 0.1 to 1 second. The single module that we envisage would be able to cool at least one species according to a standard protocol, would fit into a standard 19” rack, including all power and control electronics. It would provide essentially a plug-and-play laser source for anyone who has an ultracold atom physics package (e.g. atomic oven, vacuum cell and electromagnetic trap).

The module should provide light suitable for an atomic species that has already been cooled to quantum degeneracy in some laboratory, e.g. Li, Na, K, Rb, Cs, Ca, Sr, Cr, Er, Yb, metastable noble gases, etc. This list is not exhaustive, and will grow in time. The specific subject species must be identified and details must be given of the actual laser cooling cycle that would be implemented. It would be an advantage for proposals to identify existing or emblematic physics packages with which the module could be used, with wider applicability is highly desired. For the same general functionality, reviewers will consider smaller footprint, lower power consumption, and simpler user interface as discriminators.
Overall, proposals should describe a path to ease-of-use ultracold matter systems that can be deployed outside advanced atomic physics laboratories. System reliability and projected cost of ownership will be considered in scoring.

PHASE I: Design of a multifunctional laser system consistent with the broad program goal stated above. Design to include detailed description of a laser cooling cycle with discussion of particular system functions needed to implement it. Delivery of engineering drawings and parts list for first Phase II prototype. Additional discriminators include: actual demonstration of laser cooling cycle using an existing system; innovative laser cooling schemes, if documented; choice of an atomic species that is particularly well suited to a prospective Naval application, if documented.

PHASE II: Construction of the prototype described in Phase I; testing of the prototype against specifications; validation of the prototype in an actual cooling cycle that leads to quantum degeneracy; construction of additional prototype models, as necessary, to hit performance targets or to reduce footprint, power consumption, cost, etc. Development of manufacturing, marketing and pricing plan for Production Model to be made available in Phase III. Construction of first Production Model.

PHASE III: Seeding of a few key research laboratories with Production Models, followed by marketing and sale of devices to customers in DoD laboratories and development activities, the defense electronics industry, government and industrial laboratories, and academia.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The device would have uses in scientific research and education, as a training tool for laser applications and experiments. The laser and scientific instrument industries are potential beneficiaries of this topic.

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KEYWORDS: Laser; laser cooling; ultracold; atomic clock; Bose-Einstein condensation; quantum gas

N112-152 TITLE: <u>Context-Specific Dynamic Collaborative Information Analysis</u>

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The objective of this topic is to empower analysts working on complex intelligence tasks by dynamically forming collaborative research groups of individuals who are currently investigating similar issues, while requiring minimal or no direct input from each analyst with respect to the goals of their current mission. To this end, the goal of this topic is to develop technologies and a tool that allow each analyst to, not only, explore information in a huge database of documents, but also suggest other analysts who may provide key insights for the task at hand.

DESCRIPTION: In recent years, the web has experienced a huge increase in the number of webpages, blog posts, tweets and other information sources published daily, forcing users to cope with information overload. The task of guiding users through this flood of information has thus become critical. The DoD is also faced with similar information overload challenges: an intelligence analyst must wade through huge amounts of possible documents, both from classified sources and from the web. The main tool at the analyst's disposal, namely keyword search, provides little help when the number of matching documents is huge, or when the most relevant search terms are unclear.

To address this problem, the first step of this topic is to provide a general technology and tool for addressing such information overload challenges on any huge collection of documents. The modes of search interaction must go beyond simple keyword matching technology toward a more semantic understanding of language, allowing for a richer description of the analyst's information needs through, for example, analysts inputting specific documents related to their search goals and rating responses in an interactive fashion. Through the use of machine learning techniques, the proposed technology should learn the goals of the analyst's current task and improve the quality of the responses to the current context.

Often analysts will repeat significant work performed by other analysts, or miss key insights that are available to analysts working on related tasks. If analysts with similar goals could be connected together, we could achieve a transformative improvement in productivity and quality of the final product. Unfortunately, only very few individuals, e.g., those managing a group of analysts, may know enough about the current and past tasks of each individual to form these connections, significantly decreasing the potential for this successful synergy.

In this topic, we also seek technologies and a tool to effectively connect analysts working on related tasks or those who could provide new insights to an analyst's current task. Although a natural approach would be for each analyst to provide a detailed description of their current task, this process has the potential of being so burdensome to the individual that the tool would not be used effectively. Instead, the goal is to form these research groups solely based on each individual's interaction of the proposed search tool, and perhaps other small elements of information, such as chats between analysts and microblogs (tweets) of free text about their current goals and objectives.

A major challenge that should be addressed in this topic is scalability. The tool and methodology should progressively scale to an environment that, by the completion of Phase III, can involve hundreds of analysts research millions of documents in an interactive fashion.

PHASE I: Develop a detailed technical plan and architecture for a tool that individual analysts can effectively use to search through a large document database that goes beyond keyword search. Demonstrate the viability of this approach in a database with ten thousand documents. Based on this tool, demonstrate the ability to connect multiple analysts who are working on similar topics based only on their usage of the tool.

PHASE II: Develop a tool for individual analysts to explore a database of hundreds of thousands of documents. This tool must enable a description of the analyst's information needs that goes beyond the typical keyword matching or database query, improving the performance on their task through interaction. Based on this tool, provide and demonstrate a technology that connects tens of analysts who can simultaneously use the tool. Through its use, the system should connect analysts who can collaborate or provide key insights to the task at hand, in the user's current context. This tool should be able to exploit not only the database of documents and a user's current usage, but the analyst's previous usage history and their communications through chats.

PHASE III: Extend the scale of the technology to where hundreds of analysts examining millions of documents can use the tool at the same time. The technologies and products developed under this topic will have applications in intelligence analysis, law enforcement, and security. In particular, the approach will significantly decrease "missed opportunities" for "connecting the dots" in complex intelligence tasks in the Navy and DoD at large.

PHASE III DUAL USE APPLICATIONS: Applications of the developed tools also have significant potential impact in social networking, providing a new way to dynamically connect users, and in novel methodologies for searching information on the web.

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KEYWORDS: Huge databases of documents, learning queries, discovering collaborative groups, link mining.

N112-153 TITLE: Manufacturing of Stress Physical Scale Models (SPSMs) for Signature Reduction and Resistance to Environmental Stress

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Develop a low cost capability to manufacture physical scale models of Navy vessels that are dimensionally accurate, have electromagnetic signatures representative of the full-scale model, and react magnetically exhibiting magnetization change and hysteresis behavior properties to physically applied (environmental) stress forces as would a full-scale vessel.

DESCRIPTION: Typical scale models of ships and submarines focus on the aesthetic quality of the model and the rough scale of their major exterior features. However, scale models are crucial in the early stages of design and analysis of ship features and characteristics well before beginning production of the actual vessel. Physical scale models (PSMs) are made to be dimensionally accurate and represent the physical signatures of the vessels in a high-fidelity environment for test and evaluation. Stress physical scale models (SPSMs) mimic the effects of structure and materials in response to physical stimuli, e.g., wave action, vibration, seaway and environmental stress hull loadings, acoustic and electromagnetic (EM) propagation. This requires the model to have high-fidelity key features. The Navy is interested in studying the magnetic effects of ship hulls and hull forms that have been exposed to stresses typical of seaway loads and other environmental stress loadings along all or part of the hull structure. For this purpose, studies of SPSMs are important. SPSMs are 1/30 to 1/60 the size of full-scale with EM signatures corresponding to the full-scale structure. SPSMs need to be representative of a ship's structure including medium-to-detailed interior structure, be able to accept degaussing coils for magnetic compensation, and be instrumented with sensors for physical data acquisition during high-fidelity testing conditions involving high stress. SPSM test results are important and influence the design of ships, especially in cases when SPSM results arrive late in the design of a ship and significant design changes and extensive re-work of the ship design are necessary. Currently SPSMs are manually assembled from sheet metal that is cut and welded and manual insertion of degaussing coils. Making a SPSM is very labor intensive, expensive, and lengthy, requiring long lead times. Few models are actually available for test. The current process is slow to respond to design changes. Manufacturing of SPSMs would benefit from an integrated approach to design, modeling, physical testing, and analysis that leverages advanced information technology and fabrication technologies. Ship acquisition would greatly benefit by a capability to more rapidly and easily test more design alternatives with more and different kinds of materials while still meeting its EM objectives before committing to a final design. The goal is to reduce cost by one-half, reduce build-time from months to a few days, and allow degaussing coils be made in situ or inserted later. New technologies such as solid freeform fabrication, additive manufacturing and direct digital manufacturing, which are suitable for "art-to-part" approaches, mass customization, flexibility in design changes, automation, and robotic assembly, can be explored for their usefulness for SPSM development.

PHASE I: Develop the design of a capability and technical justification of its feasibility to prototype a SPSM with representative EM signatures and mechanical durability.

PHASE II: Develop the technology capability to make a SPSM, based the design from phase 1, and demonstrate that it meets the desired goals. Provide a significant SPMS sample, based on a drawing in a standard CAD system such as, e.g., AutoCAD or CATIA, for independent testing of EM signatures, especially under mechanical stress.

PHASE III: Transition the SPSM manufacturing technology to critical military use and the civilian sector. Build marketable manufacturing units and demonstrate the fabrication of a test model. For example, construct a SPSM of a complex Navy ship/submarine with degaussing coils.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A successful SPSM fabrication system would be useful for a variety of commercial applications. An example could be an underwater exploratory vessel. Its affordability and versatility will result in new businesses and industries, and high value jobs.

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KEYWORDS: Stress Physical Scale Model; Electromagnetic Signature; Environmental Stress; Additive Manufacturing; Cost Reduction.

N112-154 TITLE: Innovative Approaches for Predicting Galvanic Effects of Dissimilar Material Interfaces

TECHNOLOGY AREAS: Air Platform, Materials/Processes

OBJECTIVE: Develop and demonstrate an innovative analytical approach for determining the galvanic effects on dissimilar materials.

DESCRIPTION: Airframe structure is typically comprised of multiple materials forms each exhibiting unique electro-chemical properties. Examples may include graphite epoxy composites attached to metallic substructure. The differential in electro-chemical properties will result in galvanic activity, leading to a corrosive state accelerated with exposure in the aggressive Navy operational environment. The ongoing corrosive state results in material degradation and eventual structural failure, providing a substantial cost for fleet maintenance and reduced numbers of mission ready aircraft.

The current approach to airframe design is to select materials and structures for mechanical and thermal load performance based upon initial properties. Design analysis tools do not have the capability to account for degradation of these properties due to operational conditions. The current approach attempts to minimize the galvanic activity of structural designs by the utilization of sealants, coatings, and other barrier techniques, all of which typically degrade over time, resulting in corrosive damage. Areas of inadequate protection or high galvanic activity cannot be identified until the design is completed and fielded, leaving limited room to address basic design flaws in interfaces and material selection, and continuing the cycle of reactionary find/fix corrosion mitigation.

To address this issue, there is a desire to select the structure of the airframe to minimize galvanic activity from the design phase, thereby eliminating or minimizing potential corrosion issues. Therefore an innovative analytical solution that will enable the prediction of galvanic response to dissimilar materials is required.

PHASE I: Develop an analytical approach for predicting the galvanic effects on dissimilar materials. Demonstrate the feasibility of the approach by comparing predictive results with published data.

PHASE II: Fully develop the approach formulated in Phase I into a usable design tool. Provide verification of the ability of the design tool to predict the galvanic behavior of structural sub elements comprised of an array of dissimilar materials, including protective coatings, which are exposed to various chemical and thermal conditions. Verify the ability of the design tool to predict galvanic response of structures under mechanical loads.

PHASE III: Validate the design tool through an extensive test program. Transition the approach to airframe designers and manufactures.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed analytical tool has the potential to transition to the commercial aircraft market for the efficient design of airframe structure, resulting in improved component reliability and life extension due to the elimination of airframe corrosion.

REFERENCES:
1. "Military Airframe Costs – The Effects of Advanced Materials and Manufacturing Processes" Obaid Younossi, Micheal Kennedy, John C. Graser – United States, Project Air Force

2. "The Annual Cost of Corrosion for Navy and Marine Corps Aviation Equipment" David A. Forman, Eric F. Herzberg, James C. Tran, Amelia R. Kelly, Paul N. Chang, Norman T. O'Meara, Ph.D. – LMI Government Consulting, Report MEC70T3, May 2008

3. www.corrdefense.org

KEYWORDS: Corrosion, galvanic activity, dissimilar materials, cost reduction.

N112-155 TITLE: <u>Bladder Fuel/Oxidizer Delivery System for Underwater Vehicles (UUVs) and Weapon Applications</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Weapons

OBJECTIVE: Develop and demonstrate a bladder storage and delivery system to supply reactants used in air independent propulsion systems. Current R&D propulsion related efforts for both Unmanned Undersea Vehicles (UUVs) and Torpedoes are investigating the use of liquid fuels and oxidizers. Due to the mass and volume constraints and air independent nature of the system, traditional tank designs relying on displacing the consumed reactant volume with gas and/or liquids are not suitable. Therefore the technology utilizing bladders to contain the reactants where by the displaced volume is either backfilled with reaction byproducts or external seawater is required. The bladder design should be adaptable to a variety of reactant types and provide a robust cost effective means for delivering the reactants. This type of system will also address corrosion issues and the high replacement/maintenance costs of fuel tanks in weapon applications. Additionally, the corrosion associated with utilizing seawater as a back fill medium has a significant total ownership cost burden.

Identification of novel bladder material properties to allow its elastic deformation (linear or non-linear) to be the driving force to expel the stored reactants and/or mitigate the pumping power to do so; this could eliminate/reduce delivery pump/motors allowing for higher system efficiency. The use of bladders as the storage/delivery system for UUVs will provide a path to address the demand of increased endurance missions from days to months. These bladders can provide the means to store/deliver fuel and oxidizer for UUVs, by providing multi-use opportunities and reduce the burden of limited weight/volume/buoyancy issues associated with UUVs.

A bladder system had been used in the past for undersea applications; however, this system was a one-time use and lasted for hours; the current topic is looking for a bladder system that will provide multi-use applications (fill/discharge/refill) for several weeks to months of operation.

DESCRIPTION: Several air-independent energy system efforts are currently being researched. These efforts include both electrochemical (i.e., solid oxide fuel cells, proton exchange membrane fuel cells, etc.) and thermal based (bipropellants, monopropellants, etc.) systems. Both fuel cell systems utilize liquid based reactants (i.e. borohydride, dodecane, hydrogen peroxide). Torpedo propellants in more recent times have focused on the use of Otto Fuel II. The bladders must meet the stringent compatibility requirements of the reactants (i.e., concentrated hydrogen peroxide, caustic solutions, acidic solutions, Otto Fuel II, HAN, etc). In order to maximize energy density, the bladders must be capable of being fully discharged with little remaining residual reactant. Additionally, to minimize total ownership cost, the bladder system should be capable of being drained and refueled via a simple through hull penetration which does not require the disassembly of the shell sections.

The current torpedo propellant Otto Fuel II has a density greater than water and is immiscible with water. This allows for the simple displacement using seawater during torpedo operation. Otto Fuel II is also immiscible with water, but forms a corrosive interface layer at the water propellant interface causing fuel tank corrosion. Post test operations require the separation of seawater from the propellant prior to reuse. Research is currently underway to develop an aqueous based propellant in order to replace the current Otto Fuel II system. Therefore the current seawater displacement technique will need to be replaced by a system such as a bladder.

Therefore, an innovative comprehensive bladder storage/delivery/refuelable system is sought to address the needs of several air-independent energy systems (i.e. fuel cell powered UUVs and torpedoes). To meet nominal undersea vehicle power requirements, fuel delivery rate requirements will range from much less than a gallon per minute to 10 gallons per minute with the storage volume ranging from less than 10 gallons up to 100 gallons.

The current topic is looking for a bladder delivery/storage system that will provide multi-use applications (fill/discharge/refill) and for several weeks to months of operation. In addition, identification of bladders with elastic deformation material properties to enable bladder designs capable of high fill/empty volume ratios for efficient storing & delivering of fluids. The elastic nature of these materials will enable expulsion of the fluids resulting from bladder contraction to minimum volumes as well as better accommodate/prevent rupture attributed to overfill. The internal environment in which the bladder will typically be located will require the bladder system to be resistant to abrasion, irregular surrounding geometries (i.e., rib stiffeners, communication tubes, etc.), high ambient pressure, and be resistant to wear associated with “pinch off”. Bladder designs utilizing both hyper elastic and reinforced collapsible membranes are sought.

PHASE I: Demonstrate the use of a fuel bladder system to store and deliver liquid reactants such as Otto Fuel II, HAN, H2O2, NaBH4, seawater, etc with less than 1% residual fuel remaining upon discharge. The compatibility of the bladder material to 30 days of storage of the liquid reactants at temperatures ranging from -10 to 85oC at relative high humidity.

PHASE II: Construct and evaluate a comprehensive liquid reactant storage/delivery/refuelable bladder system. Test the system at full scale, to determine residuals, fill/refill procedures, etc. The system should be made available to the Navy for evaluation and testing within a vehicle to determine orientation effects during operation and refilling. Bladder systems must also demonstrate long term storage capability of liquids (up to 10 years).

PHASE III: Design and construct a fully integrated comprehensive bladder delivery system for a UUV Energy section.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This bladder approach can also be used for the DOE’s fuel cell efforts for automobiles, NASA’s fuel cell approaches and other Navy fuel cell efforts (portable power, AUVs, USVs reactant storage applications).

REFERENCES:
(1) UUV Master Plan, www.navy.mil/navydata/technology/uuvmp.pdf

(2) Naval S&T Strategic Plan, https://www.onr.navy.mil/

KEYWORDS: Bladder, fuel cell, reactants, fuels, oxidizers,

N112-156 TITLE: High Frequency Elastic Analysis Tool

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS450, Virginia program office

OBJECTIVE: Development of modeling methods and software that accurately predicts flank array self-noise levels.

DESCRIPTION: This topic seeks innovative approaches for transitioning modeling methods that can extend self-noise modeling of hull arrays where conventional finite element approaches fail (or takes an enormous amount of time to converge on a solution). Currently, a comprehensive set of fully elastic analytical models for submarine coatings, UUV coatings, flank array sonar systems and torpedo sonar windows does not exist.

Acoustic modeling requires mathematically propagating a plane wave onto a structure. When sound is incident on a hull array, it creates both dilatational (sound) waves and shear waves. Shear waves have a much slower propagation speed than dilatational waves and hence a shorter wavelength. Since finite element methods require on the order of ten elements per wavelength for accurate modeling [1,2], this means that such systems cannot be accurately modeled. The sound waves can be accurately modeled, but the shear waves (with their shorter wavelengths) cannot. As a result, the design of such arrays are severely hindered using the finite element method, since there is no way to predict shear wave behavior (which leads to noise) and hence there is no way to use design approaches to mitigate such noise.

Previous analytical models were restricted to low frequency, low wave number analysis based on governing equations that contain only a flexural wave component [3,4]. Recent analytical modeling methods incorporate higher order elastic terms [5,6], allowing undersea vehicles and their corresponding sonar systems to be modeled in high frequency regimes, fully supporting all of the dynamic wave propagation and interaction with the structure. These new methods provide a modeling capability and insight at high frequencies and high wave numbers that is unavailable through previous analytical methods. This SBIR topic seeks advanced approaches to better understand Navy systems in this regime, including UUV coatings, submarine hull coatings, weapon sonar systems, and especially hull array sonar systems.

PHASE I: Develop and validate analytical methods for a transitioning model applicable for high frequency and wave number regimes for fully elastic structures. The model should include a fluid that supports acoustic pressure, an acoustic coating, a backing plate, and ribs having three degrees of freedom.

PHASE II: Further refine analytical methods from Phase I by extending this to a multi-layer array system and develop a modeling tool that can be made available to the Navy design community. Predict the noise due to shear waves and its potential impact on system performance. Test against experimental data and key benchmarks.

PHASE III: Transition MATLAB code to the acquisition community.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The tools developed under this effort should find a wide variety of uses for modeling of fully elastic structures when conventional finite element methods fail.

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[1] O.C. Zienkiewicz and R.L. Taylor, The Finite Element Method for Solid and Structural Mechanics, Sixth Edition, Butterworth-Heinmann, 2005.

[2] R.T. Fenner, Finite Element Methods for Engineers, Imperial College Press, London, 1997.

[3] C.J. Chapman, S.V. Sorokin, "The Forced Vibration of an Elastic Plate Under Significant Fluid Loading", Journal of Sound and Vibration, Volume 281, 2005, pp. 719 – 741.

[4] B.A. Cray, "Acoustic Radiation from Periodic and Sectionally Aperiodic Rib-Stiffened Plates", Journal of the Acoustical Society of America", Volume 95, 1994, pp 256-264.

[5] A.J. Hull, "Dynamic response of an elastic plate containing periodic masses," Journal of Sound and Vibration, Volume 310, 2008, pp. 1 – 20.

[6] A.J. Hull, "Elastic Response of a Four Layer Hull Array Sonar System Subjected to Acoustic Plane Wave Excitation," NUWC Technical Report 11965, February 2010, Naval Undersea Warfare Center, Newport, RI.

KEYWORDS: flank array; hull array, sonar, periodic structures, self noise, fully elastic models

N112-157 TITLE: Non-Abrasive Propeller Cleaning System (NAPCS)

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: NAVSEA 00C

OBJECTIVE: Develop a diver-operated, non-abrasive propeller cleaning system (NAPCS) to remove propeller fouling with improved cleaning effectiveness, blade coverage, through reduced cleaning time, and risk of blade surface and edge damage.

DESCRIPTION: Fouling on the propeller causes a significant increase in fuel consumption, cavitation, and propeller noise. Fouling rates vary depending on the ship's operational profile, geographical area, and environmental conditions. Current Navy practice prescribes interim inspection and cleaning of the propellers at regular intervals (typically every 3 months). During this period, fouling accumulation can generate a 3-6% increase in power requirements, penalizing fuel consumption. If neglected, the development of hard fouling and calcareous growth can double the required power. Divers currently use a combination of hand pads brushes, scrapers, cleaning discs, and waterjet guns to clean propeller surfaces and restore a smooth blade surface (Rubert Scale B or better). Special care must be taken to select the least abrasive tool for cleaning so as not to damage the underlying surface, coatings, or thinner sections for the propeller. Due to the high risk of potential damage to blade edges, power tool cleaning is restricted. Divers currently have to manually hand clean the outer 3 inch periphery on each side of the propeller blade edges and tips. This can often increase the propeller cleaning labor by 15 to 20 hours per propeller.

This SBIR seeks to develop a non-abrasive, diver operated, propeller cleaning system to improve cleaning efficiency and reduce the risk of damage to the propeller surfaces. The current process can take 2-3 days to clean a submarine propeller. The objective of this SBIR is to shorten this period by 50%. The required capabilities of the NAPCS include:
• Removal of soft fouling, hard fouling, and calcareous deposits from the propeller surface without damaging the underlying nickel-aluminum-bronze (NAB) surface.
• Accommodate complex propeller geometry.
• Preserve surface uniformity and smoothness (Rubert Scale B or better).
• Ergonomic, to minimize diver fatigue due to reaction forces, noise, or vibration.
• Minimize equipment size and weight to facilitate transportability and provide ease of use (not to exceed 60 cu.ft. and 6000 pounds).

PHASE I: Develop an overall NAPCS concept design and evaluate the feasibility of various cleaning technologies. Determine parameters governing the effectiveness of the selected cleaning method without damaging blade surfaces. Demonstrate cleaning effectiveness through analysis, simulation and lab testing as appropriate. Option: subject several NAB (alloy will be specified) test coupons to accelerated fouling growth and deposition for Phase II testing.

PHASE II: Based on the Phase I development, refine the design and fabricate a breadboard NAPCS prototype. Demonstrate effectiveness in removing fouling and quantitatively assess the impact on the substrate through in-water testing on NAB test coupons. Study fouling regrowth characteristics (degree, rate) after cleaning with the NAPCS and compare against the regrowth after employing the conventional methods of machine and hand cleaning. Deliver a handheld prototype to conduct a field trial on a government furnished fouled NAB propeller blade. The emphasis of this demonstration shall be to validate the NAPCS non-destructive capabilities, ergonomics, and maneuverability under operation by divers.

PHASE III: Deliver system prototype NAPCS to pier and satisfactorily perform pier side acceptance testing on a full-scale ship propeller. Develop procedures consistent with the Naval Ships' Technical Manual for NAPCS operations. Develop final NAPCS packaging, manuals, and fabrication drawings to NAVSEA 00C. Transition NAPCS to NAVSEA 00C for incorporating technology into NSTM and contract specification for government contracted cleaning services.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Propeller fouling and its penalties to fuel consumption, maintenance, noise, and vibration impact both commercial and Naval ships of all classes. The advantages of this technology would provide equal benefit to divers of commercial ship husbandry operations.

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1. Naval Sea Systems Command, "Waterborne Underwater Hull Cleaning of Navy Ships," Ch081 of the Naval Ships' Technical Manual, S9086-CQ-STM-010 Rev 5, 01 Oct 2006.

2. Hundley, L. L., "Ship Performance Self-Assessment, a Method to Improve the Cost Effectiveness of the U.S. Navy Hull and Propeller Maintenance Program," CRDKNSWC/HD-1481-01, Sep 1998.

3. Jessup, S. D., "Prediction of Power Losses Due to Propeller Roughness," CRDKNSWC/HD1269-03, Feb 1998.

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5. Townsin, R. L., Spencer, D. S., Mosaad, M., and G. Patience, "Rough Propeller Penalties," SNAME Transactions, Vol. 93, pp. 165-187, 1985.

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11. Current practice of underwater propeller cleaning, 5 pages.

KEYWORDS: Propeller Cleaning, Fouling Removal, Ship husbandry

N112-158 TITLE: Underwater Internal Imaging and Diagnostic Tool for Limpet Mines and IEDs for the EOD Mission

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: Diver Hull Inspection and Navigation System (DHINS)

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

OBJECTIVE: The objective of this topic is to develop and demonstrate a single diver or small UUV portable, non-invasive capability to image and display in-situ the internal components of underwater explosive threats, such as limpet mines or underwater Improvised Explosive Devices (IEDs). This capability should be able to acquire and display internal components, such as firing train components, anti-removal and anti-tamper devices, method of attachment (if applicable), and air voids.

DESCRIPTION: Currently Navy Explosive Ordnance Disposal (EOD) Technicians have equipment capable of detecting and imaging underwater threats; however being able to identify the internal components of underwater explosive devices is critical for proper threat identification and neutralization. Conventional methods for non-invasive internal component imaging, such as x-ray, have not been successfully demonstrated in the underwater environment; therefore, a new capability or novel approach is needed. The capability developed under this effort must be able to be operated at a stand-off distance from the target of interest by single EOD diver and/or integrated onto a small (two-man deployable) UUV or Remotely Operated Vehicle (ROV).

PHASE I: Determine technical feasibility and characterize the ability of the proposed technology to image and distinguish internal components of various limpet mines and IEDs. The approach may include limited testing on and/or modeling of actual inert limpet shapes provided by the Government and/or models based on descriptions/specifications to be provided by the Government. The final report shall clearly explain the operational capabilities and limitations of the technology, including but not limited to: image resolution, depth perception, minimum/maximum stand-off distance, and underwater explosive device material constraints (i.e. items made of x material will absorb too much noise to render an image, etc.). The results shall include a preliminary optimized design for Phase II consideration.

PHASE II: Fabricate and provide a prototype of the proposed technology. Perform laboratory tests to validate the performance characteristics established in Phase I and conduct a demonstration in a realistic environment.

PHASE III: Develop an acquisition-ready system description and final design documentation that meet defined operation guidelines to enable rapid production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: While the initial purpose for this effort is to image the internal components of limpet mines and waterborne IEDs, the capability can be adapted for use with influence mines. Also, an underwater internal component inspection system will have many commercial applications: oil and gas, underwater exploration, etc.

REFERENCES:
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2. (Deleted 6/14/11: reference not available for public release at this time.)

3. (Deleted 6/14/11: reference not available for public release at this time.)

4. (Deleted 6/14/11: reference not available for public release at this time.)

KEYWORDS: Underwater Imaging; Imaging of Internal Components; Non-Invasive Imaging; Limpet; IED, Mine

N112-159 TITLE: <u>Auxiliary System Sensor Fusion</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: Integrated Condition Assessment System, ACAT IV

OBJECTIVE: Develop methods and algorithms that allow sensor information from disparate auxiliary systems to be intelligently fused to provide enhanced situational awareness.

DESCRIPTION: Currently, auxiliary systems have sensors which are used to understand the state and control the systems of which they are a part. For example, fluid systems have pressure sensors which are used to measure the flow of fluid inside the pipes. It has been shown that these sensors can also provide data to intelligent algorithms to detect and isolate pipe ruptures during damage events. Such an advance is an example of using multiple sensors to gain increased situational awareness and prescribe an appropriate control action. The next logical step is to fuse data from sensors across systems in an effort to gain an enhanced situation awareness of the ship as a whole. Such information can be used to prescribe control actions at the higher levels of hierarchical ship control system, or to perturb resident shipboard models to predict possible future states of the ship. The holistic knowledge gleaned from this sensor fusion can also be useful to lower levels of the control system. For example, a rupture detected in a piping system may be located more precisely if a higher level system passes along the information that it is likely that there is damage in a particular compartment.

The focus of this topic is use sensors from a notional chilled water system, coupled with a notional electrical system to determine the states of the two systems in a manner that is more accurate than can be accomplished using only each system's sensors individually. The notional system that will be used for this project currently exists in both a software simulation and a reduced scale hardware implementation. The simulation will be provided to the investigators of this topic. Using a notional system eliminates issues surrounding releasing current ship designs to personnel outside the Navy. The notional system has been designed such that it resembles an actual ship system closely enough that results on the simulation and reduced scale system will be applicable to actual navy systems. In addition, using the notional system allows this topic to be focused on a specific domain, with a specific design in mind. This will allow the investigators to be focused on a specific instance of the sensor fusion problem that is of interest to the navy, and helps to clarify and focus the problem of interest in what is otherwise a wide open area of investigation. The sensors to be used are also defined as a part of this system, so that the data that the fusion algorithms will use is already defined. Documentation and interface specifications to both the simulation and the hardware implementation of the notional system are available and will be provided to the investigators.

Algorithms of interest include, but are not limited to, Bayesian belief networks, linear and nonlinear classifiers, Kalman filtering, and Dempster-Schafer. These algorithms have not been applied to coupled, distributed shipboard systems in the past. Therefore, this work represents an advance in the state of the art. However, these algorithms have been applied in similar domains, so it seems reasonable that this approach is feasible.

PHASE I: Develop an approach to the fusion of the sensors of multiple shipboard auxiliary systems and investigate fusion algorithms that may apply to this problem.

PHASE II: Evaluate phase one approach and algorithms, develop simulation and perform simulation testing. Refine the algorithms, determine limitations and investigate issues such as algorithm tuning.

PHASE III: Demonstrate the sensor fusion approach in a reduced scale, hardware in the loop model.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The ability to fuse and reason over sensor data from multiple, interdependent machinery systems for aggregate control and performance increase, while increasing efficiency, capability and reducing cost will is applicable to industries that operate in a like environment. Industries include commercial shipping, manufacturing (process control), utility providers, including information technology.

REFERENCES:
1. S. Dibona and B. Callahan, “Development of a Flow Estimation Model for a Multi-mode Smart Valve”, Proceedings of the 13th Ship Control Symposium, April 7-9, Orlando Florida (2003)

2. F. Jensen, “An Introduction to Bayesian Networks, UCL Press, London (1996)

3. J Kolodner, “Case Based Reasoning” San Francisco, Ca, Morgan Kaufmann (1993)

KEYWORDS: Machinery; Control; Sensors, Fusion, Reasoning, Efficiency

N112-160 TITLE: Purification of Biogas for Fuel Cells

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: OASN(EI&E) - Energy [Non-ACAT]

OBJECTIVE: Design a low-cost regenerative gas purifier to be utilized with fuel cells for conversion of industrial landfulll or waste water treatment plant biogas to electrical power. The purifier should be compatible with a 2-5kW commercially available fuel cell of the proposer's choice. The purifier should be regenerative and capable of removing chlorinated compounds, sulfur compuounds as well as other compounds according to chosen fuel cell specification for a minimum of 2,000 continuous hours of operation with zero maintenance and must be capable of being removed, cleaned and returned to service at the operational site.

DESCRIPTION: Industrial landfills and commercial water treatment plants produce biogas through the anerobic digestion of solid organic materials. The biogas is a potential source of renewable energy that can be efficiently converted to electrical power through the use of fuel cells. For optimal fuel cell life and performance it is imperative to first purify the gas to remove compounds that lead to fuel cell degradation and shortened lifetime. The purification method chosen should operate at one (1) atmosphere pressure and be re-usable with a simple scheme for attachment/removal.

PHASE I: Develop a conceptual innovative purifier system for a chosen 2-5kW fuel cell with capabilities as described above, and demonstrate purifier technology at a laboratory scale.

PHASE II: Build purifier and demonstrate continuous operation with an appropriate fuel cell.

PHASE III: Demonstrate purifier operation in a a relevant operational setting. Demonstrate the ability to reuse.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These systems would have application to both remote civilian and military applications where water treatment plants are in use or industrial landfills are in operation.

REFERENCES:
1. http://www.hydrogen.energy.gov

2. http://www.eere.energy.gov

3. http://dodfuelcell.cecer.army.mil/rd/waste-to-energy.php

KEYWORDS: fuel cells, biogas; alternative energy; gas purification; waste-to-energy; methane

N112-161 TITLE: Exploiting Agile Waveforms and Sampling for Compressive Sensing Radar

TECHNOLOGY AREAS: Information Systems, Sensors

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

OBJECTIVE: Identify and demonstrate enhanced, efficient radar imaging and applications exploiting modern waveform generation and/or MIMO beam formation for robust compressive sensing in maritime applications such as small craft detection and imaging.

DESCRIPTION: Compressive Sensing has emerged in recent years as a potentially feasible mathematical tool and framework for efficient data collection. However, few active air-to-surface surveillance systems currently exploit the full potential of compressive sensing by probing the ground with fully randomized or partially randomized waveforms. While complete randomization may be impractical, modern digital radar systems are capable of synthesizing a wide variety of IF modulating waveforms, enabling a more complete and efficient exploration of the time-frequency-angle space over the radar system’s path than is feasible with current methods. Similarly, MIMO radar systems could introduce randomized beam patterns that introduce variations in the angular distribution of signal over targets in each range bin. Finally, an additional layer of randomization and efficient data reduction may be achieved digitally on board the aircraft by weighting and combining pulses over the aperture path before downlink.

A successful program on this topic will need to examine and address several significant challenges. One must examine the capabilities and limitations of radar systems using direct waveform synthesis and/or MIMO radar systems to understand the waveforms that can practically be produced and how robustly and reproducibly they can be created. Then, randomized waveform generation may need to be optimized to ensure robust coverage of the possible signal spaces. In addition, while much current work on compressive radar sensing focuses on reconstructing isolated sparse scatterers, which may be useful for periscope or small craft imaging, additional improvements may be possible for reducing the impact of high-sea state clutter by better filtering sea-clutter signal in appropriate compressed-sensing signal bases. Sensor noise, interference, and errors in signal generation (particularly deviations in MIMO beamshapes from what was intended) represent potentially significant confounding factors.

Proposals should address some of the core practical signal processing issues for such a system. For example, proposed approaches should ensure sufficient coverage of the signal space. They should also examine practical waveform generation and measurement. Quality measures for the output reconstruction should be considered, as well as assessments for achieving those requirements. Also, downlink requirements that include sufficiently describing the transmitted waveforms to the ground station in order to ensure accurate reconstruction. Robustness to interference and error sources in both waveform generation and receiving should be considered.

Systems using such approaches will likely be capable of simultaneous multi-mode operations and make more efficient use of their data downlink. In addition we anticipate that a compressive radar sensing system exploiting randomized waveforms could be more robust to interference (unintentional and intentional) and would minimally interfere with other EM operations (military or civilian). As an additional side benefit, such a system could be stealthier and more difficult to counter, because of its randomized, spread spectrum characteristics.

PHASE I: Determine the requirements of a compressive sensing radar system using modern agile waveform synthesis and/or MIMO beamshaping capabilities. Illustrate the capabilities and limitations of the framework in simulation for proof-of-concept. Assess performance and robustness to interference and error sources.

PHASE II: Develop waveform generation and reconstruction prototypes using compressive sensing techniques. Demonstrate the approach in an appropriate simulation, including data collection if feasible and assess the performance of techniques on previously collected data.

PHASE III: Affordable implementation appropriate to a specific system which program officer will identify in the course of phase II execution.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Many civil and military systems that depend upon electromagnetic sensing can benefit from significant advancement of the state of the art.

Robust, efficient all-weather persistent standoff imaging that is robust to interference will significantly enhance the capability of the warfighter to execute actions and gather intelligence in all environments. Efficient and flexible data transfer utilization can free spectrum for alternate uses. Satellite imaging capabilities can be significantly enhanced. Significant resource reductions could imply cost reductions, enabling more widespread uses of RF imaging and sensing. Any radar system utilizing a random or less predictable pattern of emissions will likely challenge exploitation opportunities. Alternatively, it is conceivable that many of the compressive sensing and imaging techniques developed here could also be used to enhance minimally invasive medical imaging, exposing patients to less radiation by requiring fewer probing sources.

REFERENCES:
(1) S. Shah, Y. Yu, and A. Petropulu, “Step-Frequency Radar with Compressive Sampling (SFR-CS),” in Proc. ICASSP 2010, March 2010

(2) Herman, M.A.; Strohmer, T.; , "High-Resolution Radar via Compressed Sensing," Signal Processing, IEEE Transactions on , vol.57, no.6, pp.2275-2284, June 2009

(3) M. D. Gabriel Rilling and B. Mulgrew, “Compressed sensing based compression of SAR raw data,” in SPARS’09 - Signal Processing with Adaptive Sparse Structured Representations (2009), 2009

(4) C. Y. Chen and P. P. Vaidyanathan, “Compressed sensing in MIMO radar,” Proc. 42nd Asilomar Conf. Signals, Syst. Comput, Pacific Grove, CA, Nov. 2008.

(5) Subotic, N.S.; Thelen, B.; Cooper, K.; Buller, W.; Parker, J.; Browning, J.; Beyer, H.; "Distributed RADAR waveform design based on compressive sensing considerations," Radar Conference, 2008. RADAR '08. IEEE , vol., no., pp.1-6, 26-30 May 2008

(6) Bhattacharya, Sujit; Blumensath, Thomas; Mulgrew, Bernard; Davies, Mike; "Fast Encoding of Synthetic Aperture Radar Raw Data using Compressed Sensing," Statistical Signal Processing, 2007. SSP '07. IEEE/SP 14th Workshop on , vol., no., pp.448-452, 26-29 Aug. 2007

(7) Baraniuk, R.G.; "Compressive Sensing [Lecture Notes]," Signal Processing Magazine, IEEE , vol.24, no.4, pp.118-121, July 2007

(8) Donoho, D.L.; "Compressed sensing," Information Theory, IEEE Transactions on , vol.52, no.4, pp.1289-1306, April 2006

(9) Donoho, D. L., Elad, M., “Optimally sparse representation in general (nonorthogonal) dictionaries via L1 minimization,” Proc. Natl. Acad. Sci. USA 100 (2003), 2197–2202.

KEYWORDS: Compressive Sensing, Radar, SAR, Clutter Mitigation, MIMO, Direct Waveform Synthesis

N112-162 TITLE: PerCepts

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: CMP-FY11-01 Perceptual Training Systems and Tools (PercepTS)

OBJECTIVE: Develop a suite of training and assessment tools for acquisition of perceptual skills.

DESCRIPTION: Federal agencies such as the Department of Defense (DoD), Federal Bureau of Investigation, Department of Homeland Security, and others are interested in detecting people and/or activities that are possible threats. To identify such threats, agency personnel situated within the environment rely upon their perceptual skills to identify anomalous activity. Specifically, personnel are taught how to develop a baseline from normal behavior /

activities, and then detect anomalies that indicate the presence of a threat. Personnel training and assessment of perceptual skills is critical to successfully detect anomalies, and proactively prevent impending attacks.

However, several limitations are associated with the instruction of perceptual skills. As an example, in a recent review of the USMC Combat Hunter Program (Gideons, Padilla, & Lethin, 2008) several issues were raised: (1) limited access to perceptual skill training; (2) limited course throughput; (3) limited take-home materials; (4) lack of validated performance measures; and (5) limited understanding of skills by leadership (Schatz, Reitz, Nicholson, & Fautua, 2010). Likewise, a Government Accountability Office report on the Screening of Passengers by Observation Techniques (SPOT) program developed by the Transportation Security Administration cited several issues with training and measurement (GAO, 2010). However, research has suggested that perceptual skills can be taught and assessed (Fautua, et al., 2010). What is needed is a general purpose training and assessment tool for developing and evaluating perceptual skills. Specifically, the training and assessment tools should enable better perceptual training for recognizing human behavioral characteristics and recognizing patterns by providing methods and technologies across the training continuum – pre-training skill development, training supplementation and performance assessment, and post-training skills retention.

It is strongly encouraged that this effort develops training and assessment tools that are rugged. In addition, novel visualization and interaction techniques promoting enhanced visual, auditory, and haptic simulation are also suggested. Finally, these systems also need to capture events and have the intelligence to critique poor behaviors and compare behavior to expert standards.

At a minimum, tools should provide several perceptual skill exercises, and a detailed assessment of those skills. These tools should also be portable, require minimal intervention by an instructor and require minimal instruction for individual use.

PHASE I: Develop the framework for a perceptual toolkit to train and assess perceptual skills. This framework should address pre-training, performance assessment, and post-training skills retention capabilities. Naval support will be provided to help ensure the necessary connections within the Navy and Marine Corps are established.

PHASE II: Develop a prototype suite of perceptual tools based on the framework established in Phase I. Submit appropriate and necessary regulatory documents for testing using human participants. Validate the tools through empirical evaluations with the targeted user community.

PHASE III: Produce and market the perceptual training tools for integration within the Navy and Marine Corps training curriculum.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The suite of tools will have widespread applications to military, government, and private sector organizations in which it is important to identify potential security threats.

REFERENCES:
1. Gideons, Padilla,& Lethin., (2008, September). Combat Hunter: The Training Continues. Marine Corps Gazette. pg. 79-84

2. Schatz, S., Reitz, E., Nicholson, D., & Fautua, D., (2010). Expanding Combat Hunter: The Science and Metrics of Border Hunter. Interservice/Industry Training, Simulation and Education Conference, Orlando, FL

3. U.S. Government Accountability Office. (2010, May).Aviation Security: Efforts to Validate TSA's Passenger Screening Behavior Detection Program Underway, but Opportunities Exist to Strengthen Validation and Address Operational Challenges. (Publication No. GAO-10-763). Retrieved from GAO: http://www.gao.gov/new.items/d10763.pdf

4. Fautua, D., Schatz, S., Kobus, D., Spiker, V. A., Ross, W., Johnston, J. H., Nicholson, D., & Reitz, E. A. (under PAO review). Border Hunter Research Technical Report (IST-TR-10-01). Orlando, FL: University of Central Florida, Institute for Simulation & Training.

KEYWORDS: training; performance measurement; perceptual skills, sensemaking, human system integration

N112-163 TITLE: Automated Audio Clustering

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PM Intel

OBJECTIVE: Provide a system that can autonomously cluster a large database of audio files by speaker.

DESCRIPTION: Advances in open availability and collection technology for audio data is contributing to the overall large data problem for the DoD. As the difference between collection capacity and analytic throughput grows, so does the need for automated analysis. An important enabler of this is an ability to use sound characteristics to cluster audio files by unique speaker. There is both military and commercial value to being able to rapidly search for and retrieve all additional comments made by a newly discovered specific speaker of interest from a large library of previously untagged audio files. Related technology exists such as voice print matching which is used as a biometric to establish identity using text dependent matchers. Reliable speaker ID algorithms that are text independent have limitations in that they generally rely on the availability of training data collected under controlled conditions. The goal of the topic is to support research that can cluster a large data store of audio files by unique speaker using sound characteristics without the availability of training data. The topic will require a performer to demonstrate that algorithms such as vector quantization, mixture models, self organizing maps or artificial intelligence can be used to cluster very noisy frequency based data can be successfully employed. It is possible that sound will first have to be automatically translated to phonemes or words before clustering algorithms can be applied. A successful performer will develop a system that can cluster files with a useful true and false positive rate. Both text dependent and independent techniques can be considered but if text dependent algorithms are used the system must utilize one standard set of phonemes/words that can be identified automatically with high confidence. The objective system should assign a unique ID to each cluster. When new audio data is discovered by the system, those new audio files should be automatically be assigned to an existing cluster or designated a new assignment. Periodically the system should re-run clustering across the entire data set.

Challenges for this topic include 1) optimization of extractable voice features for downstream clustering 2) implementation of the optimized text independent audio feature extraction algorithms in both batch and streaming data architectures. 3) development of a reliable word list that can be easily and reliably recognized that are also useful for extracting voiceprints 4) Demonstration the viability of vector quantization, self organizing maps, mixture models or a related technique to perform accurate audio clustering using either or both text independent and dependent features without training data 5) Extraction of features from a cluster of audio files that can be used as training data for subsequent matches.

Advances in voice print matching and speaker ID technology can be leveraged along with recent work in clustering multi-dimensional data to provide a capability responsive to the topic.
The Navy will only fund proposals that are innovative address R&D and involve technical risk.

PHASE I: Complete a feasibility study, research plan and component algorithm testing in order to mature an approach for the development an audio file clustering system that can be run in batch mode and kept current in streaming mode. Identify the critical technology issues that must be overcome to achieve success. Technical work should focus on the reduction of key risk areas. For a constrained set of audio files, demonstrate that phase 1 risk reduction work has shown that a full implementation of the approach is technically tractable. Prepare a revised research plan for Phase 2 that addresses critical issues.

PHASE II: Produce a prototype audio file clustering service that can produce accurate clusters with defining metadata. The prototype should enable a demonstration of the capability to be conducted using relevant data sources, some of which may be classified. The prototype should be capable of operating in both batch and real time streaming mode. The prototype should be relevant to both DoD and commercial use cases.

PHASE III: Produce a system capable of deployment in an operational setting of interest against relevant data loading. Test the system in a relevant setting in a stand-alone mode and as a component of larger system (programs of record). The work should focus on tailoring the developed capability in order to achieve a transition to a program of record in one or more of the military Services. The system should provide metrics for performance assessment.

REFERENCES:
1. M.A. Siegler, U Jain, B. R, and R.M. Stern. "Automatic Segmentation, Classification and Clustering of Broadcast News Audio". Proceedings of DARPA Speech Recognition Workshop, 1997

2. S. Arya, D. M. Mount. "Algorithms for Fast Vector Quantization". Proc. Data Compression Conference, J. A. Storer and M. Cohn, eds., Snowbird, Utah, 1993, IEEE Computer Society Press, 381-390

3. D.A. Reynolds, T.F. Quatieri, and R.B. Dunn. "Speaker Verification Using Adapted Gaussian Mixture Models''. Digital Signal Processing, 10, pp. 19-41 (2000).

KEYWORDS: Clustering, Audio, Speaker ID, Voice Prints, Vector Quantization, Self Organizing Maps, Mixture Models

N112-164 TITLE: Advanced Fan Coil Unit

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 320 Electric Ships Office

OBJECTIVE: Develop and demonstrate durable, long-life, advanced fan coil unit (FCU), while improving efficiency, lowering noise levels, maintaining weight/volume requirements, providing greater standardization and lowering overall life cycle costs. An intermediate sink water system (ISWS) loop supplying 68°F water (1.8 gallons per minute per cooling ton) can be used by the FCU to reject heat during cooling applications and perform useful cooling during heating applications. The dry and wet bulb temperatures of the air exiting the FCU shall be less than 55°F, requiring the use of active refrigeration.

DESCRIPTION: Thermal Management is a critical requirement for future warships with electronic, propulsion, weapon, and sensor systems. Electronic advancements are resulting in distinct differences in the distribution of shipboard thermal loads, in which electronic cooling requirements are becoming more pronounced. Cooling equipment thermal loads using legacy naval design practices will result in systems which are inefficient, heavy, voluminous, and require significant manpower to operate/maintain. Incorporation of an ISWS loop, at a notational 68°F, for cooling the HVAC equipment loads and the non-HVAC chilled water loads is an alternative thermal management strategy which provides significant benefits in energy efficiency, equipment reliability, equipment availability, commonality and maintenance. Since the thermal loads requiring air conditioning duty are relatively modest, other strategies like the advanced FCU can be utilized to satisfy this cooling requirement with dramatically less power. Development of this technology will be a key enabler for deploying the ISWS.

Fan coil units are generally located within the space served, reducing the requirement for fan rooms and providing an effective ventilation approach for recirculation air systems. FCUs are designed for horizontal mounting in the overhead, or vertical mounting on bulkheads, minimizing the deck area required for installation. A typical FCU consists of a fan/motor, motor controller, air filters, inlet and outlet grills, thermal/acoustic insulation, chilled water cooling coil, and an electric heater. Ductwork may be connected to inlet and outlet openings on some units. The fan-coil unit cabinet is designed to permit ready connection of a power supply, chilled water supply and return lines, and a condensate drainage line. The fan-coil unit draws air through the inlet and the air filters, through the fan, into and through the cooling coil, through the heater and discharges the air through the supply outlet. Since FCUs are installed in manned spaces, air-borne noise must be minimized.

Innovative research is sought to produce the next generation of FCUs. Improved reliability and reduced noise levels are primary design considerations. Weight, volume and energy savings are important but secondary design considerations. Goals for the coefficient of performance (useful heat transferred divided by the input energy) are 6.5 for cooling applications and 4.5 for heating applications. This calculation ignores the pump power to circulate the water, as well as the power to circulate the air through the FCU. During heating application, heat from the ISWS will be absorbed so useful cooling can be conducted elsewhere within the ISWS loop. The ability of the FCU to switch from heating to cooling shall be automatic and require no assistant from personnel. The fan shall be designed for continuous operation, equipped with variable speed controls and have a minimum efficiency of 80 percent. Fan efficiency is the ratio of the ideal (isentropic) fan power divided by the product of the actual fan motor input power times the motor efficiency. Maximum water-side pressure drop is 12 psid across the heat exchanger.

PHASE I: Develop advanced concepts for the next generation of Naval FCUs meeting requirements above. Evaluate the feasibility of concepts through analytical modeling. Define strategies to reduce air-borne noise and improve component reliability. Determine the size and weight expectations over existing components. Determine coefficient of performance for cooling and heating applications as well as identifying water-side pressure drop and fan performance expectations. Identify risks and mitigations, as applicable.

PHASE II: Design and manufacture a full scale next generation FCU H3 unit (1.3 cooling tons capacity, 5.25 kW heating). Performance data shall be collected at a variety of flow rates (both air and water), air temperatures/humidity, and water temperatures. Air-borne and structure-borne noise testing shall be conducted. Validate and expand analytic models developed in Phase I. Investigate the scalability of design and identify commonality efforts. Refine calculation and estimates provided in Phase I.

PHASE III: Design and develop the next series of advanced FCUs using the knowledge gained during Phases I and II. This series of advanced FCUs must meet Navy unique requirements, e.g. shock, vibration and EMI.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Advanced FCUs developed here would be suitable for use in commercial and home HVAC systems. Technology is ideal for integrating with a geothermal system to conserve much needed energy.

REFERENCES:
1. NSWCCD-98-TR–2007/06 of September 2007, “21st Century HVAC System for Future Naval Surface Combatants – Concept Development Report”, Matthew Frank and Dick Helmick.

2. MIL-PRF-24775A - Performance Specification, Air Conditioning Fan-Coil Units, Horizontal and Vertical Types, Naval Shipboard.

KEYWORDS: Thermal Management; Cooling Coils; Heating, Ventilation and Air Conditioning (HVAC); Fan Coil Unit

N112-165 TITLE: <u>High Efficiency, Compact, and Cost Effective Variable Speed Engine Accessory Drive System</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: EPE FY12-04 Fuel Efficient MTVR FNC and PM MTVR

OBJECTIVE: Design, build, and demonstrate a cost effective variable speed device that can efficiently drive engine accessories and power takeoff devices on engines relevant to both commercial and military applications. Applications include Class 4 through 8 trucks for commercial industry as well as tactical vehicles for military application (MRAP, HMMWV, MTVR, FMTV).

DESCRIPTION: Commercial products, which achieve variable speed drive for accessories (fans, pumps) both hydraulically and electrically have been demonstrated to provide fuel savings in commercial applications.

Baseline fixed ratio belt or gear driven accessory drives are designed to provide an input speed to satisfy particular component functions for all devices on the system. Due to a lack of multi speed drive, this generally causes the components to be oversized for all but the worst case operating condition. For instance, typical clutched fan drives (on/off) provide either excessive flow or insufficient flow required to satisfy component temperature conditions in all but the most extreme cooling environments, consuming greater power than relative to the ideal of “right sizing”.

While a true infinitely variable speed drive for all accessories may provide the most performance benefit, a drive of several discrete speeds may provide the most value within the cost constraints and customer requirements. The exploration of the design space to include analyses and tradeoffs within the constraints of estimated manufacturing costs is the intent of this SBIR.

Fuel consumption reduction has been demonstrated on the Superbus project through the electrification of drive mechanisms for the fan, A/C condenser, power steering, and air pumps. The fan drive was originally a simple fixed geometry pump/motor with a pressure regulator and was switched to a sophisticated electric drive system. The conclusion of the study was “accessory electrification would result in a 13-15% improvement in overall fuel economy”. As noted by the authors of the study “if complete accessory electrification is not feasible, it is estimated that most of the fuel savings (78% AC off, 81% AC on) can be achieved by electrification of just the engine fan and AC compressor.”

Numerical analysis of the Bradley fighting vehicle indicates for the Munson Fuel Economy course at Aberdeen Proving Grounds in Maryland under 80 degrees F conditions, fuel consumption can be reduced approximately 7% by replacing a functionally on/off fan drive with an efficient eight discrete speed fan drive. Additionally, gains of 5% appear likely over a wide range of speeds, courses, and ambient temperatures.

The commercially available products currently do not satisfy the military user, and commercially desirable requirements of low cost, complexity, and fuel consumption, or the derived requirements of high transmission efficiency with appropriate ratio coverage. In order to demonstrate commercial applicability, the targeted military applications (MRAP, HMMWV, MTVR, etc) have common engines and fan drive systems with commercial class 4-8 trucks.

PHASE I: Provide estimations of relative improvements for providing variable speed drive to accessories, and develop a proof of concept design for an accessory drive system for the MTVR or similar vehicle, which maximizes cost/benefit ratio within an estimated cost envelope to be negotiated.

PHASE II: Develop and demonstrate the defined prototype system in a realistic environment. Conduct testing to prove feasibility over extended operating conditions.

PHASE III: This technology could be integrated into the next generation of Fuel Efficient USMC MTVRs upon successful FNC transition. In addition, all Class 4-8 military ground vehicle program offices could utilize the results of this effort.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In addition to DoD, the mining, trucking, forestry, and farming industries could all benefit from this potential efficiency increase.

REFERENCES:
(1) DOE More Electric Truck: http://www1.eere.energy.gov/vehiclesandfuels/features/fcvt_feature_truck.html

(2) Superbus: http://www.cts.umn.edu/Research/ProjectDetail.html?id=2008078 Page, R., Hnatczuk, W., Kozierowski, J., “Thermal Management for the 21st Century – Improved Thermal Control & Fuel Economy in an Army Medium Tactical Vehicle.” SAE Paper 2005-01-2068 (2005).

KEYWORDS: multi speed drive, fuel efficiency, compact drive design, high transmission efficiency with appropriate ratio coverage, low cost, low complexity,

N112-166 TITLE: Bio-inspired Marine Biofouling-control Coatings

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: Future FNC related to “Clean Hull Technologies for a Green Navy” , EPE

OBJECTIVE: The objective for this topic is to develop durable, non-toxic, marine biofouling-control coatings that use a mechanism-based approach to interfere with bioadhesive processing and/or curing. Ideally proposals will exploit recent knowledge regarding the synthesis, secretion, cross-linking and/or curing of biological adhesives manufactured by barnacles, tubeworms, mussels, and/or seaweeds to interrupt or inhibit adhesive formation to prevent settlement, adhesion, or growth of these organisms. Successful coatings will utilize a strategy that incorporates chemistry/biochemistry-based approaches that by design will target the organism’s bioadhesives, as opposed to purely physical approaches such as foul release or textured surfaces.

DESCRIPTION: Marine biofouling causes increased drag on vessels, leading to increased fuel costs, ship husbandry costs and decreases in operational readiness. Recent analysis of coating/maintenance costs associated with hull biofouling for a single class of Navy vessels (DDG-51; 22% of the wetted hull area of the current Navy fleet) is estimated to be $56M per year or $1B over 15 years1.

Current marine biofouling control coatings utilize copper to prevent the settlement of organisms. However, increasing environmental regulation of this heavy metal makes identification of non-toxic alternatives that also meet the Navy’s desired lifecycle and performance needs desirable. Foul release coatings are non-toxic, and consist of compliant and ‘slippery’ materials to discourage adhesion by marine biofoulers such as barnacles and tubeworms. Their expense, lack of durability, and need for frequent in-water husbandry has limited their use by the Navy.

Macrofouling organisms span length scales from µM to dM, and generally settle on surfaces as an immature form (µm-mm), completing their development once adhered to the substrate. Textured, non-toxic polymeric surfaces show great promise for discouraging settlement by larval forms of some fouling organisms, but the longevity of these coatings under typical vessel conditions has not been established.

Given the shortcomings noted above for various types of commercially available and developmental biofouling-control coatings, new approaches are needed.

Recently, mechanistic details about the bioadhesives that are produced by various macrofouling organisms have been published regarding the secretion, cross-linking or curing of these adhesives2-5. These mechanisms have included free-radical-mediated cross-linking, enzyme-catalyzed protein modification and cross-linking, and development of specific protein hierarchial structures (e.g., amyloid-like fibrils). Scientists have begun to translate these studies into experimental coatings systems, through covalent linkage of settlement or adhesion inhibitors into polymers2. What is desired for this topic is to encourage new approaches for durable, biofouling-control coatings that function by inhibiting bioadhesive production, secretion, curing or surface attachment yet do not release toxic components to the environment. Coatings that contain metals such as Zn, Ni, Ag, or Cu are not of interest to this topic.

PHASE I: The objectives are: (i) to develop a coating concept and prepare initial coatings on a small scale for testing in the laboratory with in-house assays and/or possibly through collaborations with other ONR-funded lab assays; (ii) to deliver twelve coated microscope slides per coating for one or two coating variants to ONR for lab scale testing. [ONR currently supports labs that perform coatings screening assays using marine diatoms, algal zoospores, barnacle larvae, adult barnacles, and tubeworms.]

PHASE II: To perform further development and testing of the coating system. This includes both further development of the coating based on lab assays and scale-up of the proposed approach(es) into a viable coating systems. Studies shall be performed to assure the coating(s) is stable when exposed to seawater. Toxicity studies of coating(s) and leachate(s) with common marine indicator species should be performed to demonstrate the coating(s) is non-toxic. Iterative testing, refinement and optimization of the coating will be accomplished by performing static immersion field tests of small panels for fouling measurements. It is anticipated that the final coating at the end of phase II will be equal to or better than the performance of existing non-toxic coatings (e.g. silicone fouling-release coatings).

PHASE III: Prepare large panels for in-service hull panel testing that will be performed in coordination with NAVSEA.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: International, national and local environmental regulations are focused on reducing environmental impact of marine coatings, as evidenced by bans on organotin coatings and increased scrutiny of copper-based coatings. Development of a cost-effective yet durable and non-toxic biofouling-control would find applicability in the pleasure craft, commercial shipping, and military vessel coating markets. Estimated global market size for 2012 is $4.7B or over 900 million liters of paint (http://www.thefreelibrary.com/Marine+coatings+market%3a+growth+in+the+marine+coatings+market+can+be...-a0200408710).

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KEYWORDS: biofouling, anti-fouling coating, bioadhesive, marine paint, barnacle, glue curing

N112-167 TITLE: Compact, Efficient, High Power Semiconductor Laser for Undersea Communication

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Develop and demonstrate compact, efficient, high power semiconductor laser for undersea communication.

DESCRIPTION: High data rate communication between mobile platforms above and below water are typically limited to the blue-green visible frequency spectrum as other frequencies of electromagnetic energy have very limited propagation. Laser communication systems operating in this spectrum have the potential to transmit at very high data rates to submarines at speed and depth. Power and wavelength requirements for these laser systems have precluded the use of semiconductor lasers despite their intrinsic advantages in speed, size and efficiency. However, the emergence of wide bandgap Gallium Nitride-based semiconductor lasers, particularly in the non-polar crystal orientations, offers the potential for a semiconductor laser solution with improved power, efficiency and size in the green wavelengths. Developing this technology for high power devices will lead to low size, weight, and power consumption that will improve power conversion efficiency particularly on mobile platforms. The existing technology for green lasers typically involves second or third harmonic generation from a longer wavelength laser source with added complexity and efficiency limited by the harmonic generation process. The goal of this program is to develop semiconductor lasers that are capable of delivering >1W of power at 518nm with an efficiency of over 5%.

PHASE I: Demonstrate a design for a semiconductor laser capable of meeting the specified device goals. Design should show potential improvements in state-of-the-art output power, wall-plug efficiency at a wavelength of 518nm. Designs should be potentially application to other wavelengths in the blue-green spectrum. Establish feasibility of the proposed concept by modeling and bench-top demonstration of key components. The phase I deliverable will be a final report including the initial system design and performance assessment.

PHASE II: Develop, test and deliver a prototype semiconductor laser operating at 518nm with >1W output power at 5% efficiency in a packaged format of the proposer's designation. The laser should be delivered in a complete packaging solution with appropriate consideration of thermal management requirements.

PHASE III: Commercialize high power semiconductor laser diode developed on the program and develop full manufacturing process working with system integrators to meet military needs including packaging format requirements. The technology developed under this effort will be transitioned for military application to undersea communications efforts.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The private sector industry will benefit from this program as it provides a jump start toward higher power semiconductor lasers in the green wavelengths. These lasers are of great commercial interest as they are a critical component to projection display applications. A green semiconductor laser source would enable wide adoption of projection displays in conventional formats down to emerging "pico-projectors."

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KEYWORDS: semiconductor laser; gallium nitride; undersea; communications;

N112-168 TITLE: Security Strategies for Mixed Use Mobile Computing Devices

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: JPEO JTRS ACAT 1

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

OBJECTIVE: Investigate the use of sandboxing techniques to speed certification and accreditation of COTS smartphones for SBU military mission usage. Develop a software-only solution that may be fielded on COTS smartphones without specialized hardware to host SBU military-only apps capable of communicating with tethered military radios for the purpose of sharing/collecting/transmitting/storing sensitive military information, even when the COTS phone is compromised by malware and/or rootkits.

DESCRIPTION: Military personnel are increasingly using their personal smartphones in their daily duties. Sometimes these devices are used as part of mission operations. Smartphones can contain data that may be mission sensitive, including photos, geolocation information, contact information such as names, phone numbers, and so on.

In some cases, these devices may have applications that are military-only purposed apps. This data, while unclassified, may be sensitive and can result in OPSEC breaches [HIG10]. Both the sensitive data at rest, as well as the military-purpose apps, may be subject to compromise from malware that could reside on these devices, or may be inadvertently shared across an untrusted domain.

There is currently much research ongoing in the area of virtualization and hardware assisted partitioning to separate trusted and untrusted applications [BAR10]. However, none of these features are available in current smartphones, and may not appear as a standard option in COTS smartphones in the near future. Furthermore, commercial sector solutions will not address the stringent requirements of the DoD. All Army wireless devices must meet the policy guidance in DOD Directive 81000.02 and use CAC PKI capabilities as outlined in DOD Instruction 8520.2, "Public Key Infrastructure and Public Key Enabling." DARPA and the NSA have started looking at software solutions addressing the issues related to integrating smartphones with DoD networks but viable, cost effiective, elegant solutions have yet to emerge. In order to address OPSEC needs for immediate fielding of smartphone apps, a software-only solution to protect SBU data and military-use-only apps is needed for current COTS smartphones.

Under this topic, a framework of applications and services for commercial smartphones must be presented that protects data-at-rest and sandboxes military-use applications from untrusted applications[LG10], providing separation between trusted and untrusted applications, and simplifying the OPSEC concerns raised by dual use of the smartphone in an operational setting. This framework must support open source development of apps and operate on current COTS smartphone platforms in common use today. This framework should be designed to support extensions to the supported apps and services in a convenient and secure manner.

PHASE I: Design a concept that can be readily deployed on smartphones that would provide separation between trusted and untrusted applications and services, and protect sensitive data-at-rest in trusted applications. The submission must address techniques to prevent inadvertent sharing of information between trusted and untrusted applications, leakage of data to untrusted applications, and strong protections for data-at-rest on the smartphone platform. The large scope of the problem dictates that solutions identified in Phase I will be carefully defined and the scope sufficiently limited to identify achievable tasks for Phase II.

The outcome of Phase I will be architecture descriptions and a preliminary prototype description demonstrating the feasibility of the design on a single smartphone development platform.

PHASE II: Demonstrate application and data protection capabilities on two or more commercial smartphone platforms, showing resilience against malware and protections of data-at-rest using the proposed framework. The framework will be capable of identifying attempts by malware to access protected data and applications and notifying the user. The software framework will create virtual partitions and be capable of purging data of OPSEC sensitive information before releasing it outside the sandbox. The outcome of Phase II will be a full implementation of the design and prototype delivered in Phase I, providing technology that can be tested in a real-life environment.

PHASE III: The integration of COTS equipment with military communications systems will require new security policies that meet stringent DoD standards. Security will be of paramount importance in order to successfully integrate commercial handsets into military networks and communication systems. Transition opportunities will be focused on tactical wireless communications system such as JTRS.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial smartphones and social networks are becoming part of our daily culture. New security risks and vulnerabilities are revealed almost daily. The proposed technology will enable communities of interest to develop dual-use handsets for handling sensitive business information along with personal-use applications. A robust security system for personal movile devices would be of value to corporate, government and military customers.

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KEYWORDS: Smartphone; security; mobile ad-hoc networks; dual use; JTRS, Information Security

N112-169 TITLE: Miniature WCDMA Payload

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: Mobile User Objective System (MUOS), ACAT I

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

OBJECTIVE: Develop a miniature, ruggedized WCDMA payload to enable beyond line of sight communications links as an alternative or supplement to SATCOM.

DESCRIPTION: The loss of a single communications link should not lead to disaster for our war fighters. Diverse communications paths are required to ensure war fighters can communicate in a variety of austere scenarios. Technologies that enable links via multiple (ground, air, and/or space) communications layers are highly encouraged.

Wideband Code Division Multiple Access (WCDMA) is the latest generation of cellular phone technology and is being adopted for commercial, government, and military mission critical systems. In cellular systems, many users communicate with the base station over the air interface. The base station is in a fixed location, usually on a tower, to provide better propagation of the signal.

A miniaturized, ruggedized WCDMA payload could be used on balloons or unmanned aerial vehicles to provide enhanced cellular coverage in a variety of scenarios, however no such payload exists today. An airborne WCDMA payload requires beyond state of the art research and development because the payload will face many challenges not encountered on ground based systems such as: vibration; large, rapid temperature changes; extreme power limitations; and significantly different coverage geometry. Another challenge is the fact that the “tower” the user is communicating with may be moving at a relatively high speed in relation to the user, presenting Doppler and other effects. Innovative research and development is required to determine if technology can be developed to meet the challenges described above to enable operation in an airborne environment.

When combined with an appropriate communications link to the radio base station, a WCDMA payload would enable alternate or supplementary cellular communications using existing phones or radios. Areas of temporary congestion, such as stadiums and parks could be augmented with additional coverage at low cost. The system could provide emergency communications in the event of natural disasters where ground based cell towers are damaged.

PHASE I: Develop a WCMDA payload design concept(s) with analytical or numerical calculations to establish performance possibilities. Translate design concepts into a product development roadmap establishing a technical and program pathway to an operational capability demonstration.

Tasks under this phase could include:
• Create an initial design of a prototype system
• Develop new WCDMA payload technology concepts
• Predict performance parameters for the payload design

PHASE II: Implement and demonstrate a prototype payload.

• Implement and demonstrate a prototype payload
• Evaluate measured performance characteristics versus expectations and make design adjustments as necessary.

PHASE III: This phase will focus on the integration of the payload with potential aerial platforms, and interfacing with the military cellular communications systems such as the Mobile User Objective System (MUOS).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Areas of temporary congestion, such as stadiums and parks could be augmented with additional coverage at low cost. The system could provide emergency communications in the event of natural disasters where ground based cell towers are damaged.

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KEYWORDS: WCDMA, RF, communications

N112-170 TITLE: Wideband Radio Local Interference Optimization Techniques

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: Mobile User Objective System (MUOS), ACAT I

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

OBJECTIVE: Develop methods and algorithms for mitigating narrowband interference in wideband UHF SATCOM channels.

DESCRIPTION: Interference is one of the major impediments to Satellite Communications (SATCOM). Interference comes from sporadic unregulated RF transmission such as pirate radio and TV stations or other devices, as well as other sources. When strong interference is inside SATCOM channels, signals may be corrupted so that mission critical communications via satellite are disrupted. This impediment exists in both commercial and military systems.

Various methods and algorithms for mitigation of interference in narrowband (5 kHz and 25 kHz) UHF SATCOM systems have been proposed. However, narrowband interference mitigation in wideband (5 MHz) channels remains a difficult task. Coding and interleaving can only achieve limited mitigation. If some information about the interference is available, e.g. its modulation format, then one could try to estimate the wideband interference and subtract it from the received signal. If no prior information is available, however, mitigation of interference seems very difficult. This topic solicits innovative ideas for narrowband interference mitigation in SATCOM channels without prior knowledge of the interference. For example, time and/or spatial diversity could be considered.

The developed system should operate as a "black box", which sits between the original SATCOM antenna system and SATCOM receiver. The system should be able to mitigate multiple narrowband interferers, located anywhere within the UHF SATCOM frequency range. Some interferers will be relatively small (~25 kHz) while others may be larger (~300+ kHz). The interferers may appear and disappear sporadically, and the system should be able to adapt quickly to mitigate emerging interference with minimal communication down time. For signals received from the satellite, the mitigation system should be transparent to the receiver, simply passing the SATCOM signal from the antenna output to the receiver input with interference removed in real time. The ideal system would require no operating parameter information from the antenna or receiver.

PHASE I: Develop methods and algorithms for mitigating narrowband interference in wideband UHF SATCOM channels.

Tasks under this phase could include:
• Develop methods and algorithms
• Validate the proposed approach by computer simulation
• Estimate performance metrics such as bit error rate (BER), the effect of interference bandwidth and strength on BER, and adaptation time for effective mitigation
• Create an initial design of a prototype system

PHASE II: Implement and demonstrate the method(s) or algorithm(s) in a prototype device.

Tasks under this phase could include:
• Implement the new design and demonstrate its performance against expectations
• Evaluate measured performance characteristics versus expectations and make design/process adjustments as necessary
• Using a SATCOM simulator and/or actual over-the-air satellite signal, demonstrate the operation of the system and its effectiveness in mitigating various interference scenarios in UHF SATCOM channels.

PHASE III: This phase will focus on further testing and integrating the technology with existing military SATCOM systems such as the Mobile User Objective System (MUOS).

PRIVATE SECTOR COMMERCIAL POTENTIAL DUAL-USE APPLICATIONS: The technologies produced under this program could be applied to any commercial SATCOM channels/systems that experience similar kinds of interference.

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KEYWORDS: MUOS, SATCOM, UFO, Interference Mitigation, Wideband