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

The responsibility for the implementation, administration and management of the Navy SBIR Program is with the Office of Naval Research (ONR). The Director of the Navy SBIR Program is Mr. John Williams, john.williams6@navy.mil For 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 from **24 April 2012 through 23 May 2012.** Beginning **24 May 2012**, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in Section 1.5, c of the DoD Program Solicitation must be used for any technical inquiry.

TABLE 1: NAVY SYSCOM SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	Activity	Email
N122-107 thru N122-127	Ms. Donna Moore	NAVAIR	navair.sbir@navy.mil
N122-128 thru N122-133	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N122-134	Mr. Todd Groszer	NAVSUP	todd.groszer@navy.mil
N122-135 thru N122-144	Ms. Tracy Frost	ONR	tracy.frost1@navy.mil
N122-145 thru N122-151	Ms. Elizabeth Altmann	SPAWAR	elizabeth.altmann@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 Phase II start. Phase I options are typically exercised upon the decision to fund the Phase II. **The base amount of the 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 Program 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 invite, evaluate, and select Phase II proposals using the evaluation criteria in Section 4.3 of the DoD Program 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/STTR contract and awarded to the company which was awarded the Phase I/II SBIR is a Phase III SBIR contract. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description, which includes according SBIR Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR Phase I/II effort(s). The government's prime contractors and/or their subcontractors shall follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect rights of the SBIR company.

ADDITIONAL NOTES

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 six 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 http://www.onr.navy.mil/en/About-ONR/compliance-protections/Research-Protections/Human-Subject-Research.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:

The following criteria must be met 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 am ET, 27 June 2012.

____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.

NAVY SBIR 12.2 Topic Index

NAVY SBIR 12.2 Topic Descriptions

N122-107 TITLE: Improved Bearing Material for Aircraft Carrier Arresting Gear Components

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a dynamic bearing material (aka "slipper") to replace the current material used in the various subsystems of the carrier based arresting gear system that has improved service life with emphasis on galling and embedding resistance over the current material.

DESCRIPTION: Carrier aviation is dependent on the ability to recover aircraft expeditiously and safely aboard ship. The system that arrests the aircraft, the Arresting Gear system, utilizes slippers or bearing materials between moving components. The current slippers material conforms to specification MIL-P-5431 or commercial product Spaulding T-768. This material is a cotton-fabric reinforced graphite phenolic-based composite material. It is currently sole source procurement, and swells when exposed to ethylene glycol, which causes clearance issues in the operating equipment. When this material is used as packing, galling of material results in unwanted leakage, necessitating replacement prior to scheduled maintenance. Maintenance involving replacement of the slippers is a labor intensive, expensive process.

The Navy is seeking a material for the slippers that is more wear resistant than the current material. Improving the life of the slippers will result in labor savings and greater equipment availability.

The slipper materials bear the weight of the various arresting gear components: main engine cylinder piston, crosshead, accumulator piston, and sheave damper piston. The slippers are the sliding medium between arresting gear components to allow free movement during arrestments, therefore the static and dynamic frictional characteristics of the slippers are significant. The slippers bear the weight of the components both statically and dynamically during arrestments. Static loading on slippers varies from 10 psi to 530 psi. The dynamic loading has not been resolved. The slippers are subject to immersion in ethylene-glycol based hydraulic fluid, humid air, and various greases and lubricants. The slippers must maintain dimensional stability throughout their lifetime, and have low wear rates compared to the existing material. System operating temperature is ambient to 200 degrees F. Acceleration of components varies from 0 to 18 G’s during an arrestment. Total linear movement of the slippers during an arrestment is from 0 in. to 112 in. Velocity of the slippers during an arrestment ranges from 0 in/s to a peak of 540 in/s. It is desired for the slippers to have a life of 20,000 arrestments, with no shelf life limitations. The slippers are presently machined to shape, and some are required to be custom fitted and machined in situ during replacement. It is desired, but not required, for the same material to be used in all applications.

The Navy will consider proposals for new materials, application of existing materials, or novel approaches to slipper materials, but the solution must be a drop-in replacement for the current material. No proposals that require arresting gear component re-design will be considered.

PHASE I: Develop a concept for an improved "slipper" material including an approach for manufacturing the "slipper" material. Demonstrate feasibility of the approach through limited testing.

PHASE II: Fully develop the concept conceived under Phase I into a prototype "slipper" material for use in the various arresting gear system applications. Demonstrate the ability of the system to provide the required life under operational conditions along with the ability to produce the material in a repeatable fashion.

PHASE III: Perform qualification testing and transition the "slipper" material to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Developed materials have broad application as wear and bearing materials, as well as intermediate material between two metal surfaces that slide relative to each other for any industrial application.

REFERENCES:
1. Sketches of Crosshead, Sheave Damper Crosshead, Accumulator slipper cage, MEC slipper cage sketch (to be posted in SITIS during Pre-Release).

2. Slipper location, contamination factors, risks, suggested testing and change methods spreadsheet (to be posted in SITIS during Pre-Release).

3. Locations where slippers are currently used, as well as mating material and bearing material information, including surface finish, and lubrication used. (Posted in SITIS 5/15/12.)

KEYWORDS: Arresting Gear; bearing material; Wear; slipper; dynamic and static friction; Composite

N122-108 TITLE: Acoustic Array Simulation Environment System

TECHNOLOGY AREAS: Sensors, Battlespace

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 acoustic array simulation system that allows for Time/Angle of Arrival analysis, testing, validation and verification of antisubmarine warfare system (ASW) sensors on fixed wing (manned and unmanned) and rotary wing aircraft.

DESCRIPTION: ASW systems and sensors under development require increasing test and evaluation prior to production decision to ensure the adequacy and effectiveness of the technology. Sensors such as Software Defined Sonobouy Receiver (SDSR) process acoustics signals received from sonobuoys, based on Time/Angle of Arrival (T/AoA), require a dispersal pattern for the signals to test the range and accuracy of the system processor hardware and software. Current test environments only allow for acoustic signals radiated from a single source (antenna) which are not geographically dispersed. T/AoA cannot be calculated properly without geographical separation of antennas. An innovative approach is needed to provide multiple acoustic signal time and angle of arrival to simulate a real time ASW environment for the test, validation, and verification of the SDSR. In addition, up to 64 acoustic signals will need to be generated from the acoustic array simulator to ensure the fidelity of the processing hardware and software systems and sensors. Also, an innovative process to convert the acoustic signal for ground testing application and environmental simulation must also be part of the proposed solution.

PHASE I: Determine the feasibility and recommend an approach for developing an innovative, low cost, acoustic array simulation system that provides for end to end test and system effectiveness modeling of T/AoA in an ASW environment. Provide a recommendation for the implementation of acoustic signal conversion for ground testing and sensor simulations. Investigate the potential for the use of reusable sonobuoys as part of the acoustic array simulation system.

PHASE II: Develop a prototype design of the acoustic array simulation system and determine all technical challenges and risks with the implementation of the proposed design in a real time environment. Demonstrate the feasibility of leveraging new technologies into the prototype system design. Demonstrate the generation of up to 64 acoustic signals in the test model environment. Demonstrate system reliability, maintainability, and environmental ruggedness in the overall system design.

PHASE III: Build an acoustic array simulation system and demonstrate all key functional features of the system in an operational environment. Identity potential technology insertion and growth areas that can be used as targeted pre-planned product improvements and the technology areas they address as a function of the SDSR system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The acoustic array simulation system can be used in a tailored state for the monitoring of coastal traffic in remote areas that have been used in the past for drug smuggling. The passive system receives acoustic signatures generated by surface boats used in the smuggling of illegal narcotics to allow for the real time tracking of the narcotic traffickers at sea. A GPS component can be added to allow for highly accurate geo-location of the tracked surface boat when the boat is operating under emission control (EMCON) conditions.

REFERENCES:
1. MIL-STD-464A, Electromagnetic Environmental Effects; Requirements for Systems, 19 December 2002

2. Annex C to STANAG 4283 (Edition 5), Acoustic High Density Digital Recording Standard for Maritime Patrol Aircraft

3. MIL-STD-461E, Requirements for the Control of Electromagnetic Interface Characteristics of Subsystems and Equipment.

4. MIL-STD-1553B, Wideband Sonobouy Receiver System, Interface Requirements & Design Document.

KEYWORDS: Acoustic Array; RF signal; ASW; Time/Angle of Arrival, Software Defined Sonobouy Receiver

N122-109 TITLE: Heat Resistant Portable Helipad

TECHNOLOGY AREAS: Materials/Processes

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OBJECTIVE: To develop a high temperature and thermally resistant portable vertical takeoff and landing (VTOL) pad system for Marine Expeditionary Airfields.

DESCRIPTION: In austere environments, brownout conditions can be a problem to rotary wing aircraft and its personnel. A brownout condition is an in-flight visibility restriction due to dust or sand in the air. in a brownout, the pilot cannot see nearby objects which provide the outside visual references necessary to control the aircraft near the ground. This can cause spatial disorientation and loss of situational awareness leading to a deadly mishap.

To combat these types of situations, the USMC installs a lightweight mat vtol pad, such as mobimat, for landing and takeoff. Lightweight mat serves as a dust suppressing material. As rotor wash passes through the semi-permeable mat systems, the dirt, dust, and sand are kept down and prevent the brownout effects.

Mobimat fails when subjected to the increased downward thermal loads expected from future helicopters/vertical landing aircraft. The Navy needs research and development of a new lightweight mat with material that is lightweight, strong, and highly heat resistant for compatibility with future aircraft.

General requirements:
1. shall be able to withstand 650 degrees fahrenheit minimum for 20 minutes minimum.
2. shall be corrosion and weather resistant
3. shall be lightweight and quickly installed
4. the mats shall be interchangeable with one another
5. shall have a minimum air permeability of 600cfm/ft^2 in accordance with astm 737
6. shall have a minimum puncture strength of 630 lbs in accordance with astm 6241.
7. shall have a minimum tensile strength of 500 lbs in accordance with astm 4632.
8. shall have a minimum tear propagation of 115 lbs in accordance with astm 4533.

9. shall require minimal ground preparation
10. securable to ground with 1.375â€ diameter grommets
11. shall suppress dust kick up from aircraft
12. the maximum mat density shall be 0.35 pounds per square foot, with a maximum mat volume of 0.1 cubic feet per square foot.

The Navy will consider proposals such as new matting systems, improved matting materials, or heat shielding technologies compatible or integrateable with mobimat.

PHASE I: To determine feasibility of design to meet requirements, and provide defendable estimates for: cost, required manpower and support equipment for installation, and system producability, reliability, and maintainability. Prove structural and thermal properties through either analysis and/or limited lab demonstration (preferred).

PHASE II: Develop a full scale prototype and demonstrate system reliability in a relevant environment. The demonstration will analyze the VTOL pad for physical and thermal damage as well as anchor loading and dust suppression caused by aircraft during different landing and takeoff procedures. A successful demonstration will also exhibit fast setup and installation.

PHASE III: The developed technology will be produced for transition to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed may have civil/commercial applications for temporary VTOL helipads and high strength thermally resistant geotextile applications.

REFERENCES:
1. American Society for Testing and Materials (ASTM) technical standards 6241,4632, and 737

KEYWORDS: helipad; Materials; high temperature geotexile; eaf; thermally resistant

N122-110 TITLE: <u>Innovative Structural Health Monitoring (SHM) System Capable of Detecting, Localizing, and Characterizing Damage in Composite Aircraft Structures</u>

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Electronics

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 structural health monitoring (SHM) system capable of detecting damage in composite aircraft structures. The system must be able to successfully detect damage events, localize where the damage occurred, and characterize the type of damage in critical components of the aircraft structure that if left undetected might lead to loss of the aircraft and crew.

DESCRIPTION: Advanced composite materials are becoming more commonly used in modern aircraft structural components to reduce the overall weight, fuel expenditures and life cycle cost of the aircraft. Despite their high strength and flexibility in design, composite materials are susceptible to damage. The main sources of damage are fatigue and direct impact, causing cracking, crushing, or delamination of the composite material. The ability to detect anomalies or damage in composite aircraft structures could significantly reduce the amount of inspection and testing required, resulting in greater aircraft availability and higher readiness rates.

The aim of this program is to develop a structural health monitoring system capable of detecting, locating, and characterizing damage in composite aircraft structural components. The SHM system should have a math/physics based model that is the basis for characterizing damage and be capable of characterizing as many types of damage as possible.

A potential system's sensors must be capable of operating in typically harsh aviation environments including wide temperature and humidity variation as well as high vibration. Proposed systems must minimize the number of sensors used while maintaining the ability to monitor globally and detect damage locally. Ideal systems will utilize wireless sensors and technology.

PHASE I: Develop a SHM system concept that detects, localizes, and characterizes damage on composite aircraft structures. Demonstrate damage detection, localization, and characterization capability on a composite aircraft structure.

PHASE II: Develop a prototype SHM system capable of deployment for damage detection on an actual aircraft structure subjected to representative loading and environmental conditions. Demonstrate prototype system under representative loading and environmental conditions (operational cyclic loading, humidity and thermal gradients, etc.).

PHASE III: Integrate developed SHM system with end user systems and interfaces. Conduct final experimental testing on actual NAVAIR assets. Transition damage detection of composite aircraft structures into both damage prognosis and damage mitigation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A number of other applications and industries would benefit from a composite SHM system. The system could potentially benefit any Navy application where composite structures are subjected to harsh environments where the risk of damage is high. Commercial aviation could also benefit from a successfully developed composite SHM system as commercial aviation is using composites more frequently.

REFERENCES:
1. Chudnovsky, A., Donskoy, D., Golovin, E., Zarai, A. Nonlinear Acoustic Structural Health Monitoring. 47th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, May 1-4, 2006, Newport, Rhode Island. American Institute of Aeronautics and Astronautics.

2. Kosmatka, J.B., Velazquez, E. Acoustic Emission Monitoring of Interlaminar Micro-Cracking and Strength. 49th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference May 4th-7th 2008, Schaumburg, Illinois. American Institute of Aeronautics and Astronautics.

KEYWORDS: Structural Health Monitoring (SHM), Non-Destructive Inspection (NDI), composites, Damage Detection, Damage Characterization, Helicopters

N122-111 TITLE: Development of New Processes for the Refurbishment of Infrared Search and Track (IRST) Germanium (Ge) Domes

TECHNOLOGY AREAS: Air Platform, 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: Develop a process to refurbish hemispherical Ge domes, which will restore infrared (IR) transmission and meet the operational performance specifications of the IRST system.

DESCRIPTION: After extensive use in adverse environments such as sandstorms, rain, and fog, IR domes develop pits and surface anomalies, which lead to a reduction in the average transmission to below acceptable limit. New domes are quite costly since they are constructed of single-crystal germanium (Ge) with very sophisticated inner and outer surface coatings. A process is needed that is capable of restoring the Ge domes to a state or condition that will pass all imaging and environmental specifications set for the original dome design. The refurbishment process must take into consideration the tight tolerances on inner and outer radii to maintain focal length and eliminate any image distortion. A refurbishment process that results in a change in dome thickness, and therefore focal length, should be detailed. A process to rebuild the Ge dome to its original thickness should be included in the contractor's report. The IRST system operates in the nominal 7.5-13 um region. Ge is a wide-band gap semiconductor with a refractive index of n=4.00 (10 um) and is naturally 54 percent transparent to IR light in the wavelength range of 2-14 um. No IR energy is lost in the material but a reduction of 56 percent transmission occurs due to reflections at the front and back surfaces of a highly polished Ge window. Antireflective (AR) coatings deposited onto these surfaces can help to virtually eliminate surface reflections and increase IR transmission to greater than 95 percent over specific wavelength ranges. The contractor must include recommendations for the alternative AR coating materials and rain and sand erosion protection will both maximize IR transmission in the designated IR wavelength band and provide durability to withstand the operational environment.

PHASE I: Develop a process for refurbishing Ge Domes. Research existing processes and provide a conceptual analysis of the proposed process. Provide pertinent calculations, which demonstrate the knowledge required to design, develop and produce a process to re-polish and recoat existing IRST Ge domes that have not passed the transmission test. Provide an estimate of the cost benefit of refurbishment compared to dome replacement.

PHASE II: Produce and verify a process that will refurbish the Ge domes to an operationally ready state. Refine a process to rebuild the domes to their original thickness while maintaining the required performance specifications of the IRST system. A test case should be generated to validate the rebuild/refurbish process developed by the contractor.

PHASE III: Restore IRST domes to the original specifications required by the IRST system. The restoration shall, at a minimum, make ready for issue (RFI) all domes that have previously been removed from the inventory. Domes that cannot be restored should be evaluated for further reconditioning or recommended for condemnation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The electric power utility industry utilizes IR sensors in the same bandwidth as the IRST sensor to perform evaluation on above ground power transmission lines for insulation leaks. These power line insulator leaks result in power transmission loss costing the electric utility companies millions of dollars annually. To identify failures in power line insulation, public utilities use specially configured aircraft that fly over the nation's power lines using an IR sensor to detect the leaks. The IR systems used in the utility company's aircraft generally have the same type of IR window used in an IRST system. While less harsh (lower speed), the utility company aircraft's IR system is subject to much of the same environment. However, the utility companies operate their aircraft IR systems more than the Navy uses the IRST. Further, the flights are made at lower altitudes where airborne particulate matter has a greater opaquing effect on the IR window. As a result, failure of the IR window occurs as often if not more often than in the Navy. Development of a refurbishment process can be directly applied to this particular commercial application. The same applies to the oil and gas industry in the identification of leaks in their pipelines.

REFERENCES:

1. http://spiedigitallibrary.org/proceedings/resource/2/psisdg/7302/1/73020L_1?isAuthorized=no

2. http://www.amazon.com/Germanium-Based-Technologies-Materials-Cor-Claeys/dp/0080449530/ref=sr_1_3?s=books&ie=UTF8&qid=1313619172&sr=1-3

3. http://www.google.com/patents?hl=en&lr=&vid=USPAT6958254&id=VeUUAAAAEBAJ&oi=fnd&dq=germanium+deposition+on+domes&printsec=abstract#v=onepage&q=germanium%20deposition%20on%20domes&f=false

4. http://www.sciencedirect.com/science/article/pii/S0022024805001132

5. http://spiedigitallibrary.org/jnp/resource/1/jnoacq/v4/i1/p041535_s1?isAuthorized=no

KEYWORDS: Infrared Dome; Lens Resurfacing; Germanium Window; Diamond-like Carbon; DLC; Infrared Window

N122-112 TITLE: High Efficiency 808 nm Laser Pump Diode Arrays with Excellent Beam Quality

TECHNOLOGY AREAS: Air Platform, Sensors

OBJECTIVE: To significantly improve the overall efficiency of 808 nm, kilowatt class laser pump diode arrays through 1) electrical to optical efficiency improvement and 2) combined beam quality improvements to most effectively use the optical energy in the pumped, lasing medium.

DESCRIPTION: Today's commercially available kilowatt class, 808 nanometer (nm) laser diode arrays and stacks are approaching 60% electrical to optical conversion efficiency. However, due to the low combined beam quality, high temperature coefficient and line width, the generated optical pump poser cannot be used efficiently. The DARPA Super-High-Efficiency Diode Sources (SHEDS) program made great strides in the last decade, particularly in the 975 nm range. At that time though, the 808 nm efficiency was advanced to approximately 45%. To reduce the size, weight and power draw of current, near-term, and future Navy laser sensors, particularly Nd:YAG based laser transmitters, further improvements in 808 nm diode array efficiencies, approaching or exceeding 85%, must be made.

This SBIR topic focuses on several aspects of high power laser diode efficiency. The first is electrical to optical conversion efficiency, sometimes called wall plug efficiency. This high efficiency goal includes cooling of the laser diode array. If cryogenic techniques are used, this requires additional electrical power. Therefore room temperature operation with standard water or convection cooling techniques are desired. The next aspect is combined beam quality. While Gaussian beams with M2 (a popular measure of beam quality) values of 1 with low beam divergence are desired, it is difficult to achieve. However, the beam quality is very important for maximizing the optical power density and uniformity in the laser media pumped volume. This might be considered optical to optical efficiency where the maximum laser diode pump power is converted to the end product laser power, 1064 nm power in the Nd:YAG case. A third aspect that contributes to efficacy is the stability and line width of the laser diode array. The pumped laser media tends to have peaked absorption spectra so a low temperature coefficient and a narrow line width output of the laser pump diode array will contribute to the optical power conversion efficiency in the overall laser system.

In summary, Key performance objectives that are to be optimized are: 1) maximizing diode array, efficiency for kilo-watt class stacks, 2) maximizing beam combining efficiency and beam quality and 3) minimizing the temperature coefficient and laser line width.

PHASE I: Demonstrate the feasibility of the technical approach. Perform preliminary bench-top testing to verify performance of components or design.

PHASE II: Develop and demonstrate a working bench-top design. Sufficiently harden bench-top design for testing and demonstration in dynamic environment. Design and develop working proto-type based on results of bench-top device.

PHASE III: Complete prototype development and document the design. Units procured under this phase may be tested/demonstrated in Navy systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In the laboratory environment efficiency is not required, however, the cost per KiloWatt will be reduced and therefore highly desirable in a wide range of commercial laser systems.

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2. Sean Ross, and William P. Latham "Appropriate Measures and Consistent Standard For High Energy Laser Beam Quality” (Postprint), Air Force Research Laboratory, Directed Energy Directorate, Issue Date 2006-8, Journal of Directed Energy, 2, Summer 2006 pages, pp. 22-58.

3. A. E. Siegman, "Defining, measuring, and optimizing laser beam quality", Proc. SPIE 1868, 2 (1993); Issue date 1993-1.

4. C. Martin Stickley, Mark E. Filipkowski, Enrique Parra, Edwin E. Hach III, v, "Overview of progress in super high efficiency diodes for pumping high energy laser", Proceedings of SPIE Volume: 6104, Issue Date 2006-2

KEYWORDS: Laser diode; VCEL; edge emitter; beam quality; packaging; power

N122-113 TITLE: Deep Vector Sensor System

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

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: Determine the feasibility of developing a Reliable Acoustic Path Vector Sensor Sonobuoy System

DESCRIPTION: The Navy is becoming increasingly interested in the prospect of deploying acoustic sensing systems below critical depth in the ocean at extremely deep depths close to or on the ocean bottom in convergent zone type environments [1]. At these depths the ambient noise structure and sound propagation physics are unique [2] and have the potential to be exploited by future surveillance systems. The concept of reliable acoustic path sensing within the sonobuoy community is not new since a sonobuoy known as the reliable acoustic path sonobuoy was developed in the 1980s, but never went into production [3]. That buoy employed monostatic sonar system architecture and had an operational frequency of approximately 4 kHz. Recent investigation of the ambient noise structure in the deep ocean [2] suggests that a passive directional sonobuoy system covering the band from 5 to 500 Hz would be of interest. When the sea state is calm, the ambient levels are nominally 40 to 50 dB re 1 Î¼Pa2/Hz [2]. A directional sonobuoy comprised of a single triaxial vector sensor having an electronic noise floor that is 15 to 20 dB below the ambient (25db re 1 Î¼Pa2/Hz goal) is thought to be well-suited for this application particularly in view of the array gains achievable as a result of the anisotropic noise field. The low electronic noise specification puts extreme demands on the sensor given the A-size sonobuoy form factor coupled with operation at 6 km depths [4]. Another major challenge concerns the use of a hard-wire telemetry link to route the data from the sensor to a surface buoy which in turn has an RF link. The term hard-wire is meant in the general sense of having a physical connection from the sensor to the surface buoy. Given this physical connection, special consideration must be made concerning how the system is packaged, deployed, and mitigates self-noise. In addition to the difficult requirements for the triaxial sensor, innovative sonobuoy engineering concepts are needed to achieve this goal.

The lessons learned regarding mitigation of vertical motion and flow-induced noise on the AN/SSQ-53 DIFAR sonobuoy [3] should be folded into the design, as appropriate. RF link considered shall be the new proposed sonobuoy link which is composed CPGFSK (Continuous Phase Gaussian Frequency Shift Keying) waveform of 320 kbps of which 288 kbps can be acoustic data.

Note that A-size refers to the standard U.S. Navy Sonobuoy form factor or a right-circular cylinder having a diameter, length, and maximum weight of D=4.875 inches, L=36 inches, and W=39 pounds.

PHASE I: Perform modeling and simulation studies to evaluate prospective sensor, telemetry, packaging, deployment, and self-noise remediation designs within the overall architecture of an A-size sonobuoy

PHASE II: Fabricate and test a pre-prototype sonobuoy for an over-the-side test in a convergence zone type area location

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Use of these sensors has potential applications in seismology, marine mammal detection, and terrorist security systems.

REFERENCES:

1. R. J. Urick, Principles of Underwater Sound (McGraw-Hill Book Company, New York, 1975), 3rd Ed., p. 195.

2. R. D. Gaul, D. P. Knobles, J. A. Shooter, and A. F. Wittenborn, Ambient Noise Analysis of Deep-Ocean Measurements in the Northeast Pacific, IEEE J. Ocean. Eng. 32(2), 497 512 (2007).

3. R. A. Holler, A. W. Horbach, and J. F. McEachern, The Ears of Air ASW, A History of U.S. Navy Sonobuoys (Navmar Applied Sciences Corporation, Warminster, PA, 19874).

4. J. F. McEachern, J. A. McConnell, D. H. Trivett, and J. M. Jamieson, ARAP, Deep Ocean Vector Sensor Research Array, MTS/IEEE Oceans 2006 Conf. Proc., Boston, MA, September 18-21, 2006

KEYWORDS: sonobuoy, vector sensor, reliable acoustic path, deep ocean

N122-114 TITLE: Robust Power Conversion/Conditioning Technologies for High Power Aircraft Applications

TECHNOLOGY AREAS: Air Platform

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: Development of innovative high density, high efficiency power conversion and conditioning technologies supporting high power, low duty cycle applications.

DESCRIPTION: The intent of this topic is to focus innovative research on solving the technical challenges associated with developing and demonstrating a high density, high efficiency power conversion and conditioning device for high power, low duty cycle, rotary wing aircraft-based applications.

Proposals shall demonstrate the ability to receive input voltages that shall consist of standard military aircraft ac and dc voltages; to include 115 volt ac (vac), 400 hz, 3-phase; 28 volt dc (vdc); and/or 270 vdc sourced from an aircraft power generation system, unregulated aircraft-qualified transformer rectifier, battery, and/or capacitor module.

The technology solution shall provide a high vdc output (estimated between 270 and 500 vdc), at an estimated power level of 100 to 150 kwe for a minimum duration of 30 seconds. the estimated duty cycle shall vary between 10 to 25% over a period of one-hour, but will be assessed dependent on the technology solution(s) provided within the proposal. Voltage tolerances of +/- 1 to 5% during the duty cycle, independent of the change in input voltage when utilizing battery or capacitor technologies, shall be required. The technology solution shall be designed to minimize output voltage ripple amplitude throughout operation, with a maximum allowance of 6.0 volts. The technology solution may include a dedicated thermal management system (tms) to support operation, or can include requirements for interface to existing/planned aircraft tms.

The ability for the technology solution to be scalable and support paralleled operation to allow for increased system level power (>150 kwe) is valid and of significant interest under this topic. The use of multiple lower power level technology solutions in parallel to support the stated power level goal of 100 to 150 kwe may also be valid, provided benefits of doing so are clearly shown.

Proposals shall focus on the innovative use of technologies that support dc to dc and/or ac to dc conversion; which may include wide temperature power electronics/components, optimized thermal management design methodologies, and/or advanced material use; to ensure the technology solution is within reasonable size, weight, and power (swap) for use onboard a rotary wing platform. Additional system level design requirements shall be provided to support the selected design approach during a Phase I requirements review.

Technical challenges include, but are not limited to, 1) producing components of sufficient reliability under estimated high power conditions, 2) producing components of sufficient power densities for aviation applications, 3) producing components that can withstand high operating temperatures and 4) developing components that can withstand the harsh navy aircraft operational, electrical, and environmental requirements (e.g. temperature, altitude, shock, vibration, emi).

PHASE I: Define a technical approach and implementation plan for developing an aircraft electrical power conversion and conditioning technology for high power, short duty cycle applications. Validate the approach analytically or provide test data or bench top hardware that would validate the approach. Test data can include initial characterization of breadboard components or samples for electrical power and thermal limits per commercial or military standards.

PHASE II: Design, develop, and demonstrate prototype, aircraft electrical power conversion and conditioning technology for high power, short duty cycle applications based on Phase I efforts. Development should include electrical, thermal, and mechanical characterization of equipment per commercial or military standards. Demonstration can include a high-fidelity laboratory environment and/or aircraft ground demonstration.

PHASE III: Complete packaging and integration of the prototype, aircraft electrical power conversion and conditioning technology for high power, short duty cycle applications for use in a Navy aircraft platform, complete safety of flight certification, and perform a flight demonstration. Transition to NAVAIR Program Offices for final system integration, flight evaluations, and procurement.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The results of this work can be commercialized to provide high density, high efficiency aircraft electrical power conversion and conditioning technology for space, sea, air, and land vehicles. This technology will result in improved safety and reliability, reduced maintenance costs, and reduced procurement costs by extending the service life of the equipment. Private sectors that face similar reliability concerns include aerospace, power utilities, and automotive industries. Commercial airlines are specifically interested in high density and high efficiency components and conversion equipment.

REFERENCES:
1. MIL-STD-704A, Aircraft Electric Power Characteristics, 09 August 1966.

2. MIL-STD-810F, Environmental Engineering Considerations and Laboratory Tests, 05 May 2003.

3. MIL-STD-461E, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, 20 August 1999.

KEYWORDS: Electrical Power Distribution, High Temperature Components, Silicon Carbide Devices, DC to DC Power Conversion, High Power, Optimized Thermal Management

N122-115 TITLE: GPS-Iridium Anti-Jam (AJ) Antenna Systems for Air Vehicle and Sea Vehicle Platforms

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

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 integrated military anti-jam (AJ) antenna systems with small footprint which can operate using both GPS navigation satellite signals and Iridium communication satellite signals. Antennas are desired for both air vehicle and sea vehicle platforms. An integrated antenna system offers the following potential benefits compared to the use of two separate antenna systems: reduced antenna footprint more suitable for platforms with limited size, weight and power (SWAP) constraints, reduced integration and test costs, reduced complexity of upgrade (e.g. an existing GPS antenna may be replaced with a GPS-Iridium antenna), integrated antenna provides AJ benefits to both types of systems, common antenna aperture for navigation and timing, e.g. facilitates compensation of Doppler effects associated with antenna lever arms and enables enhanced signal-to-noise ratio (SNR).

DESCRIPTION: Signals broadcast by GPS satellites are susceptible to degradation or disruption by low levels of RF interference. One method to counter GPS interference is through the use of multi-element adaptive array antenna technology to either form an antenna beam null in the direction of interference sources, form beams in the direction of GPS satellites or perform a combination of these two operations. Current GPS antenna systems operate on the military L1 and L2 frequency bands.

The inclusion of iridium signal functionality within a common adaptive array antenna system introduces significant challenges into the antenna design requirements.

GPS AJ antenna systems must operate in the presence of multiple GPS satellites in view, e.g. up to 12 satellites, and also multiple GPS interferers in view having different line-of-sight (los) directions. whereas older antenna technologies often operated on the principle of "nulling" the interferer signal, e.g. by forming nulls in the antenna gain pattern in the direction of the interferers, many of the newer antenna systems combine nulling with beam forming or beam steering, i.e. forming antenna beams in the direction to GPS satellites. The combination of nulling towards interferers and beam forming towards GPS satellites has the effect of attenuating the interference signals while amplifying the satellite signals. Even when interference is not present, the effects of beam forming can provide increased SNR and link margin for processing GPS and iridium signals.

The process of "nulling" can result in rapidly changing composite RF signal phases (often in an unpredictable fashion) in the GPS receiver and navigation algorithm. Since some GPS applications, e.g. aircraft landing systems, require the use of precise carrier phase information, the navigation function associated with these applications can be degraded when nulling occurs. If the complex antenna weights are controlled (or known) in the same processor as the navigation function, then the effect of the complex weights on the composite RF signal phase can be predicted. More advanced algorithms can combine adaptive antenna array and adaptive filter technologies in the time or frequency domains to perform space-time adaptive processing (STAP) or space frequency adaptive processing (SFAP).

On some air vehicle and sea vehicle platforms the functions of beam forming and nulling must also compensate for aircraft kinematics, e.g. rotation of the antenna array plane. Thus modern adaptive antenna system signal processing may be tightly coupled with GPS and inertial navigation systems (INS) for improved performance.

Designs which digitally form the antenna array beams within the receiver/navigation processor may also generate a different beam for each satellite signal processed, with the processing of each type of signal optimized for frequency band, signal power, signal and interference characteristics within the frequency band of interest, and signal type requirement (e.g. navigation or communication), etc.

Solutions for both air vehicle and sea vehicle platforms are desired, including small form factors with diameters of four inches or less and depth of three inches or less (including antenna and antenna electronics). Both iridium signal transmission and reception functions are required. For air vehicles, AJ capability is desired for both the received GPS and iridium signals. For the sea vehicle version, aj is required for the GPS signal reception and the GPS reception and iridium transmit/receive capability does not have to be simultaneous. Objectives include frequency bandwidth compatible with the GPS m-code (L1 & L2 with at least 24 mhz bandwidth) and a 30 db interference rejection capability for at least three los directions while maintaining good signal availability for accuracy.

Some of the technical challenges associated with an integrated GPS-iridium AJ array antenna system include: (1) the antenna system must address platform constraints and interface requirements for both GPS and iridium signals, and must operate synergistically with GPS and iridium transceiver signal processing, (2) interoperability with other platform blue force RF emissions, (3) received iridium signal can be significantly stronger than received GPS signals, (4) the antenna must also support transmissions from the platform to the iridium satellites and the transmission signal is much stronger than the received signals -- thus the antenna system must provide good isolation to prevent the transmission signal from activating the nulling function, and to enable simultaneous reception of weak navigation and communication signals and transmission of strong signals, if applicable for platform mission requirements, (5) iridium is a LEO system and GPS is a MEO system so that the iridium satellites are subject to much smaller rise to setting time intervals, e.g. on the order of several minutes for iridium as compared to several hours for GPS satellites, and higher doppler and doppler rates for iridium than for GPS satellites, (6) iridium satellites do not have as much geometric diversity as the GPS satellites, e.g. whereas often eight or more GPS satellites are in typically in view, only four satellites are needed to enable a navigation solution. On the other hand, often only a single iridium satellite is in view and this satellite must maintain connectivity for the duration of the communications interval or until another satellite comes into view. Thus for a single iridium satellite in view, the los direction must be given a strong preference within the spatial processing algorithm. The beam forming may need to be coordinated with the iridium satellite communications function, including a coordinated switching to new iridium satellites at the appropriate time epochs.

PHASE I: Perform analyses and trades to illustrate a strong understanding of the requirements and to predict performance. Develop designs for integrated GPS-Iridium antenna systems or antenna/transceiver navigation/communication systems that address the technical issues and challenges indicated above. Demonstrate how the antenna system integrates into air and sea vehicle platforms and operates synergistically with the GPS-Iridium and INS, if applicable, signal processing. The design should emphasize reuse of existing antenna technology and consideration of platform requirements and constraints, including interface and availability requirements. Document the design and predicted performance results in a report.

For the sea vehicle version, a Phase I objective includes demonstration via breadboard or test bed.

PHASE II: Develop the design into a mature bread board, test bed or prototype system, and demonstrate performance in an RF interference environment using simulated or real GPS and Iridium satellite signals.

PHASE III: Develop operational GPS-Iridium integrated antenna systems or antenna/transceiver navigation/communication system, integrate and test the performance in air vehicle and sea vehicle platforms in the presence of interference.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology may also be used for navigation on commercial air and sea vehicle systems, e.g. commercial aircraft. For example, because of the proliferation of low-cost GPS jammers, the FAA is becoming more concerned about the loss of GPS or Wide Area Augmentation System (WAAS) signals due to RF interference, such as recently occurred in the Newark airport area. In this case, the antenna design could be modified to include the WAAS signal as broadcast from WAAS satellites deployed at geosynchronous (GEO) orbit.

REFERENCES:
1. The Global Positioning System, http://en.wikipedia.org/wiki/Global_Positioning_System

2. Iridium Satellite Communication System, http://en.wikipedia.org/wiki/Iridium_Communications

3. The Wide Area Augmentation System, http://en.wikipedia.org/wiki/WAAS

4. "Insights into Jammer Mitigation Via Space-Time Adaptive Processing," K. F. McDonald, P. J. Costa, and R. L. Fante, The MITRE Corp, IEEE 2006.

KEYWORDS: GPS; Global Navigation Satellite Systems; communications satellite systems; anti-jam antenna systems

N122-116 TITLE: Free Space Optical Communication for Ocean Surface Transceivers

TECHNOLOGY AREAS: Information Systems, Electronics, Battlespace

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OBJECTIVE: Provide innovative concepts leading to the development of a Lasercom (Free-space optical (FSO) communication) system for use in Anti-Submarine Warfare (ASW) Operations.

DESCRIPTION: Lasercom, also known as free-space optical (FSO) communication, has emerged in recent years as an attractive alternative to conventional RF communication [1, 2, 3]. This is due to the increasing maturity of lasers and compact optical systems as well as unique advantages of Lasercom. Setup is relatively low-cost, with no licensing or frequency allocation requirements.

Lasercom's primary advantages for military applications are covertness, lack of Radio Frequency Interference (RFI) from any RF sources (radars or communication systems), immunity to jamming, lack of frequency allocation requirements (allowing operation in all national and international waters), and high bandwidth. Lasercom inherently has a low probability of interception and detection (LPI/LPD). The successful demonstration of FSO links for ASW operations will enable diversified communication paths that will allow operations in situations where RF sources are inoperable due to multiple possible causes RF interferences, jamming, spectrum allocations issues, lack of host nation approval.

Lasercom system will consist in the implementation of a bi-directional free-space point-to-point optical link utilizing invisible beams of light to send and receive voice, video, and data information between two transceivers within line-of-sight transmission. FSO technology is based on the connectivity between FSO-based optical wireless units, each consisting of an optical transceiver to provide full-duplex (bi-directional) capability. The Lasercom system plan of integration consists of a low-cost solution, small size factor, low power consumption, and minimum hardware impact to both transceivers. For this application, acoustic data will be transmitted to the aircraft platform using the Lasercom uplink, while commands will be sent to the ocean surface transceiver via the Lasercom downlink.

Given the ever-present need for secure communication, the increasing need for higher bandwidth, and the decreasing available RF spectrum , it seems to be the question of when, not if, free-space optical links will be used for many military applications.

PHASE I: Develop an initial conceptual design for the full-duplex Free-space Optical Communication Link. Perform a design modeling in order to provide a conceptual design trade study for the proposed Lasercom Link. Identify small-size factor, low-cost and power consumption and minimum hardware impact to the ocean surface transceiver solution.

PHASE II: Refine and modify the Lasercom link design developed in Phase I. Develop, construct and demonstrate the operation of the prototype Lasercom link selected in Phase I. Perform a laboratory based proof of concept demonstration for the Lasercom link selected in Phase I.

PHASE III: Optimize the Lasercom link design based on the test and evaluation results of Phase II. Demonstrate full system performance and conduct sea tests in areas of interest.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Free-space optical communication links will provide a diversified communication path for ASW operations where RF sources are inoperable due to RFI, jamming and spectrum allocation issues. Lasercom link will benefit the U.S. DON by providing a secure communication path between ocean surface transceivers and air platforms transceivers in RF inoperable areas.

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1. H. Hemati, Optical systems for free-space laser communications, Proc. SPIE 5173, 64-68, 2003.

2. C. C. Davis, I. I. Smolyaninov, S. D. Milner, Flexible optical wireless links and networks, IEEE Communications Magazine, 41(3), 51-7, 2003.

3. H. R. Burris, et al., High speed lasercomm data transfer in Seahawk 2007 exercise, Proc. SPIE 6951, 69510V, 2008

4. W. S. Rabinovich, et al., Free Space Optical Communications Research at the U.S. Naval Research Laboratory, Proc. SPIE 7587, 758702, 2010.

KEYWORDS: Lasercom, Free-space optical communication, LPI/LPD techniques, anti-jamming techniques, frequency allocation, RFI

N122-117 TITLE: <u>Enhancing Situational Awareness to Counter Swarming and Other Nonlinear, Dispersed Tactics Against Naval Surface Forces</u>

TECHNOLOGY AREAS: Air Platform, 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: Develop innovative intelligent agents for the prediction of swarming and other nonlinear, dispersed tactics against Naval surface forces utilizing airborne radar and electro-optic sensor information.

DESCRIPTION: Naval forces conducting transits through straits and other congested littoral operational areas are presented with a challenging force protection requirement. Surface traffic density is often high, with many ferries, fishing and pleasure boats, and large cargo ships maneuvering in a small area. Existing rules of engagement designate query and warning ranges, but international law and freedom of navigation allow vessels to operate in very close proximity to our combatants. These small vessels are often difficult to regulate and many lack basic equipment such as bridge to bridge radios. With a host of stationary and seemingly randomly moving boats, determining a hostile action in a timely manner is difficult at best. These conditions make the identification of and defense against hostile small craft extremely difficult. Of particular concern when operating in these areas is countering pre-planned or opportunistic hostile swarm attacks. A variety of swarm and counter-swarm tactics exist, but the single most important enabler for success is having superior situational awareness. This is in fact a fundamental advantage that all types of military forces seek.

At present airborne surveillance radar and electro-optics are of limited value to the surface combatant as they are seen as unable to provide the ship watch standers actionable information to support the determination of hostile action and/or hostile intent. A contact's speed, angle of approach, and location are not sufficient to determine intent in such high density environments. In the absence of additional insight regarding intent, surface combatants rely on a last minute determination of intent which is based on based direct visual observation by the ship's watch standers. However, radar systems can now provide the ability to observe the behavior of specific targets over extended periods of time utilizing maritime classification aids and target fingerprinting. The missing component and the focus of this topic is the development intelligent agent to predict impending threats, much as is done with crime forecasting tools, based on a knowledge of target classification and behaviors of all contacts within the surveillance field of view. These analysis tools are necessary for general pattern analysis including the detection of preparations for swarm encirclement actions.

PHASE I: Investigate technical approaches that provide determination of, or give indications of, hostile intent against Naval surface forces operating in congested littoral operational areas. Radar and electro-optic maritime classification aids along with high range resolution radar fingerprinting and tracking are to be utilized in the technical approach. Identify the specific nature of the analysis algorithms and the human-machine interfaces to be used and develop a detailed implementation plan.

PHASE II: Develop a robust intelligent agent analysis tool for the candidate sensor suite. Demonstrate non real time processing using government-provided data with sufficient fidelity to enable assessment of operator workload reduction, algorithm tuning, and sensor utilization. Demonstrate the functionality, performance, and correctness of all components. Prepare an integration plan to complete the development and transition of the toolset into the candidate sensor suite.

PHASE III: Transition the intelligent agent to appropriate platforms and interested commercial entities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a growing need for real-time automated sensor information analysis and planning tools. The ability to analyze and assess sensor information intelligently in time-critical scenarios is crucial for many commercial endeavors.

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3. Haghshenass, Fariborz, Iran's Doctrine of Asymmetric Naval Warfare, The Washington Institute for Near East Policy, 2006

4. Fish, Tim, Sri Lanka learns to counter Sea Tigers' swarm tactics, Jane's Navy International, 2009

KEYWORDS: battlespace management; Mission Planning; information superiority: tactical decision support; counter-swarm; Radar

N122-118 TITLE: UV Obscurant Device for Aircraft

This topic has been removed from the solicitation.

N122-119 TITLE: Automated Antenna CAD for Installed Performance Assessment and Optimization

TECHNOLOGY AREAS: Sensors, Battlespace

OBJECTIVE: Develop an antenna design tool that will produce antenna CAD models and design candidates optimized for use in CEM on-aircraft antenna analysis.

DESCRIPTION: It is vital to understand the installed performance of antennas as mounted on a platform and in the presence of cosited antennas. The two alternatives for quantifying installed performance are measurement and simulation. Measurements are costly and often impractical during the design phase of antenna/platform integration. At the same time, computational electromagnetic (CEM) techniques and codes continue to mature, and CEM tools are increasingly used to assess installed performance for a known antenna placement or to optimize the placement for a given mission. Regardless of the CEM technique employed, one must ultimately acquire or develop a functional CAD model of the antenna in order to execute platform-level CEM simulations.

Many aircraft antennas are commercial-off-the-self (COTS). While manufacturers typically provide limited, top-level performance specifications and physical characteristics for their antennas (e.g., frequency range, impedance, VSWR, peak gain, highest sidelobe, principal-plane pattern cuts, power capacity, polarization, weight, form factor), they seldom make available engineering data that enables installed performance CEM simulations involving their products: the internal geometric and material structure of the antenna, its feed structure, and associated circuitry. If the function that the antenna performs is known, this helps to identify the basic antenna type but not its detailed design and engineering. Even when the detailed antenna design is known, its structure may be too complex to develop a workable CEM CAD model within the constraints of time and budget. If a similar radiation pattern and input impedance can be achieved with a simpler CEM CAD model, useful installed performance results can still be obtained.

The above demonstrates the need for a methodology (and for its implementation in software) that can produce a physical or CEM CAD model of an antenna given a subset of top-level performance data, physical characteristics, and functional purpose/type (e.g., radar, GPS, direction finding, electronic steering, etc.). Given such inputs, the capability should also produce candidate design types to assist in the selection of COTS antennas. A well-designed graphical user interface (GUI) should guide the user through the process of engaging this capability. If computationally intensive, the software should run efficiently on CPU and CPU/GPU clusters. All supporting modules in the software should either be the intellectual property of the proposing company or secured through licensing so that the tool can be commercialized.

PHASE I: Develop and demonstrate a methodology that uses COTS antenna performance and physical data to yield antenna designs and their physical descriptions. Develop a set of metrics to gauge the quality of the design versus spec. Make a list of antennas for aircraft and prioritize according to antenna complexity. Consult with the TPOC regarding interfaces between the Navy's CEM codes and the proposed tool. Develop a detailed outline of the tool requirements, including the GUI.

PHASE II: Convert the process developed in Phase I into an engineering tool, including computation engine, GUI, and interfacing to Navy CEM codes. Validate the tool on cases of interest to NAVAIR. Make necessary arrangements to commercialize the tool either in partnership with another company or alone and seek potential sponsors.

PHASE III: Refine methodology and tool developed in Phase II either alone or in partnership with another company. Port the tool to clusters of CPUs and CPU/GPUs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic has direct utility in a wide variety of commercial and military applications, such as radar, wireless communications and navigation.

REFERENCES:
1. Balanis, C. A. (2005). Antenna Theory: Analysis and Design, 3rd Edition. Wiley-Interscience.

2. Macnamara, T. M. (2010). Introduction to Antenna Placement and Installation. John Wiley & Sons.

3. Volakis, J. L., Editor. (2007), Antenna Engineering Handbook, 4th Edition. McGraw-Hill.

KEYWORDS: Computational electromagnetics; antenna; COTS modeling and simulation; optimization; CPU/GPU clusters; GUI.

N122-120 TITLE: Carbon Monoxide Detector For Aviation Oxygen Systems

TECHNOLOGY AREAS: Materials/Processes, Sensors, Human Systems

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 sensor for detecting toxic contaminants in oxygen produced by aircraft On-Board Oxygen Generating Systems (OBOGS).

DESCRIPTION: Aircraft equipped with On-Board Oxygen Generating Systems (OBOGS) provide aircrew breathing oxygen using molecular sieves and Pressure Swing Adsorption (PSA) technology. The OBOGS selectively filters compressed air from the aircraft's engine to remove nitrogen and other gaseous contaminants to provide the aircrew with an oxygen enriched breathing gas. During shipboard operations, Navy aircraft are particularly vulnerable to excessive levels of toxic byproducts from ingesting the jet exhaust from other aircraft. Under suboptimal operating conditions, toxic byproducts can breach the OBOGS and enter the aircrew's oxygen supply. NAVAIR is developing an oxidizing catalyst to eliminate these toxins, but a sensor is needed to determine when the catalyst may be losing effectiveness.

The sensor must be capable of detecting, as a minimum, low level hydrocarbons including carbon monoxide (CO), carbon dioxide (CO2), nitrogen oxides (NOx), and aliphatic and aromatic hydrocarbons that are byproducts of incomplete jet fuel and lubricant combustion. The sensor must be capable of operating in an oxygen rich environment from 21 to 100% oxygen. Oxygen system pressures range from 24 PSIA to 100 PSIA. Operating temperature ranges from -40F to +160F (objective), or from -10F to +160F (threshold). The sensor must be capable of providing a visual indicator that can be inspected by a maintainer, and an electronic output signal that can interface with an aircraft's caution and warning system to alert the aircrew. The warning should be triggered when toxic hydrocarbon contaminants have breached the oxygen system and oxidizing catalyst and entered the pilot's breathing oxygen.

Current sensor technology consists primarily of electrochemical cells and solid state detectors capable of sensing single components. These sensors tend to lack the response time, reliability, and robustness needed for military aircraft. Compact, multi-component, highly reliable sensors that do not drift over time are required for this application. The ideal technology will have sensitivity in the part-per-million range, be compact and light weight, and require minimal power. Weight limits should not exceed 1 pound, and volume limits should not exceed 2.5 inches in height, 10 inches in width, and 8 inches in depth.

PHASE I: Determine concept feasibility and should culminate with a working prototype to demonstrate the sensor's capability of detecting toxic hydrocarbons along with the capability of providing a visual indicator for maintainers, and an electronic output to interface with the aircraft's caution and warning system. Phase I shall include a draft of systems requirements for aircraft integration including environmental qualification testing.

PHASE II: Refine the operational system requirements based on the aircraft selected for flight testing. Utilize the Systems Engineering Process for solidifying the system requirements, conducting preliminary and critical design reviews, and producing flight worthy prototype hardware for concept demonstration testing.

PHASE III: Finalization of the design, low rate initial production, followed by full production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial and civil aviation are transitioning from traditional high pressure gaseous and liquid oxygen systems to OBOGS. Additionally, point-of-use oxygen generators are being developed for ground operations, mobile hospitals, emergency response vehicles, and mass casualty response systems. Many of these applications have no single sensor/system for verifying the quality of the oxygen that is produced. Developing a multi-component sensor that measures contaminants in OBOGS and other point-of-use oxygen generators has significant military and commercial application.

REFERENCES:

1. Ernsting, J. (1999). Aviation Medicine. (3rd Ed.). Hodder Arnold Publishers

2. Dehart, R. (2002). Fundamentals of Aerospace Medicine. (3rd Ed.). Lippincott Williams & Wilkins

3. MIL-PRF-27210, Performance Specification, Aviator's Breathing Oxygen, Liquid and Gas, for aircraft oxygen contaminants & allowable limits.

KEYWORDS: OBOGS; oxygen; contaminant; Sensor; Aircrew; safety

N122-121 TITLE: <u>High Efficiency SIGINT Collection</u>

TECHNOLOGY AREAS: Air Platform, Electronics, Battlespace

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: Exploit the relative sparseness and randomness of typical signal intelligence (SIGINT) signal spaces with sampling techniques that can sample a signal space at lower sampling rates without losing any information, or conversely, obtain more information from the signal space from without increasing sample rate.

DESCRIPTION: Typical SIGINT collection platforms attempt to collect signal information over a wide RF spectrum for extended periods of time, resulting in large amounts of data that need to be transported off the platform through sometimes limited-bandwidth communications links. With new communications services and radar systems being developed over an ever-expanding RF spectrum, the job of covering all signals of interest, and handling the large amount of associated data, is becoming more of a challenge for data collection platforms such as the E-2 Hawkeye and Broad Area Maritime Surveillance (BAMS). This is especially true in the case of communications intelligence (COMINT), in which it may be desirable to send samples of signals off-board for analysis.

Although the typical signal space is in fact busy, it is also commonly the case that the signals in the space are randomly spaced within the spectrum, and that there are substantial portions of the spectrum that are empty. These empty spaces are not necessarily known a priori, thus, when conventional Nyquist-type sampling is used, it is necessary to sample the space at sufficiently high speeds to cover the entire space, even the unknown blank regions.

It is desirable to exploit the relative sparseness and randomness of typical SIGINT signal spaces with sampling techniques that can sample a signal space at lower sampling rates without losing any information, or conversely, obtain more information from the signal space from without increasing sample rate. This would, for example, reduce the demands on air-to-ground links that would be used to transport samples of COMINT signals to ground-station analysis centers.

PHASE I: Identify methods of improving high efficiency SIGINT data collection and assess their feasibility in use on Navy aircraft. Select one or more critical hypotheses for small scale experimentation if necessary to support prototyping algorithms and approaches.

PHASE II: Develop and prototype the approach on one or more aircraft and/or one or more frequency band of interest. May pilot the approach with proof of concept for ground use on an aircraft with a frequency band of interest.

PHASE III: Apply lessons learned to develop and produce high efficiency SIGINT collection for Navy aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This approach can be used to design high performance communications for commercial aircraft.

REFERENCES:
1. Signals Intelligence in Modern History. http://en.wikipedia.org/wiki/Signals_intelligence_in_modern_history

2. Raymond, R. Challenge to Sigint: Change or Die.
http://www.nsa.gov/public_info/_files/cryptologic_spectrum/challenge_signit.pdf

KEYWORDS: SIGINT; COMINT; Nyquist Sampling; Spectrum; data collection; electronic support measures

N122-122 TITLE: The Airborne ASW Platform as an Underwater Sound Source

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors, Battlespace

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 system utilizing the P-3, P-8, and MH-60 air platforms or a specially designed Deployable Airborne Source (DAS) or Unmanned Air Vehicle (UAV) as sound sources to augment the capability of existing airborne ASW systems for the detection of submarines.

DESCRIPTION: It has been known for some time that the Navy's P-3 Orion ASW aircraft can transmit sound into oceans and be detected (reference 1). The use of helicopters as a source of low frequency sound for the measurement of bottom characteristics has been proposed in references 2, 3 and 4. Additional articles (reference 5) show that it is possible to determine aircraft parameters from the signals projected into the sea. Current methods used in airborne ASW use A-size sonobuoys (4 7/8" x 36" cylinders) to provide active sound sources which generally operate at 1000Hz or higher. An aircraft source can easily provide frequencies below 100Hz and also in the infrasonic region (< 20Hz). A sonobuoy source could not provide this capability in any reasonable size package. Since the patrol aircraft are already on station, they can be used as sources of opportunity and be utilized to augment existing airborne ASW systems. Using the typical frequency spectra of the P-3, P-8, MH-60 aircraft performance predictions can be generated. UAV or DAS vehicles can be designed as an airborne underwater sound source to generate an optimum frequency of transmission and source level.

Determine the detection performance for both deep and shallow water environments utilizing the above aircraft. Characterize performance as a function of platforms (P-3, P-8, MH60, DAS and UAV), aircraft speed, altitude and flight pattern, sea state, wind speed and operating frequency. Define optimum processing for the time varying aircraft signature for both narrowband and broadband signals. These tasks will require the development of numerous software packages required for range prediction, field performance predictions, signal processing algorithm and software for processing the received echo. Additional tasks will include sea test planning, sea test coordination and analysis of data collected.

PHASE I: Determine the feasibility of an in-air source as a method of generating underwater sound for submarine detection. Develop a complete propagation model for air to water and in-water propagation, and model the field detection performance. Determine the minimum aircraft source level needed and the maximum realizable aircraft source level. Determine the top level specification for a DAS or UAV which is specifically designed as an airborne source. Perform simulations as required using aircraft noise models or aircraft noise data.

PHASE II: Extend and refine critical concepts and develop a prototype based upon findings in Phase I. Perform at sea tests with an airborne source (most like a UAV) to validate models, concepts and processing. Verify processing algorithms.

PHASE III: Perform field level system sea tests. Transition system to the fleet and end users.
Private Sector Commercial Potential/Dual-Use Applications: Methods and concepts developed under this task could provide underwater acousticians with a fast economical way to measure the ocean bottom parameters over a large area. Additionally, the UAV or DAS developed could be utilized as a source for remote sensing of the mineral content of the ocean, e.g. oil, gas by energy exploration companies.

REFERENCES:
1. Urick, R.J. (1972) Noise signature of an aircraft in level flight over a hydrophone in the sea. J. Acoust. Soc. Am. 52 pp. 993-999.

2. Buckingham, M. J., Giddens, E. M., Simonet, F. & Hahn, T. R. (2002). Propeller noise from a light aircraft for low frequency measurements of the speed of sound in a marine sediment, J. Comput. Acoust. 10 pp. 445-464.

3. Buckingham, M. J. & Giddens, E. M. (2006),. Theory of sound propagation from a moving source in a three-layer Pekeris waveguide, J. Acoust. Soc. Am. 120 pp. 1825-1841.

4. Buckingham, M. J., Giddens, E. M., Pompa J. B., Simonet, F. & Hahn, T. R., Sound from a Light Aircraft for Underwater Acoustics Experiments (2002). Acta Acustica United with Acustica, Vol. 88 752-755.

5. Ferguson, B. G. & Speechley, G. C. (2009). Acoustic Detection and Localization of a Turboprop Aircraft by an Array of Hydrophones Towed Below the Sea Surface, IEEE Journal of Oceanic Engineering, Vol. 34, No. 1.

KEYWORDS: airborne source, acoustic, Deployable Acoustic Source (DAS), Anti Submarine Warfare (ASW), Unmanned Aerial Vehicle (UAV)

N122-123 TITLE: <u>Development of Materials for Metallic Direct Digital Manufacturing</u>

TECHNOLOGY AREAS: Materials/Processes

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 new high performance, aerospace grade alloys suitable for direct digital manufacturing (DDM)

DESCRIPTION: Direct digital manufacturing (DDM) processes can create complex, three-dimensional parts akin to castings, but without the high costs and logistical difficulties associated with the production and maintenance of larger-scale manufacturing facilities (e.g., foundries). However, the range of alloys that DDM can be applied to is currently highly limited and oftentimes accompanied by significant property sacrifices relative to the baseline (wrought or cast) alloys [1]. Additionally, the certification of DDM-produced components for airworthiness is time-consuming and expensive [2]. With recent advances in computational materials design [3] and process-structure-property modeling [4], the Navy is interested in the development of high performance materials specifically developed for DDM. Materials of interest include titanium, steel, and aluminum alloys for critical Navy aerospace applications such as airframe structures, helicopter rotor components, and other components of interest. The new materials should demonstrate similar (if not better) static and fatigue properties to incumbent alloys (wrought or cast). New materials may address current alloys' drawbacks and issues, such as aluminum evaporation during production with Ti6Al4V.

PHASE I: Develop DDM suitable high performance, aerospace grade alloys addressing process concerns such as material's directional characteristics (isotropic vs. orthotropic). Demonstrate the feasibility of approach with limited coupon testing.

PHASE II: Perform further computational alloy concept refinement and optimization, assisted with subscale prototypes. Produce prototypes using rapid manufacturing methodology and measure relevant properties to establish a comparison with incumbent alloys. Prototype parts should demonstrate significant production size. Devise a plan/algorithm to rapidly qualify DDM components of varying geometries.

PHASE III: Fully develop and qualify the new DDM alloy. Collaborate with relevant Navy structural and material engineers to apply the technology for the selected component(s). Additional testing necessary to qualify the material and process for service application could be performed. Establish qualification process for first articles of production parts.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development method along with the database of test results for the building blocks of various properties, geometric shapes and sizes will be a marketable tool. It will be tied to the particular DDM alloy and can be marketed to all private and public sector industries that can benefit from DDM as a lower-cost alternative to more-traditional production and manufacturing methods.

REFERENCES:

1. I. Gibson, D.W. Rosen, B. Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital, Springer Science + Business Media, NY, USA

2. William Frazier, Don Polakovics, and Wayne Koegel, "Qualification of Metallic Materials and Structures for Aerospace Applications," JOM. March 2001.

3. Kuehmann, C.J. and Olson, G.B., Computational materials design and engineering, Materials Science and Technology, 2009 4(25), p.472.

4. McDowell, D.L., Olson, G.B., Concurrent design of hierarchical materials and structures, Lecture Notes in Computational Science and Engineering, v 68 LNCSE, p 207-240, 2009, Scientific Modeling and Simulations

5. Metallic Materials Properties Development and Standardization Handbook (MMPDS)

KEYWORDS: computational materials design, direct digital manufacturing, high performance materials, cost reduction

N122-124 TITLE: Autonomous Decision Support for Unmanned Vehicle Control in a Multi-vehicle, Multi-domain Environment

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

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 software tools with the capability to provide operators of a multi-vehicle, multi-domain (air, ground and sea) common control station with decision support for real-time re-tasking and re-planning of multiple assets and the ability to visualize data and information in a complex multi-domain environment.

DESCRIPTION: Mission planning and operation of single unmanned vehicles is performed routinely by operators. There is a considerable amount of current development within both industry and government in support of these activities based on concepts ranging from basic decision theory to full automation of single vehicles. SBIR topics such as ONR managed N05-T017 NAVAIR PMA-281 managed N111-022 respectively titled Mixed-initiative Interaction Module for Littoral and Mine Warfare (MIIM-LMW) and Intelligent Proxies for Automated Mission Planning focus on the automation of unmanned vehicle mission planning problems. When simultaneously dealing with multiple unmanned vehicles in multiple domains the operator or mission commander's decision making processes are impeded by current state-of-the-art capabilities to display pertinent information. Limitations are inherent in current control systems during re-planning and re-tasking of vehicles in situations when target priorities change, a vehicle experiences a malfunction or encounters fuel limitations or inclement weather conditions and other situations. Decision making must be made in real time and many scenarios increase the complexity of decision making to a point which makes it nearly impossible for an operator to make the necessary changes. Academia and industry are addressing the topic of multi-vehicle, multi-domain, single operator issues as outlined in such reports as [ref1, ref2]. Automating complex real-time mission planning will demand development of not only novel, non-deterministic, decision-theoretic, intelligent algorithms that can perform these functions but also provide a unique human-computer interface to visualize the problems and recommended decisions. Simplicity of visualization will be required to allow operators uncomplicated control of multi-vehicle, multi-domain operations. Development should be conducted within an open architecture. Performance and evaluation metrics will need to be established in order to determine the degree of benefit of the solution. Ref3, Ref4 and Ref5 are sample reports from academia and industry providing an overview of research related to the topic. It does not imply endorsement nor guidance.

PHASE I: Develop and determine feasibility of a conceptual approach for the above mentioned complex problem and provide a limited simulation of proposed techniques including preliminary visualization concepts.

PHASE II: Full software development that will demonstrate the ability to re-plan, re-task, and re-assign unmanned multi-vehicle missions based on a variety of factors and situations and visualize results to control multi-vehicle multi-domain systems using open architecture.

PHASE III: Fully integrate phase II software into the PMA-281 Common Control System (CCS) for testing and performance validation and verification.

Dual use Application: This capability is suitable for a broad range of government missions, e.g. homeland security (border security, coastal patrol) fighting forest fires, and some industrial & commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability is suitable for a broad range of government missions, e.g. homeland security (border security, coastal patrol) fighting forest fires, and some industrial & commercial applications.

REFERENCES:
1. Cummings, M.L., Bruni, S., Mercier, S. & Mitchell, P.J. (2007). Automation Architecture for Single Operator, Multiple UAV Command and Control, The International C2 Journal, Vol 1, No 2, pp. 1-24

2. Karaman S. & Frazzoli, E. (2010). Linear Temporal Logic Vehicle Routing with Applications to Multi-UAV Mission Planning Int. J. Robust. Nonlinear Control ; pp. 1-38

3. Slear, J. N. (2006). UAV Swarm Mission Planning and Simulation System. AFIT/GCE/ENG/06-08 Unpublished Master Thesis, Air Force Institute of Technology.

4. Cummings, M.L., Brzezinski, A.S. & Lee, J.D. (2007). The Impact of Intelligent Aiding for Multiple Unmanned Aerial Vehicle Schedule Management. IEEE Intelligent Systems: Special issue on Interacting with Autonomy, Vol. 22(2) 52-59.

5. Salamon, A., Housten, D. & Drewes, Dr. P. Increasing Situational Awareness through the use of UXV Teams while Reducing Operator Workload, Lockheed Martin Advanced Technology Laboratories document, available: www.atl.lmco.com/papers/1651.pdf

6. Information related to the Common Control System (CCS). Link is:
https://www.fbo.gov/index?s=opportunity&mode=form&id=1385173de9ba89d35b55f62eaa7491b6&tab=core&tabmode=list&= (From TPOC on 5/9/12.)

KEYWORDS: data visualization, common control station, unmanned multi-vehicle, multi-domain, decision theory, human computer interface, service oriented architecture, automation

N122-125 TITLE: Innovative Approach to Bondline Integrity Monitoring

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

OBJECTIVE: Develop a bondline integrity monitoring system that can assess operational capability and service life.

DESCRIPTION: Structural designs which include composite to composite bonding or composite to metal bonding can experience failures along the bondline. The ability to monitor the bondline's integrity during operation is essential to determine the structure's health, capability, and service life. Currently, bondlines require in-service inspection of bonded joints and the development of a bondline integrity monitoring system may reduce or eliminate the need for these inspections. Additionally, future structural health management technology will need real time bondline monitoring data for use in prognostic models that are currently being considered for service life prediction.

Bondline integrity monitoring should provide low-cost, in situ measurements from production to operation. This data will be collected, stored and analyzed by on-board processors to detect and diagnose bondline degradation.

The proposed monitoring system cannot degrade bondline integrity, should be easily calibrated and interpreted, and must not be embedded within the bondline.

PHASE I: Develop low-cost approaches for a bondline integrity monitoring system to be used during production and operation of bonded composite structures. Demonstrate the feasibility of the recommended approach.

PHASE II: Fully develop identified Phase l approach into a prototype system. Test and demonstrate the operation of the prototype system under realistic environmental conditions.

PHASE III: Perform complete validation and verification of the bondline integrity monitoring system. Transition technology for implementation on Naval Airframe bonded composite structures and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Bondline intergrity monitoring can transfer to commercial aviation, aerospace, automotive and other industries with applications involving composite materials bonding to metals or other composite materials.

REFERENCES:
1. Hayden,S. & Bajwa, A. (2001), NASA IVHM Technology experiment for X-vehicles (NITEX), RECON no. 20020008402. Retrieved from

http://md1.csa.com/partners/viewrecord.php?requester=gs&collection=TRD&recid=N0237247AH&q=nasa+ivhm+technology+experiment+for+x+vehicles+%28NITEX%29&uid=790680922&setcookie=yes

2. Chang, F.K. (Ed.). (2005). Structural Health Monitoring: Advancements and Challenges for Implementation. Proceedings of the Fifth International Workshop on Structural Health Monitoring. Retrieved from http://books.google.com/books?id=yNRpsldZuwcC&dq=4th%20International%20Workshop%20on%20Structural%20Health%20Monitoring%2C%20Stanford%20University%2C&lr&source=gbs_similarbooks

3. Guemes, A. (Ed.). (2006). Structural Health Monitoring: Proceedings from the Third European Workshop. Retrieved from http://books.google.com/books/about/Structural_Health_Monitoring.html?id=NXeh2GXyb-sC

KEYWORDS: Vehicle health management, delamination, composites, diagnostic, damage detection, damage tolerance, durability

N122-126 TITLE: Innovative Method for Wirelessly Powering RFID Tags Located on Rotorcraft

TECHNOLOGY AREAS: Air Platform, Information Systems, Electronics

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 approach for generating power and remotely transferring that power using by radio frequency (RF) to power miniature active or passive RFID tags and ensuring a read range adequate to support logistics and maintenance functions. This will be used to facilitate individual parts and component identification/tracking of life-limited components, critical safety times and high cost repairables. This is complimentary to current digital DNA efforts and will greatly improve upon current methods.

DESCRIPTION: Radio frequency identification (RFID) is becoming a common tracking technology. The use of RFID to accurately track parts results in cost savings due to traceability. The ability to precisely track parts improves reliability of part usage data, supporting analysis to potentially extend the life of the part and reduce maintenance efforts.

Passive RFID systems are small and compact but are restricted in readability range because of power limitations and available antenna size. Active RFID's have a greater readability range but require primary batteries, greatly increasing the package size relative to passive RFID's. The goal is to develop a RFID tag that combines the size of a Passive RFID and the readability range of an Active RFID by wirelessly/remotely powering or recharging the battery in the RFID tag. Developing such an RFID would combine the advantages of the passive and active RFID's and eliminate some of their individual disadvantages.

The RFID tag dimensions and weight should be insignificant and must not interfere with the aircraft functionality. Therefore, tag size optimization is critical to the design and form factor and must be part of the study. In addition, the RFID tag should be strategically located to remotely access for data communication and power source. It is required that the RFID tags be mounted with the antenna on, or in close proximity to, metallic surfaces. A recharge range of 10 meters is required when using an RF source, preferably a source that complies with FCC Part 15, intentional radiators in license free ISM bands. Mounted RFID's must be able to endure aircraft environment; endure vibration, hot-wet and corrosive environments, radiation, and high pressures. Whether active or passive, the RFID tag should be compliant with DoD RFID/UID requirements with a frequency of 433 MHz or 915 MHz and ISO 18000 or ePC, respectively for active and passive RFID tags and achieve a read range in excess of ten meters.

PHASE I: Develop an innovative approach for remotely powering RFID tags that meet the requirements outlined above. Demonstrate feasibility through a breadboard concept of key technology components.

PHASE II: Fully develop the innovation into a prototype system. Perform laboratory testing to validate the desired performance characteristics. Develop a detailed plan and method of implementation into full-scale application for Phase III.

PHASE III: Transition the developed technology to military and commercial applications through implementation of the Phase III plan making sure to include FCC certification and compliance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: RF power transmission technology is applicable to almost every commercial industry. In addition to RFID tags wireless power transmission could be used in the healthcare industry, automotive industry, and aviation industry that would require additional development and testing.

REFERENCES:
1. Arms et. al, Multichannel Structural Health Monitoring Network, Powered and Interrogated using electromagnetic fields. Proceedings of SAMPE, Baltimore 2007

2. Hagerty et. al, Recycling Ambient Microwave Energy With Broad-Band Rectenna Arrays, IEEE Transactions on Microwave Theory and Techniques, Vol. 52, No. 3, March 2004

KEYWORDS: RFID, RF power, cost reduction, maintainability, usage data and tracking, wireless/remote power transmission, helicopters

N122-127 TITLE: High Powered RF Sources

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Develop an innovative radio frequency (RF) source concept that can meet requirements from four standard test environments.

DESCRIPTION: The publication of MIL-STD-464 and MIL-HDBK-235 update (see references) resulted in the lowering of the peak E-field levels while simultaneously raising the average E-field levels of four of the standard Intersystem EMC electromagnetic environments that aircraft must operate in and demonstrate survivability of prior to production and deployment.

It was initially thought that standard off the shelf traveling wave tube amplifiers would be able to augment the existing radar sources at the NERF (Naval Electromagnetic Radiation Facility) to meet the new requirements by splitting the standard RF environment into a peak and an average field level test instead of a single environment that provided both at the same time like the aircraft would see when deployed. The best technology for testing purposes currently in existence that is closest to our requirements is a type of close coupled cavity TWT (Traveling wave-tube). However, TWT amplifiers leak approximately 1 watt when they are in operate mode and this has caused systems to fail that should not.

The concept resulting must meet both the peak and average E-field levels at each of the four standard environments given within the MIL-STD-464 and MIL-HDBK-235. An additional desired, but not mandatory, requirement is to provide an illumination area of at least two foot by two foot illumination area on target at not less than ten feet separation distance.

PHASE I: Investigate, perform an analysis and determine feasibility of an innovative concept for RF sources to meet the needs of the test & evaluation (T&E) community to simulate the shipboard environment. For RF application, demonstrate feasibility of the approach through model and simulation and/or prototyping.

PHASE II: Based on the design in Phase I, construct a prototype to demonstrate the feasibility of the solution for each of the four high duty short fall areas.

PHASE III: Transition to support the development and integration into existing electromagnetic environment effects (E3) simulators.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector certification of commercial aircraft to FAA and international electromagnetic restrictions. Commercial source for MIL-STD-461 commercial test labs to enable tailored testing for aircraft avionics survival.

REFERENCES:
1. MIL-STD-464 - http://tscm.com/MIL-STD-464.pdf

2. MIL-HDBK-235 - https://acc.dau.mil/adl/en-US/131912/file/26633/MIL-HDBK-235-1B.pdf

3. Microwave Tube Transmitters, L. Sivan, ISBN 0 412 57950 2

4. Microwave Tubes, A.S. Gilmour, ISBN-10: 0890061815

KEYWORDS: Cross Field Amplifier, RF Transmitter, Wave-Tube amplifier, Traveling wave-tube, Microwave Source, High Duty Microwave Tube

N122-128 TITLE: Efficient and Lightweight Cryogenic Gas Heat Exchanger

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 501, Littoral Combat Ship (LCS) Program, 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 compact, highly efficient, and light-weight cryogenic gas heat-exchanger to maximize heat transfer while maintaining a low pressure drop for use in naval superconducting system applications.

DESCRIPTION: The Navy is developing several superconducting systems (such as degaussing, propulsion motors, electrical generators and power distribution systems) for use onboard future ships and submarines to reduce system weight, energy usage and installed volume. These systems rely on the use of cryogenic helium gas for operation. Helium has a low heat capacity at the operational temperatures of 10-150K and significant amounts of heat from 100-4000W need to be removed from these systems during operation. Current commercially available cryogenic heat exchangers utilize a combination of stainless steel and copper helix coils wrapped around a mass of metal (Ref 1). Gaseous helium is then pumped through the coils in order to convectively and conductively transfer cooling power from the cryocooler to the superconducting system. Current heat exchanger designs have a heat exchanger effectiveness of about 70%, weigh approximately 50lbs, and maintain a pressure drop of less than 1 psi. The current equipment package required to transfer the heat (cold box containing the heat exchanger plus a cryocooler) weighs approximately 350 lbs and costs approximately $75K (Ref 2). Given the amount of potential heat to be removed, a 20% increase in effectiveness will provide a significant reduction in the overall weight and cost of the system. Novel materials such as metal foams and matrix materials have been investigated for cryogenic heat exchangers but have not been implemented because of their high cost or limited availability (Ref 3). Recent improvements in material processes and additional applications for metal foams in room temperature heat exchangers have been documented but not at cryogenic temperatures (Ref 4).

The Navy seeks to develop a highly effective (>90%), low weight (<50 lbs), low acquisition cost (<$10K), low pressure drop (<2 PSI) heat exchanger for operation with a gaseous helium pressure (up to 20 bar), with temperature ranges from (10 - 150K) for flows from 1 to 20 g/s. It is anticipated that accomplishing these goals will require innovative approaches beyond the current state of the art with the potential application of new materials, methods and/or manufacturing processes in order to develop potentially viable concepts. Proposed concepts should be of sufficient ruggedness to survive a naval, shipboard environment. Aspects such as smaller physical size and lower weight are of particular interest.

PHASE I: Demonstrate the feasibility of a novel compact heat exchanger design able to operate with Navy cryogenic systems as defined above. Perform bench top experimentation, where applicable, as a means of demonstrating the identified concepts. Establish validation goals and metrics to analyze the feasibility of the proposed solution. Provide a Phase II development approach and schedule that contains discrete milestones and provides risk reduction for product development.

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

PHASE III: Upon successful Phase II completion, the company will support the Navy in transitioning the technology to military and commercial cryogenic or superconducting applications. Working with government and industry partners, as applicable, the company will install the cryogenic gas heat exchanger onboard a selected Navy ship and conduct extended shipboard testing. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A more compact heat exchanger may be of use in land based High Temperature Superconducting (HTS) power cables and power delivery applications. As land based HTS power cables transition from R&D projects to commercial installations, these heat exchangers will save on weight and promote higher cooling capability, which would promote overall higher efficiencies in the power system itself.

REFERENCES:
1. Parker, J. et al. Helical Coil Heat Exchanger. St. Martin's University, 2007.

2. Fitzpatrick, Brian; Kephart, J.; Golda, E. M. "Characterization of Gaseous Helium Flow Cryogen in a Flexible Cryostat for Naval Applications of High Temperature Superconductors," IEEE Trans. App. Super., Vol. 17, No. 2, 2007.

3. Venkatarathnam, G.; Sarangi, Sunil; "Matrix Heat Exchangers and Their Application in Cryogenic Systems", Cryogenics, Vol. 30, Issue 11, Pages 907-918, November 1990.

4. Kuang, JJ; "Ultra-lightweight Compact Heat Sinks with Metal Foams Under Axial Fan Flow Impingement", Heat Transfer Engineering, Vol. 33, Issue 7, 2012.

KEYWORDS: Cryogenics; Lightweight Heat Exchanger; Superconductors; High Temperature Superconducting Degaussing; Gaseous Helium; Compact Heat Exchanger

N122-129 TITLE: Retractable Mooring Fixture

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 400D, DDG 51 New Construction Program, ACAT 1D

OBJECTIVE: Through the application of advanced material(s) and manufacturing processes, develop a mooring fixture to replace the existing bitt and/or chock configuration onboard naval surface ships.

DESCRIPTION: Presently, both the naval and commercial industry use carbon steel bitts and chocks to properly tie-up or moor a ship (Ref 2 and 3). For DDG 51 Class ships, those bitts and chocks, which are located on the flight deck, are limited in their allowable height above the deck by specifications pertaining to helicopter operations. As a result, they are recessed into the deck itself. Raising and lowering the bitts and chocks are manual operations requiring as many as four individuals (due to the weight of the assemblies in excess of 270 lbs) and also require the use of specialized tools. Once raised, both are locked in the "up" position. For the bitt assembly, there is a rubber gasket seal at the deck opening which fits tight to the bitt barrel for the purpose of preventing water from reaching the decks below. Both have either 2-inch or 4-inch drain lines to facilitate water exiting the pockets in which the fixtures are stowed. Naval flight decks are a highly corrosive environment, and corrosion rapidly affects the operation of these mooring fixtures due to their weight, tight tolerances and method of operation. Bitt and chock assembly corrosion and the subsequent degradation of system performance are top recurring issues for DDG CLASSRON. The effort to reduce manning has forced prioritization with regards to maintenance and the attention the crew is able to pay to these mooring fixtures often suffers as a result. Limited personnel and the flight deck's highly corrosive environment present a recurring and costly maintenance challenge. System failure results in a reduced mooring capability, increased maintenance time and frequency, and as a result, increased life-cycle costs.

This topic seeks to explore innovative approaches to resolve a long-standing, life-cycle management issue for DDG 51 Class ships. Proposers are encouraged to explore alternative design solutions, manufacturing processes and/or material systems with robust mechanical properties to withstand the harsh operating environment seen by these mooring fixtures on a daily basis. Proposers are also encouraged to explore solutions that provide a combined (bitt and chock) functionality to deliver equivalent performance within the footprint of the allotted space onboard ships (Ref 1). Proposers will need to be mindful of the requirement to provide a solution that can be recessed within the storage pocket of the deck and should address the ability to be sealed to prevent water intrusion into adjacent spaces. Proposed concepts should be simple to maintain and operate. Material systems proposed should not be predisposed to galvanic corrosion. In addition, proposers should address the method of deployment and locking, with the use of minimal manpower. Meeting the need for reduced maintenance and increased operational reliability and maintainability in a maritime environment represents the most significant challenge associated with a bitt and chock replacement design solution.

PHASE I: Demonstrate the feasibility of a replacement retractable mooring fixture and its ability to reliably operate in the presence of corrosion. Proposers should identify suitable configurations, candidate materials, equipment, manufacturing processes and methods of installation anticipated to enable the development and integration of the proposed system. Establish performance goals and metrics to analyze the viability of the proposed solution. The small business will provide a Phase II development plan as well as a test and evaluation plan with performance goals and key technical milestones to be utilized to 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. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development and respective test and evaluation plans. Provide a detailed Phase III plan for 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. Develop a cost benefit analysis for Total Ownership Cost.

PHASE III: Based upon the results of Phase II, the company will be expected to construct a prototype for testing in a naval shipboard environment. Working with government and industry, install onboard a selected DDG 51 class hull and conduct extended shipboard testing. The company will support the Navy in an effort to install any necessary components required to allow for use of this technology in an extended shipboard testing operational environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Bitt and chock fixtures are widely used onboard commercial vessels. As such, corrosion, maintenance and general performance associated with bitts and chocks are not problems unique to the Navy. Additionally, commercial vessels operating helicopters or with similar height-above-the-deck restrictions have the potential to need a reliable retractable mooring fixture alternative as a means of removing possible obstructions from flight height-restricted spaces.

REFERENCES:
1) PMS 400D. “Technical Data Package.” 2011.

2) Lindenau, Peter. “Joint Guidelines on Design and Layout of Harbour Towage Equipment.” European Tug Owners Association. February, 2011.
http://www.eurotugowners.com/media/misc_media/110215%20Best%20Pract%20Final%20Rev%2011.pdf

3) Dodge, David O.; Kyriss, Stephen E. Seamanship: Fundamentals for the Deck Officer. Chapter 6, Mooring and Anchoring. Annapolis, MD. United States Naval Institute. 1981.
http://books.google.com/books?id=Jd5EfVMvOV8C&pg=PA170&lpg=PA170&dq=bitts+and+chocks&source=bl&ots=dQI5DUyDgn&sig=xskYZ1y93ZTBr9oQekR5MVm6cdg&hl=en&ei=G-_3Tfy8KMj10gGgkO3HDA&sa=X&oi=book_result&ct=result&resnum=1&ved=0CCcQ6AEwADgK#v=onepage&q=bitts%20and%20chocks&f=false

KEYWORDS: bitts; chocks; mooring; retractable bitts and chocks; corrosion; recessed bitts and chocks;

N122-130 TITLE: Innovative Silent Cooling Technology For Electronic Systems In Compact Spaces

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PMS397 Ohio Replacement Program, ACAT I

OBJECTIVE: The objective is to develop innovative non-water, low noise cooling system for shipboard electronics in compact enclosures that will be cost effective and have high efficiencies.

DESCRIPTION: Proper cooling of electronics aboard US Navy ships is critical to the operation of shipboard electronic systems. Quiet and reliable cooling technology is especially important for ship control systems. On the VIRGINIA Class submarine, most ship control equipment uses forced air cooling. Water cooling is not presently used because it creates a dependency on cooling water systems, lowering ship control system availability and reliability. However, the current ship control cooling fans in use on VIRGINIA Class have a large number of mechanical parts, requiring significant noise qualification and reliability testing. Furthermore, space and weight is very important aboard submarines and the additional space for cooling fans make arrangements challenging.

It is expected that the OHIO Replacement will experience similar difficulties and incur similar costs unless a better system is developed. The Navy would like to reduce the footprint of the cooling system and eliminate the use of fan cooling (and subsequent noise qualification testing), while maintaining the reliability of the ship control station. Although there are currently non-mechanical cooling systems used in industry, such as heat pipes, these technologies cannot always be adapted for Navy Submarine use because of material concerns (see references 1 and 2). However, companies applying to this SBIR should be encouraged to leverage commercial-off-the-shelf cooling technologies wherever applicable.

The Navy is seeking innovative technologies and methods to address the cooling problems it is having with ship control electronic equipment. Innovation should minimize the use of mechanical components such as fans, consider the use of heat pipes, and investigate innovative alternative materials for control equipment enclosures. All heat transfer methods must meet the required cooling loads (estimated to be 1kW) and be constructed of approved materials for use on US Navy Submarines. The investigation will address system hardware and associated maintenance and personnel issues (noise levels). Reference 3 below is also provided for guidance. Energy efficiency of the cooling technology must also be included in the developmental effort.

PHASE I: The small business will develop innovative concepts for cost effective and reliable cooling of ship control stations, demonstrate the feasibility of the concepts to cool ship control station within the requirements described above, and demonstrate the feasibility of developing concepts into technology that can reliably meet the cooling loads of the ship control station. A preliminary analysis of the system, which includes development of cooling system requirements, will be prepared. Prepare a development plan for Phase II with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop and evaluate a prototype cooling system to determine its effectiveness in cooling ship control stations within the performance goals defined in Phase I and the requirements above. Based on the results of the evaluations, the small business will develop a preliminary design that can be implemented on the OHIO Replacement Class submarine. Develop a Phase III development plan to transition the technology into a system that can be acquired by the Navy.

PHASE III: If Phase II is successful, the small business will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. Based on the Phase II results, the small business will develop an enclosure cooling system for the ship control station for shipboard testing. The small business will support evaluation aboard ship and in qualifying and certifying the system for use on the OHIO Replacement Class submarine and for back fit to the VIRGINIA Class submarine.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic could be used in electronic enclosures that are commonplace throughout industry, from large scale data centers containing thousands of servers in enclosures, to the use of industrial applications of electronics. The technology has the potential for use in heat transfer applications where water cooling or air ventilation systems are undesirable.

REFERENCES:
1) Pastukhov, V. G; Maidanik, Yu. F; Vershinin, C. V; and Korukov, M. A. Miniature loop heat pipes for electronics cooling. 27 December 2002

2) Zhao, C. Y.; and Lu, T. J. Analysis of microchannel heat sinks for electronics cooling. 25 February 2002

3) Raghupathy, Arun P.; Maltz, William. Innovative Rack-level Cooling Solutions (Presentation). 15 July 2009

4) This reference is not publicly available at this time and has been deleted on 5/8/12

KEYWORDS: electronics cooling; cooling technologies; passive cooling; forced air alternatives; cooling electronic enclosures; low noise cooling

N122-131 TITLE: Innovative Approach to the Control of Vacuum Collection, Holding and Transfer (VCHT) Foaming

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 400D, DDG 51 New Construction Program, ACAT 1D

OBJECTIVE: To develop an innovative approach to detect and control or eliminate foaming in sewage VCHT tanks and systems onboard naval ships without the use of biological or hazardous materials.

DESCRIPTION: Currently used DDG 52 AF Class sewage VCHT systems are highly susceptible to foaming. Foam can be generated in the VCHT tank due to the combination of liquid and solid human waste, freshwater flushing and detergents being re-circulated through the ejector pump and ejectors at high velocities. VCHT tank vents, which are under atmospheric pressure (14.7 pounds per square inch gauge (psig)), are vented to the weather decks onboard ship. Once foam enters the tank vent and tank overflow piping in sufficient quantity to prevent the venting of pressure and hazardous fumes from the tank, pressure builds up inside the tank as a result of frequent in-rush of sewage and air from the ejector pumps. The tanks become pressurized (approximately 15 – 20 psig and at some point force the foam from the tank out through the tank vent onto the weather deck (Ref 1). In addition, the foam clogs sensors, and causes premature pump failure due to the easily cavitating foam in the ejector pump. Traditionally, foam generation inside VCHT tanks has required Ship’s Force to: a) deactivate the sewage collection system; b) flush and clean the VCHT tanks, which is time consuming and often ineffective; c) increase ejector pump corrective maintenance (repair) as a result of the damage from foam, which is costly, dangerous and impacts system availability. Previous attempts at resolving this issue have resulted in numerous engineering modifications to reduce the occurrence of foam generation in VCHT tanks and subsequent spills through the tank vents. While changes to date have effectively segregated plumbing waste from the VCHT tanks, foam reduction due to these actions has not been adequate and continues to be an un-resolved issue of concern. In the commercial maritime industry, some Marine Sanitation Device (MSD) manufacturers recommend pouring diesel fuel in to the VCHT tanks to mitigate foaming, but this method is neither recommended nor approved since it introduces oily waste into a sewage system, which is regulated by different discharge standards.

This topic seeks to explore the development of innovative approaches to detect and mitigate the effects of foam generation in sewage VCHT tanks (Ref 2 and 3). Proposed concepts must be non-biological and non-hazardous, should provide an indication of when foam is detected inside VCHT tanks and should mitigate, by control and/or elimination, the effects of foam on sewage collection system operations. While foam detection is not the sole focus of this topic, it is important for several reasons. In practice, a foam mitigation system may not be required to function at all times during VCHT tank operation, but only during times when foam generation has been detected. Additionally, the ability to detect the presence of foam is important in order to be able to determine the effectiveness of the foam countermeasures proposed. Proposers should address proposed candidate processes, materials, equipment(s), and manufacturing processes, as applicable, as well as methods of installation anticipated to enable the development and integration of a detection and mitigation solution(s). Specifically, concepts proposed should contribute to a reduction in corrective maintenance and total ownership costs as well as improving system availability and may be considered for application on LPD 17 Class, LCS-1 and LCS-3 VCHT systems as well.

PHASE I: Demonstrate the feasibility of the development of an innovative approach(es) to detect and counter-act VCHT foam generation or otherwise mitigate its effects in VCHT tanks and systems based on the requirements above. With an emphasis on counter-acting foam generation, the company will demonstrate the feasibility of the concepts in meeting the Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. The feasibility demonstration will include Rough Order of Magnitude (ROM) cost estimates for system acquisition, daily operation and maintenance requirements, system size and how it would be integrated on a VCHT Tank as well as a notional commercialization plan and will identify any potential safety hazards associated with the proposed concepts. The company will provide a Phase II development plan and schedule with performance goals that contains discrete milestones for product development and will be utilized to verify candidate concept(s) performance and suitability.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a scaled prototype for evaluation. In a laboratory environment, demonstrate that the prototype system meets the performance goals established in Phase I. Perform a safety analysis of the modified system and any consumable materials and identify any potential safety hazards associated with the proposed concepts. Provide a detailed Phase III development plan for certification, validation, and method of implementation into a future ship test and/or design environment. Prepare refined cost estimates for system acquisition, daily operation and maintenance requirements as well as logistics data packages, and interface documents for use in both forward fit and retrofit ship programs. Refine the commercialization plan.

PHASE III: Upon successful completion of Phase II, the company will work with government and industry, as applicable, to construct a prototype based on the Phase II results for testing in a shipboard environment. The full-scale prototype will then be installed onboard a selected DDG 52 AF class hull and extended shipboard testing will be conducted. Upon successful completion of the testing, validation, certification and qualification requirements, the technology will be incorporated for use onboard naval ships as practicable. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These systems are installed in most modern warships, cruise ships and other commercial cargo or personnel carriers. Any vacuum collected non-oily wastewater (including sewage) system will also have foam-generation issues and should benefit from the developed product.

REFERENCES:
1) “Navy Vacuum Collection, Holding and Transfer System.” Department of the Navy. April, 2010. www.greenfleet.dodlive.mil/files/2010/04/VCHT.pdf

2) “Naval Ships’ Technical Manual Chapter 593: Pollution Control.” Federation of American Scientists (FAS). 13 Dec, 2000. www.fas.org/man/dod-101/sys/ship/nstm/ch593.pdf

3) PMS 400D. “DDG 51 VCHT Drawing and Guide Sheet.” SBIR/STTR Integrated Topic Information System (SITIS). 2011.

KEYWORDS: foaming; foaming detection; VCHT Safety; VCHT; Vacuum Collection, Holding and Transfer; waste foaming

N122-132 TITLE: Advanced Ballistic Shielding for Crew Served Weapons Stations

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMS 312, Program for Aircraft Carriers, Shipboard Protection System Integra

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 series of reconfigurable and non-reconfigurable advanced ballistic shields for crew served weapons stations.

DESCRIPTION: The existing 10 Crew Served Weapons Stations (CSWS) aboard CVN 68 class ships do not have ballistic shields installed. Commercially available ballistic shields do not meet shipboard integration requirements or military levels of ballistic defeat, and are too heavy and cumbersome to be rapidly reconfigured as shipboard operations dictate. Handling or routinely reconfiguring by personnel is generally not considered and presents a unique problem set. Innovation is required to develop ballistic protection that not only exceeds what is currently available in terms of ballistic defeat, but addresses the difficult issues associated with human systems integration and shipboard integration and operations. There is a need for the development of innovative concepts for a series of reconfigurable and non-reconfigurable ballistic shields.

It is intended that reconfiguration to remove interference with ship’s operations be accomplished without having to remove and stow the shields in a separate location. The development of shields for locations where reconfiguration is not necessary is also intended, and requires innovative integration techniques to minimize ship impact. The following ballistic defeat threshold and objective is intended: Caliber .50 MK 263 AP bullets with a specified mass of 48.6 grams (750 grains) and a velocity of 887 meters per second (2910 feet per second), and 14.5-millimeter API-32 bullets with a specified mass of 64 grams (990 grains) and a velocity of 914 meters per second (3000 feet per second) respectively. The shields are intended to meet defined environmental loads and factors, human systems, ship and weapons interfaces, and protection dimensions. Global Security and Federation of American Scientists websites have various articles pertaining to small arms, ballistic defeat materials and U.S. Navy ships (see References 1-3). Photos of shipboard crew served weapons stations can be found at photo posting sites (see References 4-5), Wikipedia and various Navy websites including navy.mil and navy.com.

PHASE I: The company will conduct the necessary R&D to develop innovative concepts for a series of reconfigurable and non-reconfigurable ballistic shields that meet the requirements described above. Define and clearly illustrate the ballistic shield concepts and materials proposed to be used in Phase II, and CSWS arrangement techniques through use of computer modeling and simulation, drawings, photographs, and data analyses. Clearly explain the proposed ballistic defeat and shipboard integration methods and provide supporting data that ensures environmental loading factors have been taken into consideration. Provide all findings and any supporting data in a final report. Provide a Phase II development plan with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will produce prototype samples of each shield type. If variations in materials and techniques within each type are intended for experiment, samples of each variation shall be produced. Samples shall exhibit all of the physical configuration, materials and ship's interface features as the proposed production units including mounting features and hardware, coatings and markings, in addition to the primary ballistic defeat components. Samples shall be subjected to ballistics testing as defined by the Navy. Computer modeling and simulation will be used for selected environmental tests. The company shall provide test samples and all findings, test reports, collected data and supporting photographs, video, and modeling results in a final report.

PHASE III: If Phase II is successful, the company will work with a selected shipbuilder and/or prime contractor-integrator to refine the ballistic shield design and manufacturing process for cost effective production. Test fixtures will be produced representative of deck, bulwark, life rail or other ship structure for mounting test articles as intended for shipboard integration. Prototype test articles shall be subjected to environmental loading tests including shock and wave slap. Additional ballistics testing will be performed if required as a result of design modifications. Subsequent to successful environmental and ballistics prototype testing, the company will develop a complete ship set of CSW station ballistic shield manufacturing and installation drawings for a selected ship. The company will manufacture all shields and one spare of each type necessary to outfit the ship. Working with the shipbuilder, prime contractor-integrator and/or Alteration Installation Team, the company will install appropriate shields at all CSW stations, and will provide documentation and training to Ship's Force on the reconfiguration and maintenance of the shields as necessary. The selected ship will conduct sea trials of installed shields during scheduled underway periods. Together with NSWCCD, the company will collect data on shields' performance based on Ship's Force reports and inspections conducted during in port periods and will provide PMS 312 with a report of findings and a recommended plan ahead.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The advanced ballistic shielding developed here can also be used for ballistic protection for law enforcement, security industry, maritime security, and emergency ordnance disposal.

REFERENCES:

1. The Federation of American Scientists website provides multiple articles on ballistic protection. http://www.fas.org/

2. The Global Security website provides multiple articles on ballistic protection. http://www.globalsecurity.org/index.html

3. Vehicle Hardening. http://www.globalsecurity.org/military/systems/ground/vehicle-hardening.htm

4. Photo of Crew Served Weapons Station. http://www.flickr.com/photos/usnavy/5387312741/in/photostream/

5. Photo of Crew Served Weapons Station. http://imageshack.us/photo/my-images/295/web070719n7981e237ss9.jpg/sr=1

6. Drawings Mount, Gun, l50 CAL #8241756, 4 pages, uploaded in SITIS 6/12/12.

7. Drawings Mount, Gun, l50 CAL #7520804 Rev D, 2 pages, uploaded in SITIS 6/12/12.

8. Photos of selected stations, photos showing no shields, 4 images, uploaded in SITIS 6/18/12.

KEYWORDS: Ballistic protection; AT/FP; force protection; crew served weapon; small arms; ballistic defeat

N122-133 TITLE: Enhanced De-Interleavers for Submarine Electronic Warfare Support (ES) Systems

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS-435 Submarine Imaging and Electronic Warfare Program Office -- ACAT III

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

OBJECTIVE: The objective is to develop innovative algorithms and techniques to automatically detect, classify, and uniquely identify emitters exhibiting multi-dimensional agilities, extremely wide band RF distribution, high time bandwidth coherent characteristics, and solid state power amplifier technologies.

DESCRIPTION: As the submarine’s electronic operational environment becomes increasingly complex and dense, the AN/BLQ-10 (the submarine Electronic Warfare (EW) system) cannot provide accurate data to the Electronic Warfare Support (ES) operator. The automatic functions of the system are not keeping pace with the new technology in emitters being fielded. This forces the operator to spend the majority of his time processing, verifying accuracy, correlating, and trying to provide timely operational information to decision makers. Consequently, ES operators are drawn from their primary responsibilities of ship safety, self protection, and 360 degree situational awareness to a more time consuming effort of signal recognition and analysis.

De-interleaving is the process of taking random RF energy as it is received by the ES system and sorting the energy into cluster/groups so that all the received energy from individual emitters is separated out into their individual components. De-interleaving is the process used to ensure all pulses being used to identify an emitter actually come from the same emitter and are not being intermingled with other emitter pulses. Submarine ES operators need de-interleaving techniques that can deal with the rapid proliferation of extremely complex emissions. These new target sets are agile in multiple dimensions simultaneously, can exhibit random / pseudo random characteristics in all parameters, and are demonstrating a trend to lower peak power transmissions yet maintaining extremely capable detection properties through coherent integration.

The complex electronic environment of today demands newer algorithms to be able to detect, classify, localize, and uniquely identify the current extremely agile emitters and the new solid state radars.

Current State of the Art capabilities for de-interleavers do not address these new emitter types. State of the Art for the detection and classification of LPI emitters is the PENNANT/SHAWNA capability and it cannot handle these new emitter classes. It is extremely capable against first generation coherent emitters, but the second and third generation coherent emitters are too complex for the current capability to classify and identify them. For the current generation of radars that are demonstrating agilities on a pulse by pulse basis, the traditional delta Tau de-interleavers are inadequate. These emitters change their parameters so frequently that the current state of the art algorithms cannot adequately detect, classify or identify them.

The Navy is seeking de-interleavers that do not require a priori knowledge of the emitters to be able to automatically detect, classify, and uniquely identify the extremely complex emissions of today and tomorrow. This must be performed in real time while operating in extremely dense littoral mission areas.

Specific items that will need to be addressed:
1) Radars that can change Pulse Repetition Interval (PRI), Pulse Width (PW), Frequency (RF) on a pulse by pulse basis.
2) Radars that can change their Intra-Pulse Characteristics on a Pulse by Pulse basis.
3) Radars that can change their Inter-Pulse Characteristics on a Pulse by Pulse basis.
4) Radars that are very low power (less than 200 Watts peak transmit power).
5) Radars that are extremely low power (less than 10 Watts Peak transmit power).
6) Real time processing of a dense environment (greater than 5 Million pulses per second in a 10 millisecond burst; and greater than 2 million pulses per second at a sustained rate)

7) Pulse widths varying from 10 nanoseconds to 10 milliseconds wide
8) Frequency agility greater than 400 MHz wide
9) Emitters exhibiting phase coded RF properties.

The current capabilities of the AN/BLQ-10 are severely handicapped by the proprietary nature of the individual subsystem (Early Warning receiver (EWR), Radar Wideband (RWB), Radar Narrowband (RNB), Specific Emitter Identification (SEID), Advanced Processing Receiver (APR), Automatic Direction Finding (ADF) and Improved Communication Acquisition and DF (ICADF)) and the age of the systems involved (ADF is greater than 20 years old and RWB and RNB are each greater than 15 years old). These systems do not have the capability of de-interleaving today's complex emitter sets. There are currently no current techniques available to perform the de-interleaving of these complex emitters of today's operational environment.

The NAVSEA PMS435 need is to develop new de-interleavers that can automatically detect, classify and uniquely identify these new complex emitters, allowing the operator to spend his time performing ship safety and self protection vice signal analysis and classification. These new algorithms must be open architecture in nature and easily extensible as future radars create new requirements.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for autonomous algorithms to de-interleave extremely complex radar emissions in real time that meet the requirements identified above. Demonstrate the feasibility of the concepts in de-interleaving these emitters in extremely dense RF environments with a very high degree of accuracy (> 90% correct reports) for operators within the requirements described above. Demonstrate the feasibility of technology development to achieve the objective. Develop and evaluate breadboard concepts of key technology components. Prepare a Phase II development plan with performance goals and key developmental milestones and identify risks and risk mitigation efforts.

PHASE II: Based on the results of Phase I and the Phase II development plan, develop a working prototype of the selected concept. Evaluate the prototype in the laboratory to prove the ability of the concept to meet performance goals established in Phase I and Phase II development plan. Based on the results of the evaluation, finalize the concept into a preliminary design. Develop a detailed plan and method of implementation into a full-scale application.

PHASE III: If Phase II is successful, the small business will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. The small business will implement the Phase III plan developed in Phase II and will prepare a manufacturing plan for the technology. The small business will be expected to make the necessary teaming arrangements with the manufacturers of the components used in end product.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The US Coast Guard and Homeland Defense have a need (requirement) to be able to detect and classify these next generation Solid State Radar systems. Advanced Signal Processing Techniques are needed in the commercial communications fields. Advanced de-interleaving techniques can be used by communication companies to allow for more users to occupy the same frequency spectrum via more complex spreading techniques.

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KEYWORDS: EW; Unique Identification (Specific Emitter Identification); De-interleavers; RF detection and classification; Advanced Signal Processing; Pulse grouping and binning; Solid State Radars; Coherent Radar Processing

N122-134 TITLE: Seam Engineering: Stitchless Seam Technology

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The aim of this Small Business Innovative Research (SBIR) opportunity is to systematically investigate and analyze current and evolving stitchless seam technologies, and to evaluate their use in existing Navy clothing end-items. The desired end result would be a reduction in bulk and weight, enhanced performance characteristics such as moisture management (breathability), wind/water resistance, durability, abrasion resistance, flexibility and improved ergonomics. In conjunction with improved technical performance, a reduction to end item costs will be realized through manufacturing efficiencies given the speed of the proposed processes. Furthermore, rapid prototyping of test quantities could be employed using the selected technology in support of developmental garment programs versus current cost-prohibitive approaches.

DESCRIPTION: Historically, production methods for clothing manufacturing involve traditional labor intensive mechanical stitching processes in conjunction with operator precision which involves a variety of stitch types, each utilizing a specific sewing machine. The construction of a typical garment would incorporate many stitch types and associated machines requiring virtually endless transportation from station to station as the garment is formed. Detrimental to the garment performance and functionality are overlapping and complex seams in areas such as the crotch, armhole, neck, cuff, pocket, waistband, and hems. These areas are the source of increased bulk and a source of abrasion and potential failure. In the case of high performance technical apparel, seam sealing tape is applied to the sewn seam to prevent penetration of liquids, chemicals and particulates. This seam sealing operation can add as many as eleven yards of tape to a garment, thereby increasing bulk, weight and stiffness. The process of sewing and seam sealing adds approximately 25% to the manufacturing costs and therefore presents a fine opportunity to realize cost savings.

PHASE I: Phase I will examine and rank novel stitch-free technology processes currently in development by manufacturers. The investigation would include welded seams, adhesive techniques or unique bonding mechanisms.

Promising concepts will be produced and compared to traditional sewn seams using a variety of internationally recognized standards and test methods such as those referenced in International Organization for Standardization (ISO), ASTM International, and the American Association of Textile Chemists and Colorists (AATCC) to determine the most appropriate candidate technologies prior to down selection and subsequent assembly of pre-prototype garments. Tests of interest will include bonding/seam strength, hydrostatic pressure resistance, stiffness, dimensional stability and durability predictions. Results documenting the potential viability of novel seaming techniques into Navy garments will be compiled into a final report with recommendations for Phase II. It is also envisioned that leap ahead technologies would emerge and could be pursued in later Phases of the effort.

PHASE II: The focus of Phase II will be to design, develop and test prototype garments utilizing the best candidate stitch-free technologies selected from Phase I and to conduct a manufacturing feasibility analysis. A standard Navy garment will be chosen as a demonstration model but it is anticipated that the Parka, Navy Working Uniform (NWU) which utilizes both traditional stitching and complex seam sealing techniques would be an excellent example to assess the technologies' viability. Garments will be developed and subjected to laboratory durability prediction assessments using multiple shipboard launderings, prior to laboratory testing. The best candidates will be subjected to a limited shipboard and shore side user evaluation. Following the wear test, they will be evaluated through objective laboratory assessments and by collecting user feedback through focus groups to determine performance, durability, reduction of bulk and weight, operational compatibility and ease of care.

PHASE III: Equipment and processes will be optimized for the selected technology which will transition to end items on a prioritized basis and accompanying technical data packages updated to reflect the changes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Alternate seam technologies are employed in a variety of garment manufacturing processes. They have been in the commercial market for several years, however situations where seam strength is critical, the alternative solutions did not create satisfactory results. Some manufacturers in the commercial sector have adopted stitchless seam technology in recreational garments in the areas of pockets, zippers and other “non-stress” seams. The technologies have evolved dramatically and are worthy of consideration. This initiative will analyze the technology improvements.

REFERENCES:

1. ASTM International Test Method D-751 - Water Resistance of Cloth; Water Permeability; Hydrostatic Pressure Method

2. ASTM International Test Method D3884 Standard Guide for Abrasion Resistant of Textile Fabrics (Rotary Platform, Double-Head Method) or Test Method D4157 Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)

3. ASTM International Test Method D4884 Standard Test Method for Strength of Sewn or Thermally Bonded Seams or Test Method D1683 Standard Test Method for Failure in Sewn Seams of Woven Apparel Fabrics

4. Technical Manual of the American Association of Textile Chemists and Colorist (AATCC). Test Method 135 Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics

5. Navy Shipboard Wash Formula III

6. Technical Association of the Pulp and Paper Industry (TAPPI) Test Method T-451, Stiffness, Preferred Procedure Stiffness or ASTM International Test Method D747 Standard Test Method for Apparent Bending Modulus of Plastic by Means of a Cantilever Beam

7. Seams to be an Advantage, Martin Vilaboy. Inside Outdoor Magazine. Spring 2003.

8. A New Joining Fabrication Technique for Collective Protection: The Duraseal™ Seam, Christine W. Jarvis. 2000.

KEYWORDS: Stitch-free, seam sealing, seam engineering, environmental protection, apparel construction

N122-135 TITLE: High Power Vertical Gallium Nitride (GaN) Transistors on Native GaN Substrates for Power Switching Applications

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

OBJECTIVE: Develop homoepitaxial GaN high voltage (5000V) vertical power switching transistors on GaN substrates to enable compact, efficient high power converters.

DESCRIPTION: GaN power switching transistors have recently been demonstrated with performance superior to conventional silicon (Si) or silicon carbide (SiC) based devices. The demonstrated GaN devices offer a better combination of on-resistance, capacitance and breakdown voltage than competing technologies. However, GaN devices have been limited by the non-native substrates (such as Si or SiC) required to date. The heteroepitaxy of GaN material on non-GaN substrates has led to lower quality material and required thick GaN buffer layers to support the depletion region required for high voltage devices, limiting practical devices to ~1,500 volts (V). The recent and on-going development of high quality bulk GaN substrates offers the new possibility of GaN transistors developed homoepitaxially on GaN substrates. This approach would reduce the requirement for thick GaN buffers, lowering materials growth and process costs, as well as, open the door to new power device topologies, such as vertical devices, which could potentially support up to 5 kilovolts (kV) with 50% lower resistance versus SiC devices.

State of the art is focused on Si, SiC and GaN devices. Si devices are the most mature but disadvantaged relative to Wide Bandgap (WBG) materials (SiC and GaN) due to fundamental materials aspects that limit breakdown field and on-resistance. SiC materials are similar to GaN but are more developed with demonstrated Depletion Metal Oxide Semiconductor Field Effect Transistor (DMOSFET) devices operating up to 15kV. Due to higher critical breakdown field, GaN offers the best combination of fundamental materials properties for power switching but has been exclusively developed on non-GaN substrates to date. GaN Schottky diodes have been demonstrated to benefit from free standing substrates, but this effort will focus on transistor structures.

PHASE I: Design/develop an innovative concept that demonstrates the scientific merit and feasibility of developing a normally-off, high voltage Field Effect Transistor (FET) technology in GaN on native GaN substrates. The effort will demonstrate a device approach that provides a blocking voltage of 5,000V, a threshold voltage >1V, with a specific on-resistance, RDS,ON-SP of 30 mOhm-cm2. These specifications are to be achieved in a vertical device geometry that is capable of comparable frequency response characteristics to current SiC power switching devices.

PHASE II: Demonstrate a device with a 1 amp drain current while maintaining the blocking voltage at 5,000V, a threshold voltage >2V, and reducing the on-resistance, RDS,ON-SP to 20 mOhm -cm2. In addition the drain current collapse, RAC/RDC, at 600V, will be <3. Device yield on-wafer should be > 50%.

PHASE III: Demonstrate a device with a 5 amp drain current with a blocking voltage to 5000V, a threshold voltage > 2V, and reducing the on-resistance, RDS,ON-SP to 10 mOhm-cm2. Reduce the drain current collapse, RAC/RDC, at 600V, to <1.5. Advance on-wafer yield to > 90%.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Normally-off GaN devices will replace Si in most power applications where improved efficiency is required. This is currently a major drive in the commercial sector in an effort to reduce energy costs.

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KEYWORDS: Power efficiency; Gallium Nitride; GaN

N122-136 TITLE: <u>Tell Me About</u>

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PM Intelligence Systems Acquisition Program, APTS (Mobile ISR-C2) FNC

OBJECTIVE: Develop and demonstrate a capability to automatically respond to “tell me about” questions with finished information products.

DESCRIPTION: Military Intelligence and Operations staff spend large amounts of time preparing reports and briefings by searching for related information from many data stores, estimating data relevance, and then fusing and formatting relevant data as information products. Active Wiki technology has been used to update web pages about specific topics, but these sites require advance knowledge of where to find relevant content. Additionally, search engines based on user input of words to find various types of data are common.

This SBIR topic will advance the state of the art by providing a capability to accept broader “tell me about” questions (e.g. persons, groups, places, events) and by requiring the system output to look like a finished information product. To accomplish this, a system is needed that can semantically understand the content requirement of questions and semantically enrich raw unstructured data. Progress made in automated semantic extraction, or the extraction of entities with information/context associated with that entity could be applied to this problem. The recognition of content, in the form of word frames or themes is also applicable to the topic’s challenge. Due to these and other advances in semantic natural language processing, it should now be possible to translate the information content requirements of a "tell me about a person, event or place" question to machine understandable ontology. The Phase I performer will need to select several "tell me about" questions to consider, translate these to content models, automatically discover, fuse, and import relevant information, calculate how much of the content required was found, and package discovered/distilled data as a finished information product.

Key technical challenges include: question content modeling, semantic enrichment of unstructured text, automated tracking of the sufficiency of discovered content to a semantic question, and automated production of a finished product in a commonly used format (e.g. output to an MS Office application). The Navy is interested in innovative R&D that involves some measure of technical risk. Proposed work shall have technical and scientific merit. Creative solutions are desired.

PHASE I: Select several “tell me about” questions to consider. Reduce the technical risk associated with the development of a system that can model the content required to address a complex question, semantically enrich raw data, and produce a finished intelligence product relevant to the question asked. Track key technical performance parameters. Conduct a demonstration at the end of the Phase I effort that clearly shows how much risk, relative to the production of a full prototype system, has been mitigated.

PHASE II: Develop and demonstrate a prototype system that is capable of producing finished intelligence products from “tell me about persons, groups, places, events, etc.” questions by discovering the full answer to these questions from semantically enriched unstructured text. A proof-of-concept should be shown with relevant document corpus and content completeness of 80% and content inclusion accuracy of 90%.

PHASE III: Produce a system capable of deployment and operational evaluation. The system should address “tell me about” questions that have relevance to intelligence fusion cells. Increase performance over Phase II demonstration that can produce finished products with a completeness of 80% and accuracy of 90%.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are many potential commercial applications, including law enforcement and internet search engines, for an application that can produce a summary word document vice a list of links in response to a question about a person, or any other topic.

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KEYWORDS: Natural language processing; semantics; content modeling; auto-generation; complex queries; meta data tagging; machine understanding

N122-137 TITLE: Team Performance Metrics for Command and Control of Unmanned Systems

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: Capable Manpower FNC EC: Human Systems Integration

OBJECTIVE: Develop and demonstrate metrics for a team of decision makers, managing multiple autonomous vehicles, to assess transaction efficiencies given autonomy and control interventions.

DESCRIPTION: Unmanned systems currently require increasingly large teams of operators. Diagnostic system and operator team metrics for teams of decision makers supporting these systems largely do not exist. Autonomy, currently being developed, will transform the nature of these systems and the requirements of warfighters to support them. Tools and metrics to assess the impact of autonomy, identify system performance issues, and to evaluate the impact of interventions do not currently exist. This topic will provide tools to measure the impact of emerging autonomy systems on warfighter manning and training requirements and ensure that the autonomous systems being developed meet the Navy's operational objectives and life cycle costs.

Autonomous systems will require warfighters to interact with vehicles and other warfighters using higher-level information related to missions and tasks. Alternative schemes for managing autonomous systems are under development to achieve appropriate manning levels. As unmanned systems increasingly involve multiple vehicles with different levels of automation, the impact and utility of the autonomy to the warfighter and the overall man-machine system must be evaluated. New metrics and assessment techniques to evaluate alternative schemes, given the autonomy, are desired for evaluating overall system effectiveness and performance. System-level metrics may include: efficiency of warfighter control and information transactions, bandwidth impact, scope of control, and timeliness. User-level metrics may include: warfighter-autonomy expectation convergence, situational awareness, information uncertainty and operator workload. Metrics should result in a real-time, graphical model to aid in the visualization of transaction effectiveness and assist in the diagnosis of issues in the coordination of the human-machine system. This topic seeks innovative proposals for evaluating the users and usage of autonomous systems.

PHASE I: Conceptualize and design an innovative approach to assess performance of teams operating multiple autonomous vehicles. The proposed approach should describe human performance metrics and their application in evaluating the operational use of autonomous systems. Clearly state what diagnostic requirements are anticipated and how the proposed approach would address them. Metrics should identify and quantify critical, anticipated human performance capabilities and limitations relevant to managing autonomous systems as well as mission-based performance parameters. Metrics could include: operator information processing effectiveness, speed of decision making, minimization and/or reduction of procedural errors, and tactical control performance. The proposed metrics should operate in real time and communicate with operators in "quick look" graphical formats. Successful metrics will support both overall assessment of the autonomy in operational contexts as well as diagnostic indicators of critical factors contributing to the observed performance. Phase I must identify a proposed operational context (i.e., application) for developing and demonstrating proposed metrics that would be employed during Phase II.

PHASE II: Develop and demonstrate tools, techniques and metrics) to assess the management of highly autonomous systems. Conduct testbed-based validation in a lab or using a modeling and simulation environment. Initial demonstrations may be conducted using a notional scenario and synthetic data; however, evaluations with actual data are desired by the end of Phase II. Conduct one or more controlled experiments to validate tools and quantifiably demonstrate their benefit in improved team decision-making performance. Prepare guidelines and documentation for transition of the tool to an operational setting. Use the results of the development phase to build and test a prototype to assess the impact of system design changes (e.g., different autonomy designs) on team performance in a subsurface or similar tactical environment.

PHASE III: Conduct testing to validate, standardize, and document metric evaluation and assessment software and implement in a field experiment. Collect performance data with an autonomous system to validate improved performance. Develop guidelines and documentation for transition to an operational setting. Field-test the tool in an operational setting and produce improved performance measures. Implement the tool in a comprehensive package that would include an intuitive graphical user interface.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector products could utilize evaluation tools and techniques to assess complex human-machine systems with various degrees of automation. These might include multi-robot applications and any team performance situation that involves high-volume data and quick response requirements with significant coordination requirements across person-machine systems. Applications could include state and local emergency intervention teams for crisis response and humanitarian aid response.

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KEYWORDS: Unmanned autonomous systems; metrics; command and control; decision making; autonomy; human performance

N122-138 TITLE: Interactive Generative Manifold Learning

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: Network-Centric Sensor Analysis for Mine Warfare (NSAM), PMS-495, PEO-LCS

OBJECTIVE: Develop techniques or mechanisms whereby a human operator may describe and/or generate previously unseen realizations of target data based on a low-dimensional representation learned from a training dataset (i.e., without a physical model.)

DESCRIPTION: Within the field of target recognition, the use of manifold learning has become increasingly popular and powerful (Ref. 1-3). Consider a classic example from facial recognition where a dataset is comprised of a single face imaged at many rotations (e.g., profile, head-on, etc.). In this example, a learned manifold would be low dimensional (here, one-dimensional) and correspond to rotation angle. There would be a corresponding mapping from the high-dimensional space of the image (where the dimensionality equals number of pixels) to the low-dimensional manifold. Therefore any point on the manifold would correspond to an image of the face at that given rotation. Recent advances have developed generative models for manifolds as well as one-to-one mappings (Ref. 4). Therefore, it is now possible to pick any arbitrary point along a manifold and map it back into the high dimensional space. This allows one to generate previously unseen data directly from the manifold without a physical model of the process that generated the data. The purpose is to enable the human to both "explore" and "describe" target characteristics beyond those represented by existing datasets.

The goal of this effort is to investigate methods and develop techniques for a human operator to explore high-dimensional data by: 1) traversing along the low-dimensional manifold in a meaningful, intuitive, and efficient manner (i.e., interpolating along the existing manifold); and 2) exploring data that either lives on the existing manifold beyond the currently characterized regions or exists on an expanded manifold of larger dimensionality (i.e., extrapolating beyond the existing manifold). This later focus on extrapolation is aimed at leveraging the expertise of the human operator to characterize manifestations in the data that have not been sufficiently sampled yet are well understood by the human. For example, in the facial recognition problem, manifestations due to head tilting, illumination effects, or facial gestures may be present to a minor degree. These manifestations could be brought out by the operator, characterized, and used to generate additional previously unseen data.

It is emphasized that facial recognition is used here as an example only; the high-dimensional data of interest to this effort may be imagery, video, etc., derived from electro-optic, sonar, radar, etc. Additionally, the data characteristics to be interactively explored by the human include any meaningful characteristics of the data (e.g., target shape, pose, appearance, motion, motion characteristics, background effects). Finally, recall that a low-dimensional manifold may still have dimensionality greater than three; therefore, a significant portion of this effort should focus on how the human may effectively interact with the low-dimensional data to explore the implications in the high-dimensional representation.

PHASE I: Investigate methods and techniques for a human operator to generate meaningful, previously unseen data in a high-dimensional space by exploring a low-dimensional manifold in an intuitive and efficient manner (i.e., the interpolation goal). For Phase I, developers should use their own data, publicly available data, or data they acquire after approval by the technical point of contact (TPOC) (i.e., data will not be provided by the government for Phase I). The nature of this data is less important and may, in general, be anything that is intuitive to a human (e.g., camera images, video). Additionally, the data provided by the performers need not be from a military application.

The option period will ensure that the methods and techniques investigated in the base effort are amenable to manifolds of dimensionality greater than three. It will also begin investigating methods and techniques for exploring data beyond the currently characterized regions of the existing manifold and extending the dimensionality of the existing manifold in a meaningful way, the extrapolation goal.

PHASE II: Develop prototype software system complete with user interface for both interpolation and extrapolation. Phase II will be initiated with data provided by the developer; however, the government may elect to provide additional data and/or sensing modalities as appropriate. Again, the nature of the data is secondary; the primary focus of this effort should be on the interaction between the human and the data.

The option period will be used to expand the robustness and effectiveness of the interface with the human. Emphasis here will be placed on the extrapolation goal.

PHASE III: Extend the software to operate effectively, be robust, and be fault tolerant to a full spectrum of government-provided data. This will involve significant coordination with a government laboratory to fully integrate and test in the program of record.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability is applicable to any recognition system in any problem domain that requires gathering training data. Therefore, it has significant commercialization potential (e.g., medical, entertainment, web, etc.).

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KEYWORDS: Compression; machine learning; manifold learning; low-dimensional; sparse; target recognition

N122-139 TITLE: Cost-Effective Technologies for Fabrication of PiezoCrystal Vector Velocity Sensors

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

ACQUISITION PROGRAM: PMS 401, PEO IWS5A Integrated Warfare Systems, ONR FNC Submarine Thin-Line

OBJECTIVE: Devise and demonstrate cost-effective methods for the fabrication of vector velocity sensors from relaxor piezoelectric single crystals.

DESCRIPTION: Arrays of vector velocity sensors provide major system gains over legacy arrays of omnidirectional hydrophones in bottom moored and submarine/unmanned undersea vehicle (UUV) towed applications. For example, the left-right ambiguity of legacy devices is eliminated and an array sensitivity null can be steered at a noisy source of interference making much quieter targets detectable. The exceptionally sensitive, compact accelerometers made possible by the new relaxor piezocrystals are the key enabler for this performance enhancement. Since these sensors are only millimeters in size and are required in large numbers, a major technical hurdle for this technology is to devise cost-effective ways to manufacture the vector sensor. A cost model, relating the component and touch labor costs, is needed for the various design options. Once the dominant cost drivers have been identified, approaches to reducing costs, either through reducing component or labor costs, are essential if the Navy is to benefit from the new technology.

A variety of accelerometer designs are under development for these vector velocity sensors, for example, cantilevered-beams, shear-mode, and pressure-gradient devices. While acoustic performance is the primary driver in the choice of device configuration, cost will ultimately determine the acquisition choice.

PHASE I: Devise cost-effective innovative technologies to fabricate high-performance vector velocity sensors. Design, build, and test a vector velocity sensor incorporating at least one of these innovations. Estimate production costs when these technologies are introduced into volume production.

PHASE II: Devise a full set of technologies to make vector velocity sensors which optimize both performance and cost-effectiveness. Demonstrate performance using appropriate in-water testing. Devise a cost model for volume production.

PHASE III: Using the optimum production route devised, these technologies will be used to produce vector velocity sensors in Navy acquisition programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Vector velocity sensors have a variety of civilian sector applications that would profit greatly from the enhanced sensitivity and reduced size and noise levels afforded by the piezocrystal technology. Most closely paralleling the Navy's interest in undersea towed arrays are similar towed arrays used by the oil exploration industry. In a different context these sensors are employed in vibration sensing/suppression in HVAC systems and in heavy machinery (e.g., for example for machine tool control).

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KEYWORDS: Vector velocity sensor; piezoelectric; single crystals; undersea sensors; towed arrays; moored arrays

N122-140 TITLE: Energy Efficient Signal Classifier for Dense Signal Environment

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

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OBJECTIVE: Design a signal classifier that is capable of handling diverse, agile signals in an energy efficient manner in a dense signal environment.

DESCRIPTION: Signals of interest (SOI) are becoming much more frequency agile, numerous, and have a low probability of intercept (LPI) by design, making signal recognition and classification much harder. The saturation of state-of-the-art Si clock speeds, increased operational tempo, and surging interest in light-weight, low-power, distributed sensors have focused attention on low latency, energy efficient digital signal processing. Re-optimization of signal classifiers is needed to allow discrimination based on agilely defined subsets of a large set of potential attributes which differentiate specific SOI. Initial ambiguity regarding which attributes are required call for multiple interpretation hypotheses to be generated, their reality probability evolved, and the branching set thinned every time a new piece of information is received. A method for backing up to still viable hypotheses when new information assigns a low probability to a previously high probability hypothesis is needed. The virtue of maintaining an evolving database of all the signals currently in the environment, as a way of eliminating the need to recategorize packeted and discretely pulsed signals, could be considered. Systems capable of differentiating receiver caused spurs and intermodulation distortion (IMD) from real signals are desirable. Improved data management efficiency is a key requirement.

PHASE I: Determine the feasibility of and develop an approach, as outlined in the topic objective and description, to improve the energy efficiency of signal classification in a dense environment of agile signals. During the Phase I base, complete a proof of concept demonstration and scope a plan for Phase II. The Phase I option may be used to prove an additional functional virtue of the approach, begin work on a foreseeable hard problem, and/or refine the Phase II plan.

PHASE II: Implement the Phase I approach, building out the software/firmware/hardware enablements and demonstrating their utility and energy efficiency in a simulated dense signal environment. The limiting factors on the ability of the new system to keep up in real-time with an evolving situation should be quantitatively explored. Its applicability to wideband reception of all incident signals should be evaluated. It is likely that Phase II will involve classified aspects. Demonstrate the technology developed in Phase II under more realistic settings during a possible Phase II option.

PHASE III: Transition to a program of record in Phase III.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Under the name cognitive radios, the practice of moving signals into a currently available portion of the spectrum and back out if the owner arrives has become widely appreciated as a means of increasing capacity at minimum spectral cost. Indeed, the XiMax standard is evolving toward both center frequency and instantaneous bandwidth agility. This sort of energy efficient signal classification will also assist base stations in sorting the signal environment into paying users, non-disruptive interlopers, and spectral interlopers who are disruptive and should be pursued (e.g., thorough the civil courts). The techniques developed may also have applicability to large data set mining (e.g., in looking for purchasing trends and crowd sourcing). The more processing that can be done locally, the lower the charges will be for cloud computing and data movement.

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KEYWORDS: Cognitive radio; software defined radio; data base management; energy efficient software; reduced instruction sets; data thinning

N122-141 TITLE: <u>Predictive Model for Imaging Underwater Objects through the Air-Sea Interface</u>

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PMS-495; SHD12-04 "Detection and Neutralization of Drifting Mines"

OBJECTIVE: To develop a radiative transfer model to predict visibility of submerged objects by above-surface sensors accounting for realistic sea surface geometry as well as water column and seafloor characteristics.

DESCRIPTION: Detection of underwater objects by above-surface passive and active electro-optic (EO) sensors is required for a variety of DoD and civilian applications. Existing models crudely parameterize the complex, time-dependent sea surface geometry, which may include wave-breaking, sea foam, and surfactants. Detailed multi-scale models for sea surface geometry are now available; likewise, in situ instruments provide water column properties including inherent optical properties, suspended sediment, biologics, and bubbles. Finally, in shallow environments the optical properties of the seafloor can impact the ability of a sensor to detect submerged objects near the sea surface, in the water column, or on the seafloor. Robust, high-fidelity, algorithmic approaches and modular software for predicting the time-varying visibility of submerged objects having arbitrary optical and geometrical properties should be developed to address: 1) a high-fidelity treatment of the geometry and properties of the air-sea interface, including foam and surfactants, 2) a description of the water column including suspended sediment, biologics, and bubbles, 3) a description of relevant seafloor properties, and finally, 4) estimates of uncertainty for the derived environmental characteristics.

PHASE I: Develop a plan, based on current state-of-the-art knowledge of oceanographic phenomena, to build and validate an EO radiative transfer model to predict time-varying visibility of submerged objects having arbitrary optical and geometrical properties using sensors located above the sea surface. The plan should, at a minimum, address the plan for software modularity, modeling of the relevant oceanographic/radiative transfer phenomena, development of algorithms, implementation of computer code, and methodology for estimation of prediction uncertainties.

Develop an algorithmic strategy and software modules to address topic objectives that are compatible with Navy Mine Warfare (MIW) Command and Control (C2) software systems. Demonstrate efficacy of selected algorithms across a wide range of the multi-dimensional parameter space by comparison to existing laboratory and field measurements. Describe data input requirements and output products, including treatment of uncertainty in input parameters.

PHASE II: Develop algorithms and implement a set of modules, in computer code, addressing each of the components of the radiative transfer problem described in Phase I. Develop plans for, and implement in computer code, the ability to: 1) visualize the results, 2) implement underwater targets with arbitrary geometry, optical properties, and location within the water column, and 3) implement the capability to select from active and passive sensors having a broad range of characteristics. Test simulation predictions using available data from the literature or other existing data. Develop interface control documentation for MIW C2 Mine Warfare and Environmental Decision Aids Library – Enterprise Architecture (MEDAL-EA), Environmental Post-Mission Analysis (EPMA) and Network-centric Sensor Analysis for Mine Warfare (NSAM) and control software and demonstrate compatibility with those systems.

PHASE III: Transition MIW C2 compatible modular software to US Navy and/or US Marine Corps program of record.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Models for prediction of radiative transfer through the air-water interface have application to a wide variety of civilian engineering and scientific applications. These applications include, among many others: remote sensing of water depth in nearshore waters, reefs, and rivers; airborne measurement of the opacity of turbid water due to suspended particles, surfactant films, and foams; and, the impact of changes in water optical properties and the impact of such changes on ocean biota.

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KEYWORDS: Underwater imaging; ocean optics; electro-optical; radiative transfer; air-sea interface; surface gravity waves

N122-142 TITLE: Compact High-Power Broad-Band Spherical PiezoCrystal Acoustic Source for Countermeasures

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

ACQUISITION PROGRAM: PMS 415 Undersea Defensive Systems

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OBJECTIVE: Design, build, and test a compact, high power, broad bandwidth, highly efficient acoustic source made from relaxor piezocrystals whose shape approximates a sphere.

DESCRIPTION: Acoustic countermeasures, deployed from ships and submarines, serve as decoys by mimicking the acoustic signature of the vessel. These autonomous devices require a highly efficient, high-power, broadband, compact acoustic source to achieve their goals. The combination of the most effective acoustic radiator design (i.e., a sphere) and the new high-coupling, high-strain relaxor piezocrystals provides an optimum combination to meet these exacting requirements. The primary technical challenge is to devise a cost-effective method of making a tiled approximation to a sphere; much as current piezocrystal cylindrical transducers are tiled approximations to a cylinder. Other issues to be addressed, primarily by modeling, include specifically the actuation mode (d31 or d33) of the crystals, whether a fully active tiling is appropriate or whether some passive tiles should be included, and the implications of these choices for the drive electronics.

In these applications both cylindrically and spherically shaped sources made from legacy piezoceramics have been employed with good results. Segmented cylinders of the relaxor piezocrystals provide a dramatic enhancement over the legacy piezoceramic cylinders, matching their acoustic performance in a package one hundredth the size requiring only half the energy. A tiled sphere (like a soccer ball) of piezocrystals will provide a similar step improvement over legacy piezoceramic technology.

PHASE I: Design a transducer that closely approximates a sphere using tiles made from plates of relaxor piezocrystals. Model the acoustic performance of the design: crystallographic orientation of the plates, location of the electrodes, dimensions of the components and overall transducer size for the frequency bands appropriate for acoustic countermeasures. Devise a method to assemble a notional transducer and validate the feasibility of the assembly technique by making at least one example and measuring the acoustic performance of that example. A Phase I Option could include assembly of additional samples and measurement of their acoustic performance.

PHASE II: Using the results from Phase I, vary the design parameters of the candidate transducer configuration to optimize its acoustic performance as a countermeasure source. Optimize the transducer assembly method, then build and measure the acoustic performance of at least two devices. Phase II work that focuses on a specific device may be classified.

PHASE III: Transition a compact, high power, broad bandwidth, highly efficient acoustic source made from relaxor piezocrystals whose shape approximates a sphere to upgrade the performance of present countermeasure devices and to make new, improved countermeasures feasible into a program of record.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The compact, broadband, highly efficient acoustic source developed in this effort will find applications in a broad spectrum of civilian underwater sonar systems in applications ranging from bottom profiling through obstacle avoidance and acoustic beacons to acoustic communications modems.

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KEYWORDS: Single crystal; transducers; countermeasures; spherical; piezocrystals; broad bandwidth

N122-143 TITLE: Analytical Processes for Predicting Nanosecond Response of Highly Rate-Sensitive Materials

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO Ships/Carrier and shipyards.

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OBJECTIVE: Develop an analytical capability to predict the response, in nanosecond time intervals, of highly rate-sensitive materials to a ballistic or blast threat.

DESCRIPTION: The protection of vital spaces on ships is a critical concern. Recent efforts utilizing low-cost glassy, highly rate-sensitive materials (e.g., conventional soda-lime glass, Plexiglas, and highly rate-sensitive polyurea and polyurethane polymers) to defeat ballistic and blast threats have been demonstrated. These materials exhibit strongly nonlinear, strain rate dependent behavior that can currently only be determined by costly and time-consuming test series. In order to rapidly design and evaluate different configurations of these materials, a modeling and simulation methodology is necessary to evaluate the trade space.

The primary focus of this topic is to develop an analytical capability/method to predict the complex responses, in nanosecond time intervals, of these highly rate-sensitive materials when under stress. This predictive method should capture the transient levels of stability, support, and load transfer as well as the erosion characteristics and fracture and failure waves generated by armor penetrators such as hypervelocity jets and fragments.

The predictive method should be capable of characterizing: shockwave propagations and interactions; the generation of failure waves; granulation/comminution; and, the erosive capability of conventional glass. For Plexiglas specifically, the predictive method should include fracture property transitions at high rates of loading (petalling to Hertzian failure) and the partitioning of energy and erosive capability. Additionally, high rate properties, rate-induced glass-transition, and phase change effects are of specific interest in predicting behavior in polyurea and polyurethane polymers.

The predictive method will support the analysis of a layered structure of highly rate-sensitive materials with different thickness and component arrangements. It should be able to distinguish different thicknesses, placements, and orientation (obliquity of the threat) of these materials. It should also incorporate capabilities for energy loss from momentum trapping from failed components. The predictive method should include constitutive equations and Equation of State (EOS) in subroutines that can be readily utilized in existing computer programs such as ABACUS, AUTODYN, DYNA-S, LS-DYNA, and CTH or in Meshless and Particle methods.

The predictive method should be capable of responding to threat weapons of interest. A sample weapon, a long-rod penetrator, will be provided by ONR to support the development of a predictive capability in Phase I. Later phases will include an Explosively Formed Projectile (EFP) and other shape charge threats. Optimized designs, derived for maximum protection against these various threats, will be required.

PHASE I: Develop an analytical capability (i.e., subroutines) to predict, with nanosecond time resolution, the response of layered components of glass, Plexiglas, and polyuria/polyurethane to a ballistic or blast threat. The capability should incorporate: erosion/comminution, wave propagation/reflections, phase changes, fracture transitions, and momentum trapping. ONR will supply a long-rod penetrator for analytical purposes.

PHASE II: Transition the analytical capability to an existing computer program such as ABACUS, AUTODYN, DYNA-S, LS-DYNA, and CTH or to Meshless and Particle methods. Perform blind design and optimization of targets to validate and verify the analysis against test data and actual EFP and shape charge threats test results supplied by ONR (some of this information may be classified).

PHASE III: Upon successful Phase II completion, the company will support the transition of the technology to support the development of low-cost protection systems for a wide range of military, civilian, and space applications (e.g., protected vehicles, secure buildings, patrol craft, meteor and space debris impacts).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This SBIR may provide support to the design and acquisition community in the area of lightweight protective systems. This capability could have use in the development of low-cost protective systems for a wide range of military, civilian, and space applications (e. g., protected vehicles, secure buildings, patrol craft, meteor, and space debris impacts).

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KEYWORDS: Modeling and simulation; constitutive modeling; Equation of State; glassy state; phase transition; explosively formed projectile; penetrators; shape charge; blast; momentum trapping

N122-144 TITLE: Technologies for Enabling Warfighter Intuitive Decision Making

TECHNOLOGY AREAS: Battlespace, Human Systems

ACQUISITION PROGRAM: Squad Immersive Training Environment (SITE) program of record

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OBJECTIVE: Develop innovative technologies that blend rapid data processing capabilities of computers with intuitive decision making skills of humans to improve human information throughput and decision making.

DESCRIPTION: Computers can process vast amounts of data in a short time but programming them to detect patterns is extremely difficult. Humans, on the other hand, are adept at extracting patterns from large amounts of data, yet are limited by the rate at which they can apply these cognitive abilities to large amounts of quickly changing information. Consequently, computers have low success rates when tasked with detecting relevant and important information embedded in complex data streams, while humans are unable to effectively process large amounts of data that are fast becoming a hallmark of today's decision-making environments. Compounding the problem, traditional support technologies, like decision aids and visualization tools, create an artificial barrier which plays to either the strengths of computers or the strengths of their human operators, but not both.

The process through which humans quickly make sense of partial, incomplete, or rapidly presented information is known as intuition. Intuitive decision-making processes are associated with rapid recognition of patterns among incoming streams of information followed by retrieval of associated knowledge without conscious attention. The neural processes underlying intuition occur on a very rapid timescale and can be captured by non-invasive imaging technologies. Combined with cognitive and behavior-based measures of intuition, neural measures should provide significant improvement in measurement accuracy. In parallel to these discoveries, advances in bio-inspired adaptive data analysis techniques like genetic algorithmic modeling are now being used to filter and sort information presented to humans. This is achieved by first generating "hunches" around likely human responses, then using human behavioral responses to establish the plausibility of such hunches and finally, refining the information being presented through multiple iterations of this process. Consequently, it should be possible to augment the support of these bio-inspired data processing techniques by integrating into them neuro-cognitive measures of intuition, enabling humans to accurately and quickly detect meaningful information from a mass of data.

The requested effort will augment current data processing techniques by developing measures of intuition (e.g., cognitive, behavioral, and neural markers) that can be used to rapidly identify the initial saliency and relevance of information, and then refine the information presented through multiple iterations. This will enable humans to rapidly analyze large amounts of information in complex information environments. This effort will develop a suite of neuro-cognitive measures that can be reliably detected, integrate this measurement suite into decision support and analysis technologies, demonstrate increased amounts of information processed per unit time, show reduced overall decision-making time, and quantify decision-making effectiveness using signal detection theory.

PHASE I: Determine the feasibility of developing a system that will blend rapid data-processing capabilities of computers with intuitive decision-making skills of humans to improve human information throughput and decision making. The performer will propose a prototype system and a preliminary design and architecture, including descriptions of the following: proposed measures of intuition; appropriate sensor technologies for detecting these measures; and, proposed method for linking these measures to decision support and analysis technologies and the planned experimental paradigm and use case. Modeling and simulation are encouraged to guide the development of overall system design as well as to demonstrate the potential effectiveness of the proposed system. A final report will be generated, including system performance metrics and plans for Phase II. Phase II plans should include key component technological milestones and plans for at least one operational test and evaluation event. Phase I should also include the processing and submission of all required human subject use protocols.

PHASE II: Develop a prototype system based on the preliminary design from Phase I. All appropriate testing and a critical design review will be performed to finalize the design. Phase II deliverables will include: (1) a working prototype of the technology, (2) specification for its development, and (3) test data on its performance collected in one or more operational settings.

PHASE III: Deploy the developed system for use in high operations tempo environments, such as Command and Control, Maritime Operations Center or disaster management information centers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology will have broad application in military as well as commercial settings in which large quantities of information must be quickly and accurately analyzed for effective decision making in high-risk and high-stress operational settings. The military is reducing the number of personnel involved with weapons platforms and Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) systems while increasing the total amount of information that these reduced crews must manipulate. Therefore, systems that help warfighters effectively process this information are urgently needed. Similar trends are occurring in commercial sectors, where fewer personnel are tasked with processing ever-increasing amounts of information (e.g., air traffic control, commercial shipping, manufacturing facilities, power plant control systems, crisis management, and emergency management). For the DoD, this technology will provide a means for ensuring that reduced manpower does not result in reduced readiness and performance. Commercially, this technology will provide a new capability to enable fewer personnel to handle increasingly greater quantities of information across a wide range of domains.

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KEYWORDS: Intuition; Decision Making; Decision Support; Neural Imaging; Human Machine Interaction; Hunch

N122-145 TITLE: Data Storage and Transmission Strategies for Wireless Ad Hoc Networks

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: JPEO JTRS - ACAT I

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

OBJECTIVE: To develop a service that provides distributed, secure data storage and sharing on a tactical wireless ad hoc network.

DESCRIPTION: The new generation of tactical radios and networks will include remote unmanned sensors and radio nodes that dynamically join and leave self forming networks and subnets. The dissemination and storage of data across wireless links pose new challenges on how these systems will access data and where the actual data will reside. The Joint Tactical Radio System Program (JTRS) encompasses a family of multi-functional Software Defined Radio (SDR) communications systems that provide the next generation of voice, video and data for the warfighter. Although JTRS is the platform of choice for this future, JTRS, and any tactical networking system, must be supported by developments in networking and applications to meet future warfighter data needs.

Specifically, while distributed data storage and sharing is an important paradigm that has been embraced in many computing contexts, it faces unique challenges in the military wireless domain. Military tactical networks have unique characteristics that are not easily addressed by available commercial solutions existing today. Military networks are composed of mobile nodes with different, often highly-specialized mission functions and capabilities, such as, sensing, fusion, planning, command and control, situational awareness, storage, computation power, etc. Node mobility in a noisy, often-obstructed, adversarial communications environment causes nodes to lose contact with the network frequently and unpredictably. The network can, and often must, be partitioned into smaller sub-networks. Nodes can be lost due to loss of power or destruction, and they can be captured. Moreover, the data in the network is highly dynamic, time sensitive, and critically, it is prioritized relative to vital mission roles that vary by node and over time.

Data must be reliably stored and accessed in military networks under the above conditions. Solutions for data storage and transmission in military mobile ad-hoc networks should address issues of i) performance: the warfighter should be able to access the information products needed for current mission functions efficiently and selectively; ii) security: the data stored and transmitted over the network should be secured from outside eavesdropping or loss of a node to destruction, capture, or compromise by an enemy; and iii) resilience: the data should be highly available in the face of node loss, interference and temporary loss of connectivity, with priority relative to mission roles and objectives. Proposed research developments should be compatible with planned future tactical platforms and components (e.g., JTRS), but are expected to impact other situations where highly-dynamic data is maintained in highly-disrupted networks. In the commercial world, first responder and homeland defense communication systems present similar characteristics and requirements.

PHASE I: Develop initial concept design and model key elements of an enterprise level strategy to distribute and store digital data collected from nodes in a tactical mobile ad-hoc networking topology. Develop an initial concept design, identify and define key parameters necessary to store, secure and access data in a system where nodes dynamically join and leave the network in realistic, dynamic tactical scenarios.

PHASE II: In Phase II the contractor will finalize and validate the ‘distributed data storage’ design proposed in Phase I as well as construct and demonstrate a working prototype with a minimum of 30 networking nodes, showing resilience against lost nodes, network interference and protection of data-at-rest. The contractor will also provide a detailed plan for practical implementation in larger networks with potentially hundreds of nodes.

PHASE III: The transition opportunities within the DoD will grow in parallel with the deployment and adoption of mobile ad hoc networks. A secure, distributed data, storage strategy will be necessary in order to share information between network nodes in a tactical environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial systems are moving to a ‘cloud storage’ topology and DoD systems will eventually make the same transition. Strategies developed through this SBIR will leverage existing research and develop a ‘distributed storage’ strategy applicable for the first responder and homeland defense communication systems.

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(2) Jun Feng ; Yu Chen ; Wei-Shinn Ku ; Zhou Su, “D-DOG: Securing Sensitive Data in Distributed Storage Space by Data Division and Out-Of-Order Keystream Generation”, Proceedings of the International Conference on Communications (ICC), pp. 1-6, May 2010

(3) Dudkowski, D.; Marron, P.J.; Rothermel, K., "An Efficient Resilience Mechanism for Data Centric Storage in Mobile Ad Hoc Networks," Mobile Data Management, 2006. MDM 2006. 7th International Conference on, pp. 7, 10-12 May 2006, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1630543&isnumber=34194

(4) Greenan, K.; Storer, M.; Miller, E.L.; Maltzahn, C., "POTSHARDS: storing data for the long-term without encryption," Security in Storage Workshop, 2005. SISW '05. Third IEEE International, pp.9-20, 13 Dec. 2005. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1628478&isnumber=34160

(5) Min Zhang; Desheng Zhang; Hequn Xian; Chi Chen; Dengguo Feng; "Towards A Secure Distribute Storage System," Advanced Communication Technology, 2008. ICACT 2008. 10th International Conference on, vol.3, pp.1612-1617, 17-20 Feb. 2008.
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KEYWORDS: Data; storage; security; mobile ad-hoc networks; data at rest; cloud storage

N122-146 TITLE: Novel CubeSat Payloads for Naval Space Missions

TECHNOLOGY AREAS: Space Platforms

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 novel CubeSat payloads for Naval space missions.

DESCRIPTION: Nano-satellites are popular among universities and gaining momentum with commercial and government organizations. Standards based satellite buses and deployment mechanisms, such as the CubeSat and Poly Pico-satellite Orbital Deployer (P-POD), have stimulated growth in the area. Small satellites have proven capable and cost effective in many areas traditionally dominated by large satellites, however many challenges remain.

Beyond state of the art research is needed to drastically reduce the size, weight and power of payloads that have traditionally performed Naval space missions on much larger satellites. Traditional Naval space missions include narrowband communications (UHF Follow On, Mobile User Objective System), astrometry (Joint Milli-Arcsecond Pathfinder Survey), and ocean sensing (GEOdetic SATellite, GEOSAT Follow On). Other missions of Naval interest will also be considered. Smaller, more cost effective satellites will enable the Navy to continue vital space missions despite limited resources.

One important consideration in developing a new CubeSat payload technology is mission life. Most CubeSats are deployed in Low Earth Orbit (LEO) where atmospheric drag is considerable. Since they generally do not carry propellant for station keeping, atmospheric drag is often a mission life limiting factor. The technology’s impact on mission life must be weighed in the design process.

Novel technologies will enable CubeSats to expand from university experiments to operational missions. It can be assumed that approximately two thirds of the 3-U spacecraft size, weight and power will be used for power management, attitude control, communications and other basic spacecraft functions. In general, proposed payloads should:

- Meet the CubeSat Design Specifications
- Fit within approximately 10x10x10 cm and have 1.33 kg or less mass (fit within 1-U of a CubeSat)

- Generate less than 32 kilobits per second of data to be transferred to the ground
- Survive the LEO space environment for at least two years
- Operate with significant power constraints, either very low duty cycle or very low instantaneous power

PHASE I: Develop a novel payload design for CubeSats to support a Naval space mission. Payloads of interest include:
- UHF Satellite Communications
- Ocean sensing and/or radar altimetry
- Astrometry
- Maritime Domain Awareness

Tasks under this phase could include:
- Develop the technology design
- Predict payload performance using modeling and simulation or other tools
- Estimate mass and volume requirements
- Estimate the design's impact on atmospheric drag

PHASE II: Build a prototype payload and test it in the space environment.
- Optimize the payload design
- Demonstrate operation of the prototype in a space environment such as thermal vacuum.
- Evaluate measured performance characteristics versus expectations and make design adjustments as necessary.

PHASE III: This phase will focus on integrating the technology into potential Naval CubeSat missions.

PRIVATE SECTOR COMMERCIAL POTENTIAL DUAL-USE APPLICATIONS: The technologies developed under this topic can be applied to a variety of commercial, military and space exploration CubeSat missions.

REFERENCES:

1. Naval Open Architecture. https://acc.dau.mil/oa

2. CubeSat Design Specification REV. 11, http://cubesat.calpoly.edu/

3. "The Navy's Needs in Space for Providing Future Capabilities", 2005, National Academies Press, http://www.nap.edu/catalog.php?record_id=11299

4. PEO Space Systems programs. http://www.public.navy.mil/spawar/PEOSpaceSystems/ProductsServices/Pages/default.aspx

5. GFO overview. http://www.public.navy.mil/usff/chips/Documents/PDFs/chipsJun06.pdf

KEYWORDS: CubeSat; communications; nano

N122-147 TITLE: <u>Advanced WCDMA Algorithms for Rapidly Changing Coverage Geometries</u>

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 algorithm(s) necessary to enable WCDMA service between rapidly moving platforms and radio base stations.

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 commercial 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.

Miniaturized, ruggedized WCDMA payloads will soon be deployed (separate from this SBIR topic) for use on satellites or UAVs to provide enhanced cellular coverage in a variety of scenarios. Beyond state of the art research is required to develop innovative new algorithms to enable WCDMA based radios to overcome many challenges not encountered on ground based systems. Rapid movement of users and radio base stations will create significantly different and rapidly changing coverage geometries than is seen in traditional systems. Another challenge is the fact that the radio base station the user is communicating with may be moving at a relatively high speed in relation to the user, presenting Doppler and other effects at both ends of the link. Innovative research and development is required to develop algorithms to enable WCDMA use in next generation communications capabilities.

State of the art WCDMA algorithms 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. Satellite based WCDMA systems could be deployed in innovative arrangements such as the Molniya orbit.

PHASE I: Develop WCMDA algorithms to enable service between rapidly moving users and radio base stations in a scenario such as a satellite in a Molniya orbit. Perform 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 algorithms
- Develop new WCDMA algorithm concepts
- Predict performance parameters

PHASE II: Implement and demonstrate algorithms in a laboratory environment.
- Implement and demonstrate prototype algorithms
- Evaluate measured performance characteristics versus expectations and make design adjustments as necessary.

PHASE III: This phase will focus on the integration of the algorithms with WCDMA payloads 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.

REFERENCES:
1. Naval Open Architecture. https://acc.dau.mil/oa

2. "Multiband Frontend For A Medium Range Basestation", Wolfgang Koenig, Siegfried Walter, Ulrich Weiss, Dirk Wiegner. Proceeding of the SDR 03 Technical Conference and Product Exposition. 2003.

3. “The Sdr Approach In A Wideband Airborne Communication Node,” Jean-Christophe Schiel, François Montaigne, Guy Philippe. Proceeding of the SDR 06 Technical Conference and Product Exposition.

4. J. Sadowsky, “The MUOS-WCDMA Air Interface”, http://www.gdc4s.com/documents/MUOS_WCDMA_Air_Interface.pdf

KEYWORDS: WCDMA, RF, communications

N122-148 TITLE: Deployable Multi-Band Radio Base Station

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 deployable, multi-band radio base station for use with cellular systems.

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 generally located on a tower to provide better propagation of the signal.

WCDMA repeater payloads are in development for use on balloons or unmanned aerial vehicles to provide enhanced cellular coverage in a variety of scenarios. When combined with an appropriate communications link to a deployed radio base station, a WCDMA payload would provide alternate or supplementary cellular communications using existing phones or radios.

There are a multitude of aerial vehicles employing a variety of communications links. The interface to the radio base station must be capable of operating in multiple bands to ensure communications in all scenarios.

The radio base station should connect to existing cellular networks to provide reach-back and enhanced functionality. The base station should provide standard, open network interfaces such as TCP/IP to ensure interoperability. Deployed base stations connecting to un-trusted networks will require the use of approved encryption devices.

PHASE I: Develop a deployable, multi-band radio base station 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 multi-band interface technology concepts
• Predict performance parameters for the design

PHASE II: Implement and demonstrate a prototype multi-band interface to a radio base station.
• Implement and demonstrate a prototype multi-band radio base station
• Evaluate measured performance characteristics versus expectations and make design adjustments as necessary.

PHASE III: This phase will focus on the integration of the multi-band interface with military cellular communications system base stations 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.

REFERENCES:
1. Naval Open Architecture. https://acc.dau.mil/oa

2. "Multiband Frontend For A Medium Range Basestation", Wolfgang Koenig, Siegfried Walter, Ulrich Weiss, Dirk Wiegner. Proceeding of the SDR 03 Technical Conference and Product Exposition. 2003.

3. "The Sdr Approach In A Wideband Airborne Communication Node," Jean-Christophe Schiel, François Montaigne, Guy Philippe. Proceeding of the SDR 06 Technical Conference and Product Exposition.

4. J. Sadowsky, "The MUOS-WCDMA Air Interface", http://www.gdc4s.com/documents/MUOS_WCDMA_Air_Interface.pdf

KEYWORDS: WCDMA, RF, communications

N122-149 TITLE: Secure Mobile Interfaces for Business Systems

TECHNOLOGY AREAS: Information Systems, Electronics

ACQUISITION PROGRAM: Personalized Recruiting for Immediate or Delayed Enlistment (PRIDE) (AAP)

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: Users of DoD business systems need a secure, more efficient means to access systems performing recruiting, personnel, travel and training functions. An integrated approach is needed to make maximum use of mobile, hand held technology while maintaining information security.

DESCRIPTION: There are several initiatives throughout DoD that focus on: portal consolidation, the delivery and use of hand-held devices (e.g. tablets, mobile phones and other PDAs) for mobile users, and a DoD enterprise marketplace for widgets and web apps that can be rendered in i-frames for user configurability with browsers. This task is to investigate current DoD and commercial products and initiatives for mobile users and develop a security approach that supports integration of these devices for use with business systems. The security challenges (e.g. protection and integrity of data in transit and at rest) associated with use of the latest hand-held devices need to be investigated and a strategy for resolution of these security concerns needs to be identified and proven. A light weight mobile device management approach is desired which balances the use of server side platforms with a more containerized solution. The approach should support a cloud construct.

A common user interface is needed to give users the flexibility to configure according to their specific needs. It needs to make use of widgets developed to perform simple business functions and provide interfaces to all the appropriate business systems. These widgets need to be discoverable and able to be downloaded from a DoD repository. In addition to the challenge associated with data security, single sign-on access control should be considered to simplify user access to needed systems.

Mobile users of business systems also need the ability to download and use simple web apps. A standard approach and web apps need to be developed that provide functionality in disconnected, intermittent, and limited communications conditions as well as safeguard the data (i.e. personally identifiable information) that is used by the particular business application. Additionally, an approach for the use of these user-facing capabilities needs to be integrated with portal consolidation strategies.

The ideal solution would provide for device diversity such that multiple OS systems can be supported as well as various mobile platforms ranging from laptops, to tablet to smart phones. Securing and compliance verification should also be a capability as well as software distribution. Emerging techniques using hardware devise virtualization should be explored to determine if this technique could provide improved security and manageability.

PHASE I: Feasibility evaluation includes: the investigation of current DoD capabilities and initiatives, research and development of a strategy and security approach that allows for adaptation of these capabilities for users of business systems, and recommendations for the products and security that would be best suited for use with business systems and to be piloted in Phase II. The strategy, approach, and recommendations need to ensure data security, access controls, performance, cost, and effectiveness for the user within a mobile device management architecture. Architectural standards and constraints for these capabilities should be defined as well as an improved mobile device policy.

PHASE II: Piloting of the security approach for using these capabilities should include best-of-breed for selected types of user devices, environment and need. The pilots should include demonstration of appropriate security for data and access controls using a representative set of web apps and widgets as extensions of selected business systems. Typical users should be included in the demonstrations with feedback regarding utility. Cost estimates and benefits analysis should be performed.

PHASE III: A plan for execution needs to be coordinated with all appropriate stakeholders. A secure prototype capability should be implemented as a reference implementation. Documentation of the information assurance principles and design guidance needs to be established that is acceptable for IA accreditation of systems implementing mobile user devices.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The private sector application will be a device such as the I Pad or similar device. Developers of computer based tablets would benefit.

REFERENCES:
1. DoD Net-Centric Data Strategy, 05/09/2003

2. DoD 8320.02-G, Guidance for Implementing Net-Centric Data Sharing

3. DoD Enterprise Architecture and Standards

4. DoD Information Enterprise Architecture (IEA) 1.2, 05/10/2010

5. Enterprise-Wide access to Networks and Collaboration Services (EANCS) Reference Architecture (RA), 08/24/2010

KEYWORDS: Mobile; Devices; Information; Security; Architecture; User; Interfaces

N122-150 TITLE: Advanced Software Defined Radio Capabilities and Information Dominance

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: JPEO JTRS - 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: Investigate and validate Software Defined Radio (SDR) based, multi-function portable network sensing and intrusion detection algorithms suitable for small dismounted radio platforms. DoD military SDRs in the battlefield will be in close proximity to hostile foreign networks and have the potential to be cognizant of their surrounding Radio Frequency (RF) environment. Applications need to be investigated that utilize the SDR's ability to sense the presence of other wireless networks, monitor those networks and detect hostile intrusion attempts. The multi-function capability will support Command and Control (C2) standard sensor interfaces carried in the field and sensor data exfiltration.

DESCRIPTION: Dismounted and Special Forces personnel have to rapidly adapt to hostile environments and need to acquire relevant operational information as quickly as possible. SDRs are poised to deliver a paradigm shift in operational awareness on the battlefield as a platform that can sense the surrounding RF environment. The ability to sense the electromagnetic spectrum, along with onboard computing capabilities provides a platform that can quickly deliver electronic information not previously available to the operator. To realize the full potential benefits of an RF cognizant, mobile computing device (or SDR), dynamic network sensing and discovery techniques, as well as defensive algorithms will be required.

This effort will focus on the discovery and engagement of local area wireless communications networks encountered in the battlefield, utilizing the unique capabilities of SDRs such as the JTRS Man Pack and Rifleman Radio. The access shall include, as mission requirements dictate, a capability to join IEEE standard 802.11/16 wireless networks, Automatic Identification System (AIS), low bandwidth links, SATCOM and/or cellular; e.g. Long Term Evolution (LTE) networks, in addition to military communications systems.

There are many challenges presented by this research, among them is how to adapt the newest Field Programmable Gate Array (FPGA) technology, board level and software/firmware design, with control logic that is agile, survivable and cost effective. Significant consideration must also be given to Size, Weight and Power (SWAP) and Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC) packaging, and hardware/software integration.

PHASE I: Propose algorithms and develop a system design that can protect forward deployed Internet Protocol (IP) based, networked radios that encounter hostile RF environments and defend against potential network threats. Provide a design and define the cost/performance trade space based on state of the art networking, RF and SDR technology roadmaps.

PHASE II: Demonstrate state of the art algorithms that sense the presence of wireless networks and detect network intrusion attempts by first utilizing Commercial-Off-The-Shelf (COTS) wireless equipment. Immediately following the network intrusion detection algorithm proof-of-concept, implement the software in an SDR radio such as the JTRS Manpack and/or Handheld type platforms. Substantiate the trade space by models and simulations and documented industry projections.

PHASE III: Utilizing feedback from end users, conduct additional real life testing in various operational environments. Identify other DoD and Federal programs that will benefit from small tactical SDRs capable of sensing wireless networks and preventing network intrusions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL USE APPLICATION: SDR technology is rapidly being adopted by the military as well as civilian first responders. In the near future all users of radio equipment, industry wide will demand adaptable, re-configurable, software defined radios. The performer on this effort will be well poised to answer the demand for better security strategies and intrusion detection software.

REFERENCES:
1. Mitola, J., III and Maguire, G.Q., Jr., “Cognitive radio: making software radios more personal” IEEE Personal Communications, August 2002

2. Clancy, T.C., Goergen, N., “Security in Cognitive Radio Networks: Threats and Mitigation”, Cogintive Radio Oriented Wireless Networks and Communications, 2008

3. Ruiliang Chen; Jung-Min Park; Hou, Y.T.; Reed, J.H.; “Toward secure distributed spectrum sensing in cognitive radio networks”, Communications Magazine, IEEE, April 2008

KEYWORDS: communications diversity, contingency, cognitive radio, agility, environmental sensors, ad hoc network

N122-151 TITLE: Advanced Cellular Network Optimization Tool

This topic has been removed from the solicitation.