NAVY
13.2 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 through 23 May 2013.** Beginning **24 May**, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in Section 4.15.d 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
N132-084 thru N132-087	Ms. Elizabeth Madden	MARCOR	sbir.admin@usmc.mil
N132-088 thru N132-107	Ms. Donna Moore	NAVAIR	navair.sbir@navy.mil
N132-108 thru N132-120	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N132-121 thru N132-125	Mr. Chris Coleman	NSMA	chris.coleman@navy.mil
N132-127 thru N132-138	Ms. Lore Anne Ponirakis	ONR	loreanne.ponirakis@navy.mil
N132-139 thru N132-141	Ms. Elizabeth Altmann	SPAWAR	elizabeth.altmann@navy.mil
N132-142 thru N132-146	Mr. Mark Hrbacek	SSP	mark.hrbacek@ssp.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.navysbir.com. 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. It is highly recommended that you follow the Navy proposal template located at http://www.navysbir.com/submission.htm as a guide for structuring your proposal. Cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings are recommended for all proposals.

Technical Volumes that exceed the 20 page limit will be reviewed only to the last word on the 20th page. Information beyond the 20th page will not be reviewed or considered in evaluating the Offeror's proposal. To the extent that mandatory technical content is not contained in the first 20 pages of the proposal, the evaluator may deem the proposal as non-responsive and score it accordingly.

The Navy requires proposers to include, within the **20** 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.**

PHASE I PROPOSAL SUBMISSION CHECKLIST:

The following criteria <u>must be met</u> or your proposal will be REJECTED.

____1. Include a header with company name, proposal number and topic number on each page of your Technical Volume.

____2. Include tasks to be completed during the option period in the 20 page technical volume and include the costs as a separate section in the Cost Volume.

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

____4. The base effort should not exceed $80,000 and have a period of performance of six months and the option should not exceed $70,000 and have a period of performance of six months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the Cost Volume, and in the work plan section of the proposal.

____5. Upload your Technical Volume and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and Cost Volume electronically through the DoD submission site by 6:00 am ET, 26 June 2013.

____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.

The Navy will evaluate and select Phase I proposals using the evaluation criteria in Section 6.0 of the DoD Program Solicitation 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.

Protests of Phase I and II selections and awards shall be directed to the cognizant Contracting Officer for the Navy Topic Number. Contracting Officer contact information may be obtained from the Navy SYSCOM SBIR Program Manager listed in Table 1.

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.

In accordance with section 4.10 of the DoD Instructions, your request for a debrief must be made within 15 days of non-award notification.

CONTRACT DELIVERABLES

Contract Deliverables (CDRLs), typically progress reports, final reports, and initial Phase II proposals should be uploaded to https://www.navysbirprogram.com/navydeliverables/ as required by the contract.

PHASE II GUIDELINES

All Phase I awardees will be allowed to submit an **initial** Phase II proposal for evaluation and selection. The Phase I Final Report and Phase II Initial Proposal will be used to evaluate the offeror's potential to progress to a workable prototype in Phase II and transition technology in Phase III.

The details on the due date, content, and submission requirements of the initial Phase II proposal will be provided by the awarding SYSCOM either in the Phase I award or by subsequent notification. **All SBIR/STTR Phase II awards made on topics from solicitations prior to FY13 will be conducted in accordance with the procedures specified in those solicitations (for all Department of Navy topics this means by invitation only).**

Section 4(b)(1)(ii) of the SBIR Policy Directive permits the Department of Defense and by extension the Department of the Navy (DoN), during fiscal years 2012 through 2017, to issue a Phase II award to a small business concern that did not receive a Phase I award for that R/R&D. The DoN will **NOT** be exercising this authority for Phase II awards. **In order for any small business firm to receive a Phase II award, the firm must be a recipient of a Phase I award under that topic.**

The Navy will evaluate, and select Phase II proposals using the evaluation criteria in Section 8.0 of the DoD Program Solicitation 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 typically awards a cost plus fixed fee contract for Phase II. The Phase II contracts can be structured 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. Each SYSCOM has specific guidance for Phase II.5 which can found at http://www.navysbir.com/phaseII5andcpp.htm

DISCRETIONARY TECHNICAL ASSISTANCE - The SBIR Policy Directive section 9(b), allows the DoN to provide discretionary technical assistance to its awardees to assist in minimizing the technical risks associated with SBIR projects and commercializing into products and processes. Firms may request, in their application for Phase I and Phase II proposals, to contract these services themselves in an amount not to exceed $5,000 per year. This amount is in addition to the award amount for the Phase I or Phase II project.

Approval of direct funding for this discretionary technical assistance will be approved by the DON SBIR office if- the firm's proposal clearly identifies the need for assistance, provides details on the provider of the assistance and why they are uniquely skilled to carry out this work, and the cost of the required assistance. If the firm requests discretionary technical assistance in a Phase II proposal, they will be eiliminated from participating in Navy Transition Assistance Program (TAP) and Navy Opportunity Forum or any other assistance the Navy provides directly to firms.

Phase I awardees that propose more than $150,000 in total funding (Base, Option and discretionary technical assistance) cannot receive a purchase order. The need to issue a Firm Fixed Price (FFP) contract may result in contract delays if the SYSCOM normally issues Phase I awards as purchase orders.

All Phase II awardees not receiving funds for discretionary technical assistance in their award must attend a one-day Transition Assistance Program (TAP) meeting during the second year of the Phase II. 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.

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 the rights of the SBIR company.

AWARD AND FUNDING LIMITATIONS – In accordance with SBIR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per firm per topic. Additionally in accordance with SBIR Policy Directive section 7(i)(1), each award may not exceed the award guidelines (currently $150,000 for Phase I and $1 million for Phase II) by more than 50% (SBIR/STTR program funds only) without a specific waiver granted by the SBA.

TOPIC AWARD BY OTHER THAN THE SPONSORING AGENCY – Due to specific limitations on the amount of funding and number of awards that may be awarded to a particular firm per topic using SBIR/STTR program funds (see above), Head of Agency Determinations are now required before a different agency may make an award using another agency's topic. This limitation does not apply to Phase III funding. Please contact your original sponsoring agency before submitting a Phase II proposal to an agency other than the one who sponsored the original topic. (For DoN awardees, this includes other SYSCOMs.)

TRANSFER BETWEEN SBIR AND STTR PROGRAMS – Section 4(b)(1)(i) of the SBIR Policy Directive provide that, at the agency's discretion, projects awarded a Phase I under a solicitation for SBIR may transition in Phase II to STTR and vice versa. A firm wishing to transfer from one program to another must contact their designated technical monitor to discuss the reasons for the request and the agency's ability to support the request. The transition may be proposed prior to award or during the performance of the Phase II effort. Agency disapproval of a request to change programs shall not be grounds for granting relief from any contractual performance requirement. All approved transitions between programs must be noted in the Phase II award or award modification signed by the contracting officer that indicates the removal or addition of the research institution and the revised percentage of work requirements.

ADDITIONAL NOTES

Due to 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 at: 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.

NAVY SBIR 13.2 Topic Index

N132-128	Concept Maps from RDF (Resource Description Framework)
N132-129	Compact, Repetitive Pulsed Power Driver Design for Emerging High Power Radio Frequency Sources
N132-130	Rapid Synthetic Environment Tool for Virtual Battlespace 2 (VBS2)
N132-131	Scalable, Secure Associative Database
N132-132	Cognitive Modeling for Cyber Defense
N132-133	Advanced Helo Display for Zero-Zero Shipboard Landings
N132-134	High Power Radio Frequency (HPRF) Dynamic Surface Engagement Modeling and Simulation Tool
N132-135	Fusion in a Cloud
N132-136	Mine Drift Prediction Tactical Decision Aid (TDA)
N132-137	Low-loss Optical Polymer Materials in Multi-kilogram Quantities for Optical Lens Development
N132-138	High Data Rate Acoustic Communication
N132-139	Tripwires for PEO C4I Systems
N132-140	Utilization of Inference Engine Technology For Navy Cyber Situational Awareness
N132-141	Determining Evaporative Duct Afloat
N132-142	REUSABLE FORWARD CLOSURE SYSTEM
N132-143	FLEXIBLE LATERAL MISSILE SUPPORT SYSTEM
N132-144	Development of Novel and Emerging Technology for the Enhancement of Fault Diagnostics
N132-145	Advanced Radiation Hardened Data Converter Architecture
N132-146	High Temperature Material Coatings

NAVY SBIR 13.2 Topic Descriptions

N132-084 TITLE: Human Surrogate Test Target

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: Joint Non-Lethal Weapons Program; (ACAT IV)

OBJECTIVE: Design, build and test a test target approximating human anatomy, capable of generating the data required to populate existing government models that predict the risk of significant injury to humans subjected to various non-lethal stimuli.

DESCRIPTION: Non-lethal weapon stimuli include blunt trauma, monochromatic (laser) and broadband (flashbang) light, blast over-pressure, thermal energy, electrical current, chemical irritant (riot control agents) and electromagnetic radiation in the L, S, and W-bands. The Joint Non-Lethal Weapons Program (JNLWP) has developed a suite of computer models that predict the risk of significant injury to human targets of these stimuli, but needs an improved method for gathering the input data for these models. To effectively run these models, the JNLWP requires input data such as: sound pressure levels at the ear, the fluence and wavelength of light (including infrared) incident on the cornea and retina, pressure at many points on the body as possible, concentration of chemicals at the face, temperature at various positions (including the face) and EM field intensity. All of these need to be measured as a function of time.

PHASE I: Design a human surrogate test target capable of collecting the data required to run the JNLWP's prediction models.

PHASE II: Build and test the human surrogate test target, ensuring the accuracy of generated data by validating against existing data collection systems.

PHASE III: Design, develop, test and deliver a prototype system, along with detailed engineering drawing, allowing for the production of multiple test targets for use in the development and testing of non-lethal weapons.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Law enforcement is the primary user of non-lethal systems and would benefit the most from this development. Furthermore, such a device could be used to test the safety of commercial products, designed for any purpose. This technology can benefit from and contribute to advancements in crash test dummies.

REFERENCES:

1. Duma, S. M., Ng, T. P., Kennedy, E. A., Stitzel, J. D., Herring, I. P., & Kuhn, F. (2005). "Determination of Significant Parameters for Eye Injury Risk." Journal of Trauma 59: 960-964.

2. Rigby, P. and P. Chan (2006). A Review of Central Nervous System (CNS) /Cognitive Effects due to Blast. San Diego, CA, L-3 Communications/Jaycor.

3. Shen, W. & Niu, E. (2003). "The Development of Biomechanically-Based Criteria of Rib Fracture from KE-NLW Impact." San Diego, CA.

4. Zhang, J., B. Song, et al. (2008). "How to test brain and brain simulant at ballistic and blast strain rates." Biomed Sci Instrum 44: 129-34.

KEYWORDS: Non-Lethal; Human Effects; Test Target; Human Surrogate; Blunt Impact; Electro-muscular

N132-085 TITLE: Aqueous Based Automatic Fire Extinguishing System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT I & II

OBJECTIVE: The development of an aqueous based, automatic, fire extinguishing system concept that provides protection to mitigate injuries from both short duration internal fires and longer duration external fires thereby allowing occupants to egress or be rescued.

DESCRIPTION: Military vehicles may be exposed to external fires (fuel tank, tire, and/or engine) caused by Improvised Explosive Device (IED) detonation. Although external, these long burning fires quickly envelop the vehicle and result in significant heating of the cab and injury to the crew, especially if incapacitated or unable to egress. Vehicle crew cabs attacked by Field Expedient Molotov (FEM) cocktails or fuel spray generated from hydraulic ram within a damaged fuel tank, produce internal fires as well. These short duration fires typically cause severe burns to the crew within seconds of exposure and are also prone to reflash. Current military vehicle (Ref 1) automatic fire extinguishing systems are designed to react quickly to internal crew cab fires and mitigate crew injury by displacing oxygen from the crew cab. The protection provided by these systems is not optimal because it is short in duration, typically utilizes agents with toxic byproducts, and affords no protection to incapacitated crew members from long burning external fires.

A vehicle integrated aqueous based automatic fire extinguishing system is required that provides 1) an instantaneous reaction to mitigate injury from short duration internal fires (those produced by Molotov cocktails and fuel spray fireballs), 2) a long enough reaction that continues to coat the crew and cool the cab to mitigate second degree burn injuries from long duration external fires (those produced by fuel tank, tire, and/or engine crew cab fires as a result of IED attack), 3) functional operation in all vehicle orientations, 4) discharge immunity from an outside radiation source and 5) can operate in all environmental conditions. By providing long duration protection, the aqueous based automatic fire extinguishing system would also mitigate injuries from fires that result from re-flash while giving crew members additional time to egress or be rescued from the burning vehicle. While there are technology solutions employing aqueous based agents on the commercial market, to date, none have been able to demonstrate the additional requirement of being capable of preventing second degree burns. Cycling water mist discharge systems as well as technologies that employ efficient water droplet size, velocity, momentum, and spray geometry combinations to effectively cool occupants and prevent burns are examples of current state of the art technologies that appear to have merit for advancement (Ref 2-4). However, proposers are also encouraged to explore new and innovative approaches toward resolving this challenge.

The US Marine Corps is seeking innovative approaches toward the development of an aqueous based, automatic, fire extinguishing system for use in military vehicles. Proposed concepts should address any research and development necessary to enable the development of 1) aqueous agents that when heated, are able to minimize or eliminate byproducts that are harmful or toxic to the skin, lungs, and any other exposed body part; 2) a delivery system that, when exposed to both short duration internal fires and long duration external fires, provides up to 5 minutes of protection against 2nd degree burns; 3) crew casualty/injury criteria applicable to the proposed aqueous based system solution(s), and 4) test instrumentation and techniques applicable to measuring crew casualty/injury levels for the proposed aqueous based system solution(s) while keeping in mind the challenges created by steam production and wetting of the occupants (Ref 5).

PHASE I: Demonstrate the feasibility of the development of an automatically activated, aqueous based, fire extinguishing system for use in military vehicles that can protect personnel from injuries associated with both short duration and long duration fires. Proposed concepts will need to address any research and development efforts needed to enable the identification of crew casualty/injury criteria. Proposed concepts should address any potential chemical compositions, environmental and health risks, injury protection capabilities, and delivery systems as well as identifying the requirements for test instrumentation and any techniques applicable to measuring crew casualty/injury levels for the proposed concept. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based upon the result of Phase I and the Phase II development plan, develop a working prototype of the selected concept. The prototype will be evaluated in a realistic test environment using the identified casualty/injury criteria for aqueous based systems and the performance goals identified in phase I. Evaluation results will be used to refine the prototype into an initial design that will meet the described the Marine Corps requirements. The company will also develop and validate any test instrumentation and techniques required for assessing the performance of an aqueous based fire extinguishing system. The company will prepare a Phase III development plan to transition the technology to use in applicable military vehicles.

PHASE III: The company will be expected to support the Marine Corps in transitioning the technology for Marine Corps use. Both the Program Manager Medium and Heavy Tactical Vehicles (PM M&HTV) and the Program Manager Light Tactical Vehicles (PM LTV) are actively pursuing an aqueous based upgrade/replacement of the dry chemical AFES systems currently installed on the Medium Tactical Vehicle Replacement (MTVR), Logistics Vehicle System Replacement (LVSR), and the High Mobility Multipurpose Wheeled Vehicle (HMMWV). Development of an aqueous based automatic fire extinguishing system prototype and associated crew injury/casualty criteria are part of a validated Marine Corps universal need statement and the technology developed will be utilized by the MTVR, LVSR, and HMMWV Original Equipment Manufacturer (OEM) to meet this requirement. A significant outcome of this effort will also be the transition of this same technology to the OEM’s commercial vehicle product line, which includes crash and rescue firefighting vehicles. The company will also be expected to support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The aqueous based fire extinguishing technology developed can be applied to a variety of fire and rescue vehicles, commercial trucks, and residential buildings, providing injured or incapacitated occupants with additional protection against 2nd degree burns while first responders begin rescue procedures.

REFERENCES:
1. Oshkosh Defense: Medium Tactical Vehicle Replacement.
http://www.oshkoshdefense.com/products/6/mtvr

2. Liu, Zhigang and Kim, Andrew K. "A review of Water Mist Fire Suppression
Systems - Fundamental Studies” Journal. of Fire Protection Engineering, 2000, pp 32-502..
http://fire.nist.gov/bfrlpubs/fire00/PDF/f00180.pdf

3. Liu, Zhigang and Kim, Andrew K. "A review of Water Mist Fire Suppression
Technology: Part II - Application Studies" Journal. of Fire Protection Engineering, 2001, pp 16-42
http://jfe.sagepub.com/content/11/1/16.short

4. Kim, A., Zhigang, L. “Fire Suppression Performance of Water Mist Under Ventilation and Cycling Discharge Conditions” 2nd International Water Mist Conference, 2002, pp 61-76.
http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=3&ved=0CDwQFjAC&url=http%3A%2F%2Fciteseerx.ist.psu.edu%2Fviewdoc%2Fdownload%3Fdoi%3D10.1.1.9.4043%26rep%3Drep1%26type%3Dpdf&ei=eaArUdryC9Dy0wHJxoDQDw&usg=AFQjCNE7r3jdKx92BoYp5mXOaVMYaqt1hQ

5. Walter Reed Army Institute of Surgical Research: "Medical Evaluation of Non-fragment Injury Effects in Armored Vehicle Live Fire Tests: Instrumentation Requirements and Injury Criteria" Department of Respiratory Research Division of Medicine 1989. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA233058

KEYWORDS: aqueous; automatic fire extinguishing; IED fires; casualty criteria; crew injury; crew cab fires

N132-086 TITLE: Prime Power System Development for Active Denial Technology (ADT) and High-Power Radio-Frequency (RF) Systems

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: Joint Non-Lethal Weapons Program; (ACAT IV)

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 a small, light-weight, prime power system for Directed Energy Weapons (DEW) capable of producing large amounts of power in very short but numerous timeframes.

DESCRIPTION: As solid-state RF and millimeter wave (mm-wave) sources continue to revolutionize weapon systems while meeting Army, Navy, Marine, Air Force and Coast Guard requirements, there is a growing need for an innovative, compact, light-weight prime power system for high-power mm-wave generation and RF sources. Solid state sources are of a particular interest due to the potentially superior reliability, maintainability, compactness, weight, versatility, and ruggedness characteristics. Solid-state Active Denial Technology (ADT), high-power, RF systems are relevant to the Joint Non-Lethal Weapons Program because of the desire for advanced, compact, mm-wave sources having a high conversion efficiency of electrical energy to 95 GHz energy.

This topic seeks to explore innovate approaches to the development of a small, light-weight, prime power system which is required for integration with small, compact: (1) solid-state ADT sources and (2) mobile, high-power microwave, RF systems. Currently, this technology is not available and is considered a limiting factor in producing a compact and mobile ADT or RF system. Power systems for DEWs can be quite different from continuous AC/DC power generators or sources in that DEWs commonly need large amounts of power but in only very short, but numerous, timeframes. Notional examples of prime power systems that could potentially be applicable include, but are not limited to, load-following diesel and gasoline-powered conventional motor generator sets, rotating storage machines such as pulsed alternators that include flywheel-type energy storage elements, and turbine generator sets powered by distillate fuels similar to aviation jet fuel. An example load versus time profile for a non-lethal directed energy system would be 100% load for 5 minutes and 25% load for 55 minutes each hour.

Of interest are proposed power system concepts capable of achieving the following performance metrics:
• Average power output: 150 kW to 250 kW
• Fuel type: JP8 Fuel
• Fuel Efficiency: 210 kW/kg
• Operating temperature range: -50 °C to +50 °C
• Total Weight should be <500 lbs (threshold), <250 lbs (objective)
• Output voltage: 345 VDC +/- 10%
• Output of 36,000 W/ft3 of size volume
• Output of 400 W/lb of system weight
• Efficiency: 96% efficient generator head (defined as: Generator Head is the part of the generator that produces the electrical output from the mechanical input supplied by the engine. It contains an assembly of stationary and moving parts encased in housing. The components work together to cause relative movement between the magnetic and electric fields, which in turn generates electricity.)

PHASE I: Identify potential approaches to develop a load-following DEW power system capable of producing large amounts of power in very short but numerous timeframes. Perform feasibility studies to determine the extent to which the potential approaches meet the ADT and RF system power requirements as defined above. Proposed concepts should include specific power density in watts per pound, architecture tradeoffs to minimize volume, and average power capability calculations. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based upon the result of Phase I and the Phase II development plan, develop a working prototype of the selected concept. Finalize the design or designs of the prime power system and system trade-offs. Develop the prototype prime power design for the integrated systems, including materials specification, fabrication approach, and performance prediction modeling. The company will prepare a Phase III development plan to transition the technology to use.

PHASE III: The company will be expected to support the Joint Non-Lethal Weapons Program Office in transitioning the technology for military use. The company, working with the JNLW Program, will continue to develop the technology and will utilize a method for verifying the prototype prime power system performance through testing. The company will also be expected to support the JNLW Program for test and validation to certify and qualify the system for military use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be used by any branch of the military or by civilian forces as a subsystem required for a reduced size, highly mobile power supply.

REFERENCES:
1. JOINT NON-LETHAL EFFECTS CAPABILITIES-BASED ASSESSMENT REFERENCE SHEET, December 2010. http://info.publicintelligence.net/DoD-NLW.pdf

KEYWORDS: Non-lethal weapon; prime power system; ADT solid-state arrays; high-power microwave

N132-087 TITLE: Compact Radar Antenna

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: Joint Non-Lethal Weapons Program; (ACAT IV)

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 compact, highly efficient antenna for two separate mobile high-power radar systems, one operating in L-Band frequency range (1-2 GHz) and the other in W-Band frequencies (95GHz). Radio frequency systems, using high power microwaves, operating in L-Band have military utility for RF Vehicle Stopping and non-lethal counter-electronics missions. RF Systems operating in the W-Band are used for non-lethal counter-personnel Active Denial Technologies (ADT) missions. The two systems are not identical; therefore, design solutions will be accepted for both requirements or for only one of the two requirements.

DESCRIPTION: The L-Band system produces greater than 10 megawatts peak power into the antenna. The desired antenna must be waveguide-fed and able to operate at a peak power duty cycle greater than 0.001 with a voltage standing wave ratio (VSWR) no greater than 1.5:1. The desired solution will achieve high gain (30 dB or greater) with a small diameter (1 meter diameter or less) aperture, assuming an aperture area-efficiency of at least 50%. The ability to steer the antenna is preferred with plus/minus 30 degrees threshold and 60 degrees objective in azimuth and plus/minus 5 degrees threshold and 15 degrees objective in elevation angle.

The W-Band system produces greater than 30 kilowatts peak power into the antenna. There is no VSWR requirement for the W-Band system as the antenna should be a quasi-optical feed (instead of waveguide feed). The entrance pupil shall be ¼ inch square (porting the 10kW of power) and be able to: (1) project a collimated uniform beam of 95GHz energy with an effective beam size that will repel human targets; human effects data will be provided at contract award and (2) deliver a power density that will be specified to the performer once the contract is awarded. The design shall also have the ability to steer the antenna to provide a plus/minus 30 degrees threshold and 60 degrees objective in (pan) azimuth and a plus/minus 5 degrees threshold and 15 degrees objective in (tilt) elevation angle.

Any physical configuration that could meet the stated requirements providing substantial reduction in antenna size (i.e., smaller than 28 inches x 28 inches x 80 inches) and weight (i.e., less than 500 pounds (threshold), less than 250 pounds (objective)) will be considered. Solutions may include, but do not have to be limited to, "RF Lensing, RF Dielectric Meta-materials, 3D RF Antenna Stacking, and RF MEMS Based" technologies.

PHASE I: Identify potential approaches to develop a compact, high efficiency antenna for the two separate mobile high-power radar systems. Perform feasibility studies to determine the extent to which the potential approaches meet one or both of the antenna requirements.

PHASE II: Perform design and trade-off studies between competing designs to determine the best possible approach or approaches to achieve the antenna requirements. The design and trade-off studies should include specific antenna gain and architecture trade-offs to minimize volume. Build a prototype from the best possible approach or approaches.

PHASE III: Develop and utilize a method for verifying the prototype antenna system performance through testing. Document the testing method and results.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be used by any branch of the military or by civilian forces as a subsystem required for a reduced size, highly mobile RF antenna.

REFERENCES:

1. Antoniades, M.A. et al, "Compact, Wideband and Multiband Antennas Based on Metamaterial Concepts", IEEE.

2. Balanis, Constantine, Antenna Theory Third Edition, "Fundamental Limit of Electrically Small Antennas" pp 637-641.

3. Volakis, John L., Antenna Engineering Handbook, Fourth Edition, Lens Antennas, Chapter 18, and Millimeter-wave antennas, Chapter 23.

4. Ziolkowski, R. W.; Lin, Chia-Ching; Nielsen, Jean A.; Tanielian, Minas H.; Holloway, Christopher L. (August - September 2009). "Design and Experimental Verification of...". Antennas and Wireless Propagation Letters, IEEE 8: 989-993.

KEYWORDS: Non-Lethal Weapons, RF Lensing, RF Dielectric Material

N132-088 TITLE: Integrated Oil Condition Monitor and Debris Sensing System

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: JSF-Prop

OBJECTIVE: Develop an oil condition monitoring system for automated real-time evaluation of lubricant contamination and degradation, including the characterization of ferrous and non-ferrous debris and particulate.

DESCRIPTION: Oil condition monitoring has been widely implemented by the Navy through the Joint Oil Analysis Program (JOAP), which provided common standards and practices for oil sampling and laboratory analysis. The ability to embed automated oil analysis capabilities directly into lubrication systems would provide increased responsiveness and awareness of conditions that promote corrosion and increased wear rates. One potential beneficiary of such technology is the lubrication system for the Joint Strike Fighter LiftFan, which has an open-air breather design that permits water intrusion. An applicable technology that monitors this lubrication system in an automated, embedded fashion would be highly desirable.

Despite special handling, preservation, packaging and an oil lubricated environment, the low chromium content permitted in conventional high-strength steels, renders the steel non-stainless and susceptible to corrosion. Newer alloys are being developed, such as Pyrowear 675 that offer some corrosion resistance, but are limited by cost and material characteristics, rendering them not suitable for all required applications. Corrosion leads to premature surface crack initiation and spalling that cascades into accelerated surface damage, increased vibration, and potentially catastrophic failures of drive system components. Other mechanisms of lubricant contamination, due to seepage into the lubrication system, misidentification of fluids, or improper handling result in oxidation and additive depletion causing increased wear of contacting surfaces and corrosion-fatigue. Additionally, variations in usage patterns and operating conditions inevitably affect the optimal timing for replenishment (topping or replacement), creating additional rationale for on-platform oil condition monitoring.

Develop and demonstrate a fluid contamination monitoring capability using representative industrial sources (water, incorrect lubricants, fuels, hydraulic fluids, glycols, cleaning agents, etc.). Develop packaging with form factor and interconnections that permit direct substitution of existing debris monitoring systems on applicable end-items, and which facilitates oil sample collection for supplemental laboratory analysis. Demonstrate the performance of the integrated oil debris monitoring capability for ferrous and non-ferrous particle distributions.

The system should include all necessary sensor suite instrumentation, embedded electronics and processing for operating as an automated system, and should measure, compute and/or infer characteristics of lubricant condition, debris and entrained particulate that are pertinent for preserving the operational integrity and durability of oil-wetted components. Relevant characteristics and properties pertaining to lubricant quality and condition include moisture content, additive depletion, oxidation and sulfation. The technology should have sufficient sensitivity and measurement frequency to provide rates-of-change of the tracked parameters (condition indicators), and the ability to correlate observed changes with operational usage and parametric data.

PHASE I: Design and prove feasibility of a system for performing integrated oil condition/debris monitoring, including all necessary sensor suite instrumentation, embedded electronics and processing for operating as an automated system.

PHASE II: Develop and fabricate a prototype system. Develop and refine the sensing instrumentation and algorithms to include additional indicators and characterizations of lubricant condition, and further improve upon the sensitivity, accuracy and repeatability of the Phase-I design.

PHASE III: Finalize the monitoring system design, conduct necessary qualification testing , and transition developed technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Lubrication condition monitoring and wear debris analysis in industrial environments (including power generation facilities, process plants, mass transit and commercial aerospace) have predominantly relied upon manual, periodic oil sampling strategies. An integrated oil condition monitoring system, offering comprehensive monitoring coverage would afford significant safety and total ownership cost improvements, and would be immediately applicable across numerous industrial sectors.

REFERENCES:
1. Higgins, F., Agilent Technologies Application Note, (2011, May 01), Onsite additive depletion monitoring in turbine oils by FTIR spectroscopy, http://www.chem.agilent.com/Library/applications/5990-7801EN.pdf

2. NAVAIR 17-15-50.2, (2011, 15 September), Joint Oil Analysis Program Manual (Volume II): Spectrometric and Physical Test Laboratory Operating Requirements and Procedures.

3. NAVAIR 17-15-50.3, (2011, 15 September), Joint Oil Analysis Program Manual (Volume III): Laboratory Analytical Methodology and Equipment Criteria (Aeronautical).

KEYWORDS: Lubrication; Debris; Monitoring; Oil; Lubricant; Contamination

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

N132-089 TITLE: <u>Simultaneous multi-beam high-bandwidth conformal tactical data link antenna systems</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA 266

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

OBJECTIVE: Design and develop a conformal phased-array antenna with the capability to provide simultaneous multi-beam high-bandwidth tactical data links.

DESCRIPTION: Real-time situational awareness information and voice communications are being exchanged across battle space using high bandwidth data links. These encrypted, jam-resistant communication systems use multilink antenna systems to simultaneously share vast amounts of data among many military assets through line-of-sight (LOS) air-to-air communication, and air-to-ground communication. The critical data exchanged includes fixed formatted messages, radar tracks, target information, platform status, imagery, text messaging and command assignments. Despite the many capabilities of the data link, there is still a need for improvement to antenna systems currently implemented into airborne platforms.

Airborne data link antenna systems experience difficulty maintaining a stable pattern and LOS during the maneuvering of aircraft, which can interrupt the data link. This decreases mission effectiveness and can be detrimental to the user; as target and threat information sharing, while operating under rapidly changing operational conditions, is no longer being provided. This effort will focus on the development of a high-gain and high-efficiency, small-aperture, conformal phased-array antenna with Right Hand Circular Polarization (RHCP) capable of providing simultaneous multiple beams operable in the Ku band. The new system should retain all the capabilities of a current data link antenna system, while also maintaining multiple LOS data links. Computational Electromagnetic (CEM) simulation tools should be used to demonstrate proof of concept. Also, utilize simulation tools for the design and deployment of the multiple-beam phased-array antenna close to the surface of the aircraft.

PHASE I: Design a high-gain, high-efficiency, small-aperture airborne data link phased-array antenna able to transmit and receive multiple high-gain beams. The design should include both the aperture and beam-forming/manifold architecture.

PHASE II: Optimize the parameters of the array established in Phase I. Fabricate a prototype conformal phased-array antenna and demonstrate its performance.

PHASE III: Illustrate the performance of the new antenna system implemented into data link systems on military airborne platforms. Consideration should also be given for adaptation to sea platforms, moving ground platforms, and ground-based terminals.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology is directly applicable to both commercial communication/data link systems and radar systems. The technology developed under this effort will have potential commercial applications, such as in-flight entertainment (IFE) on commercial aircraft, and commercial airborne and ground communication terminals that require simultaneous contact with multiple satellites.

REFERENCES:
1. Brukiewa, T., Cho, C., Jenabi, M. & C. Quintero (2003). Development and Test of an X/Ku Band Tile Technology Multi-Link Antenna System for CDL Communications. Proceedings of the 2003 IEEE International Symposium on Phased Array Systems Technology, Boston, MA, pp. 417–422.

2. Geezer, B. (2006). Multi-Beam Digital Antenna for Radar, Communications, and UAV Tracking Based on Communications, and UAV Tracking Based on Off-the-Shelf Wireless Technologies. M.S. thesis, Naval Postgraduate School, Monterey, CA.

3. Abrams, J., Rhodes, J., Smith, B. & Kinnan, T. (2000) TADIL J: Introduction to Tactical Digital Information Link J and Quick Reference Guide. [online] http://www.globalsecurity.org/military/library/policy/army/fm/6-24-8/tadilj.pdf

4. Boudriau, E. (1995)., Multiple-Beam Antennas for Military Satellite Communications Systems. Defence Research Establishment Ottawa, Tech. Note 95-1.

5. Schippers, H., Verpoorte, J., Jorna, P., Hulzinga, A., Meijerink, A., Roeloffzen, C., Heideman, R., Leinse, A. & Wintels, M. (2008) Conformal Phased Array with Beam Forming for Airborne Satellite Communication. International TIG Workshop on Smart Antennas, WSA, pp. 343-350.

6. Josefsson, L.& Persson, P. (2006) Conformal Array Antenna Theory and Design, John Wiley & Sons, Inc., Hoboken.

7. Lacomme, P. (2003). New Trends in Airborne Phased Array Radars. IEEE International Symposium on Phased Array Systems and Technology, pp. 17-22.

KEYWORDS: Sensing; Phased Array; Communication; Data Link; Multi Beam; Conformal

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

N132-090 TITLE: Atmospheric Environmental Metrology for Electro-Optical/Infra-Red (EO/IR) Sensor Flight Test

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: JSF-MS

OBJECTIVE: Design and develop a capability for measuring the atmospheric absorbers along the line-of-sight of airborne Electro-Optical/Infra-Red (EO/IR) sensors in support of sensor flight tests

DESCRIPTION: Currently, flight tests of airborne EO/IR sensors typically rely on the use of data from radiosonde balloons to characterize the test atmosphere. However, radiosonde balloons measure the atmosphere at a single location and time. As EO/IR sensor missions require imaging at longer slant ranges, higher altitudes, and over longer flight durations, the sparse spatial and temporal nature of the radiosonde data has become inadequate. A capability is needed that can accurately measure atmospheric conditions in support of EO/IR sensor flight testing. The ideal solution should characterize the atmosphere along the slant path from the ground target to the airborne sensor continually throughout test periods of up to eight hours, and perform in both day and night conditions. At a minimum, the capability to characterize atmospheric constituents such as Precipitable Water Vapor (PWV) along a vertical path from the ground to the aircraft test altitude is needed. Consideration should be given to promising technologies such as Fourier Transform IR (FTIR) Spectrometers and GPS Meteorology. An approach that focuses on software and minimizes the use of expensive test instrumentation is desirable.

PHASE I: Design, develop and demonstrate the feasibility of a software and hardware solution implementing atmospheric environment metrology.

PHASE II: Develop and demonstrate prototype hardware and software solution based upon the findings in Phase I.

PHASE III: Field a working system for acceptance test and develop system hardware and software refinements to enhance overall performance and allow for application growth. Transition the developed technology to appropriate users and platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are numerous public and private applications that require characterization of the atmospheric constituents such as precipitable water vapor (PWV). These include characterization of airborne EO and IR sensors, estimating predicted detection ranges, calibrating ground based telescopes, and others.

REFERENCES:
1. Schneider, M. et al. (2010), Continuous Quality Assessment of Atmospheric Water Vapour Measurement Techniques: FTIR, Cimel, MFRSR, GPS, and Vaisala RS92, Atmospheric Measurement Techniques, 3, 323-338, 2010. www.atmos-meas-tech.net/3/323/2010

2. Schneider, M. et al. (2009), Ground-based FTIR Water Vapour Profile Analyses, Atmospheric Measurement Techniques, 2, 609-619, 2009. www.atmos-meas-tech.net/2/609/2009

3. Duan, J., Bevis, M., et al. (1995). GPS Meteorology: Direct Estimate of the Absolute Value of Precipitable Water, Journal of Applied Meteorology, Vol 35. http://www.soest.hawaii.edu/met/Faculty/businger/PDF/DOC44.pdf

KEYWORDS: EO/IR; FTIR; Precipitable Water Vapor (PWV); GPS Meteorology; Atmospheric Transmittance, Atmospheric Measurement

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

N132-091 TITLE: Improved Electronics Maintenance through Tester Prognostics

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMA 260

OBJECTIVE: Develop innovative tools and processes required to leverage electronics prognostics and health management (ePHM) in Navy Automatic Test System (ATS) environments to support electronics maintenance

DESCRIPTION: Within the aviation arena, virtually all electronic Units Under Test (UUTs) are tested on Automatic Test System (ATS). By improving the overall maintenance of UUTs, operational availability and readiness of their weapon systems can be improved. Current approaches to prognostics have focused on physics based and data driven models. These approaches require extensive data about the UUT, some of which can currently be provided by the UUT itself. However, it has become evident that supplementing the UUT provided data with data from the Automatic Test Equipment (ATE)test results will greatly enhance the analyses. The combination of UUT and ATE data to support Prognostics and Health Management (PHM) will require a system that can manage data across multiple networked ATSs and combine data and results among multiple maintenance organizations. In order to ensure consistency of approaches and tools, industry standards related to test results, maintenance history, diagnostic session data, and Automatic Test Markup Language (ATML) need to be incorporated, and possibly enhanced. Therefore, participation with industry standards organizations in developing and/or applying such standards to electronics PHM will be necessary.

To achieve these objectives, a set of tools that uses domain ontologies, system-level approaches to health monitoring, diagnostics, and prognostics, is sought. These tools should build upon previous successes in the electronics prognostics domain by managing and combining test and diagnostics data from the UUTs themselves (e.g. Built In Test, and on-system diagnostics) and ATE test results (e.g. Test Program Set test logs), and aggregating this information across the spectrum of UUTs and ATE in the Navy to enhance the prognostics results. The tools developed will implement a process for model maturation based on historical data, with methodologies and supporting algorithms to analyze the models. The tools will also consider development for real time monitoring. Finally, a mechanism for creating and utilizing a library of degraded component models, along with environmental effects, which will allow for simulations of system degradation, should be considered.

The proposed system needs to draw upon the existing IEEE SCC20 and other industry standards while identifying ways to enhance these standards to support the PHM objectives outlined here. If necessary, new standards can also be recommended. Finally, the approach needs to consider the various ATS and processes used across the Navy and DoD so that the resulting solution can be applied to a broad spectrum of electronics maintenance activities.

PHASE I: Develop and demonstrate a proof of concept system for one of the members of the DoD family of testers. The proof of concept should focus on information obtained from UUTs and ATE test results.

PHASE II: Fully develop the system from Phase I into a usable analysis tool. Evaluate and demonstrate the prototype tool using one of the members of the DoD family of testers. Implement a process for model maturation based on historical data. Continue to refine analysis methodologies and supporting algorithms, including development for real time monitoring. Ensure the approaches and tools are consistent with industry standards.

PHASE III: Refine and deliver algorithms and a tool for a generic PHM, suitable for use on general-purpose ATS across the DoD. Transition the technology to appropriate test platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Industries involved in large scale, weapon-system maintenance, such as the automotive, shipping, space, and aviation industries.

REFERENCES:
1. Sheppard, J., Wilmering, T., & Kaufman, M. (2008). IEEE Standards for Prognostics and Health Management. IEEE AUTOTESTCON 2008 Conference Record, Salt Lake City, UT, pp. 97-103. Digital Object Identifier: 10.1109/AUTEST.2008.4662592

2. IEEE Std 1232-2010, Standard for Artificial Intelligence Exchange and Service Tie to All Test Environments (AI-ESTATE), Piscataway, NJ: IEEE Standards Association Press, 2010. Digital Object Identifier: 10.1109/IEEESTD.2011.5743076

3. IEEE P1636.1, Draft IEEE Standard Software Interface for Maintenance Information Collection and Analysis (SIMICA): Test Results and Session Information, Draft 1.0, Piscataway, NJ: IEEE Standards Association Press, 2011. http://standards.ieee.org/develop/project/1636.1.html

4. IEEE Std 1636.2-2010, IEEE Trial Use Standard Software Interface for Maintenance Information Collection and Analysis (SIMICA): Maintenance Action Information, Piscataway, NJ: IEEE Standards Association Press, 2010. Digital Object Identifier: 10.1109/IEEESTD.2010.5648434

5. IEEE Std 1671-2010, IEEE Standard for Automatic Test Markup Language (ATML) for Exchanging Automatic Test Equipment and Test Information via XML, Piscataway, NJ: IEEE Standards Association Press, 2010. Digital Object Identifier: 10.1109/IEEESTD.2011.5706290

6. Wilmering T. & Sheppard J.(2007) Ontologies for Data Mining and Knowledge Discovery to Support Diagnostic Maturation. Proceedings of the 18th International Workshop on Principles of Diagnosis (DX-07), Nashville, TN, pp. 210–217. http://w3.isis.vanderbilt.edu/dx07/Proceedings/Proceedings.pdf

7. IEEE SCC20 (2012), IEEE Standards Coordinating Committee 20 on Test and Diagnosis for Electronic Systems. http://grouper.ieee.org/groups/scc20/

KEYWORDS: Ontology, Diagnostics, Prognostics and Health Management, Automatic Test System, Maturation, Electronics Maintenance

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

N132-092 TITLE: <u>Innovative Method for Determining the Vorticity Confinement Term for Rotorcraft Computational Fluid Dynamics (CFD) Computations</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA 261

OBJECTIVE: Develop a rigorous algorithm to define the vorticity confinement terms for rotorcraft Computational Fluid Dynamics computations, damping the numerical diffusion of vorticity.

DESCRIPTION: The accurate representation of the rotor wake, especially the tip vortex structure, is crucial to the accurate prediction of blade loading and rotor performance. The vortex structures predicted by conventional CFD, however, diffuse much more than given by real viscous diffusion. This problem has generally attracted much attention in the past. High order solvers and/or grid refinement in the vortex regions have been explored (e.g., [1]). Certain level of success has been achieved, but not without significant computational resources (for more than 2~3 rotor revolutions). Another strategy involves the coupling of Navier-Stokes solver with a separate wake model or vorticity transport equation (e.g., [2-3]). Practical applications have been demonstrated with this approach, which is necessarily more algorithmically complex. A practical compromise for minimizing numerical diffusion of vorticity in rotorcraft CFD is the vorticity confinement method (e.g., [4]). It artificially introduces extra terms to the Navier-Stokes equations as a source to control the diffusion. Many conventional implementations of this method use an adjustable coefficient in the confinement term, reducing its robustness. As a first step, the development of a rigorous algorithm for defining the vorticity confinement terms for inviscid computations is needed. Adjustable coefficients are not encouraged and the confinement terms should ideally be automatically adjusted to achieve the accurate prediction of the vortex structures.

PHASE I: Develop a rigorous algorithm that will define the vorticity confinement terms without an adjustable coefficient, and demonstrate feasibility analytically.

PHASE II: Further develop the algorithm into a usable tool that can be coupled with CFD computations. Perform initial verification and validation of the methodology.

PHASE III: Perform rigorous correlation with test data to provide validation and verification (V/V). Transition the technology to commercial and military applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed algorithm can be implemented in Helios, a helicopter simulation tool in DoD or private sector helicopter simulators.

REFERENCES:
1. Wissink, Katz, A. , Chan, A., & Meakin, R. (2009). Validation of the Strand Grid Approach. AIAA-2009-3792.

2. Khanna, H. & Baeder, J. (1996). Coupled Free-wake/CFD Solutions for Rotors in Hover Using a Field Velocity Approach. American Helicopter Society 52nd Annual Forum, Washington, D.C.

3. Brown, R. & Line, A. (2005). Efficient High-resolution Wake Modeling Using the Vorticity Transport Equation. AIAA Journal, Vol. 43, p. 1434-1443.

4. Steinhoff, J. & Raviprakash, G. (1995). Navier-Stokes Computation of Blade-vortex Interaction Using Vorticity Confinement, AIAA-1995-0161.

5. Lorber, P., Stauter, R., Pollack, M., & Landgrebe, A. (1991). A Comprehensive Hover Test of the Airloads and Airflow of an Extensively Instrumented Model Helicopter Rotor, Vol. 1-5, USAAVSCOM TR-D-16 (A-E).

KEYWORDS: CFD; Vorticity Confinement Method; Rotor Wake; Vortex; Numerical diffusion; artificial viscosity

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

N132-093 TITLE: Mask-on Hypoxia Training Device

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA 205

OBJECTIVE: Design and develop a mobile-sized hypoxia training device capable of delivering continuous pressure-on-demand airflow to an aviator's oxygen mask with varying oxygen levels simulating sea level (ambient air) to 30,000 ft.

DESCRIPTION: Annual hypoxia training, required for all ejection seat equipped aircraft aviators, addresses both recognition of symptoms and recovery procedures to mitigate the risks associated with hypoxia incidents that occur each year. The training is currently accomplished either by the command's Aeromedical Safety Officer in the fleet simulators or at the local Aviation Survival Training Center.

The Reduced Oxygen Breathing Device, 2nd Generation (ROBD2) is currently being used to simulate altitude exposure for hypoxia training. The ROBD2 device has several limitations including the lack of mobility due to the need for large gas bottles, high maintenance requirements including filter replacements, calibration and gas bottle replacement, and delivery of breathing air at 50 Liters Per Minute (LPM) rather than a pressure-demand system, which increases the risk of generating air hunger.

A small, portable system (no larger than 18 inches by 18 inches and no heavier than 25 pounds) capable of pressure-demand airflow which can easily integrate with the current instructor operator station software is envisioned. The system should have biometric monitoring capability and interface with standard USN oxygen equipment. The standard USN part used to connect the oxygen mask to a regulator is the Connector, Oxygen Mask, MS27796 (National Stock Number: 1660007302247).

This low cost, low maintenance and fully mobile device free of gas bottle connections would significantly improve and expand the capability, efficiency and quality of training provided to the fleet.

PHASE I: Design, develop and demonstrate proof-of-concept of proposed technology to deliver a mobile-sized hypoxia training device.

PHASE II: Further develop and demonstrate a prototype mobile-sized hypoxia training device.

PHASE III: Complete acceptance testing to validate requirements and transition the technology to U.S. Navy and other military and private interests.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Any aviation organization that conducts hypoxia training as part of the Federal Aviation Administration/Department of Defense (FAA/DoD) requirements could utilize this technology to train individuals.

REFERENCES:

1. Coste, O., Van Beers, P., & Touitou, Y. (2007). Impact of hypobaric hypoxia in pressurized cabins of simulated long-distance flights on the 24 h patterns of biological variables, fatigue, and clinical status. Chronobiology International, 24(6), 1139-1157.

2. Harding, R. & Mills, F. (1983). Problems of altitude I: Hypoxia and hyperventilation. British Medical Journal, 286, 1408-1410.

3. Legg, S., Hill, S., Mundel, T., Gilbey, A., Schlader, Z., & Raman, A. (2012). Could mild hypoxia impair pilot decision making in emergencies? Work: A Journal of Prevention, Assessment, and Rehabilitation, 41(1), 198-203.

4. Slobodnik, B., Wallick, M., & Chimiak, J. (1991). Effectiveness of oxygen-nitrogen gas mixtures in inducing hypoxia at 1 ATA. Navy Experimental Diving Unit. http://www.stormingmedia.us/31/3187/A318732.html

5. Toff, W., Jones, C., Ford, I., Pearse, R., Watson, H., Watt, S., Ross, J., Gradwell, D., Batchelor, A., Abramns, K., Meijers, J., Goodall, A., & Greaves, M. (2006). Effect of hypobaric hypoxia, simulating conditions during long-haul air travel, on coagulation, fibrinolysis, platelet function, and endothelial activation. Journal of American Medical Association, 295(19), 2251-2262.

6. Westerman, R. A. (2004). Hypoxia familiarisation training by the reduced oxygen breathing method. Aviation Medicine, 5, 11-15. http://www.defence.gov.au/health/infocentre/journals/ADFHJ_apr04/ADFHealth_5_1_11-15.pdf

7. Carey, C. T. A Brief History of US Military Aviation Oxygen Breathing Systems. http://webs.lanset.com/aeolusaero/Articles/A_Brief_History_of_US_Military_Aviation_Oxygen_Breathing_Systems.pdf

KEYWORDS: Mobile Hypoxia Training System; Pressure-demand Airflow; Oxygen Mask; Simulated Training; Physiological Monitoring; Symptom Recognition Training

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

N132-094 TITLE: Jam-Resistant Global Positioning System/Inertial Navigation System (GPS/INS) Deeply-Coupled Navigation System

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: PMA 170

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

OBJECTIVE: Design and develop high performance and jam-resistant Global Positioning System/Inertial Navigation System (GPS/INS) navigation technologies in support of the Navy Warfighter.

DESCRIPTION: GPS vulnerability to radio frequency (RF) interference is well known. An inexpensive one-watt noise jammer can deny GPS availability at distances of many miles for some receiver types. The integration of GPS with INS offers significant anti-jam (AJ) and other navigation performance benefits. The INS can aid the GPS signal tracking loops, allowing reduction in bandwidth and hence provide more immunity to jamming. The INS error models may be calibrated by GPS when available, and the INS may be used as a flywheel navigation capability when GPS is completely denied by jamming [1].

Many loosely and tightly-coupled GPS/INS navigation systems have been deployed in existing air vehicle and other types of systems, e.g. the Embedded GPS/INS (EGI) [2]. More recently deeply-coupled GPS/INS architectures have been shown to offer significant enhancements to AJ and other measures of performance beyond traditional GPS/INS loose and tight-coupling configurations. Two examples of deeply-coupled GPS/INS designs are described in references [3] and [4].

Standardized requirements, form factors and interfaces suitable for replacement and upgrade of currently deployed military navigation systems in existing air, sea and ground systems, and for integration in new military systems are desired. The GPS/INS technologies developed under this SBIR will need to surpass the existing technologies by maintaining the Positioning Navigation and Timing (PNT) service and achieving good accuracy at jammer-to-signal power ratio J/S levels of at least 75 dB using Microelectromechanical systems (MEMS) Inertial Measurement Unit (IMU) quality characteristics as indicated in reference [4]. Fast, jamming and spoofing-resistant capabilities are desired for the GPS signal acquisition and reacquisition states. Size, weight and power (SWAP) should be suitable for precision guided munitions (PGMs) tactical weapon systems ranging from 10-inch to 30-mm diameters, and unmanned air systems (UAS) ranging from Group 1 to Group 4 categories. [5]

The GPS/INS technologies need to meet military GPS receiver Selective Availability Anti-Spoofing Module (SAASM) security, reliability, environmental, and other requirements for operational use. Objectives include anti-spoof protection and synergistic operation with other GPS anti-jam technologies.

Offerors should consider working with platform prime contractors, navigation system prime contractors and others, as appropriate.

PHASE I: Design and demonstrate proof-of-concept for GPS/INS deeply-coupled configurations. Analyze performance and suitability of designs to support successful mission operations using representative air and other vehicle mission scenarios.

PHASE II: Further develop the designs into mature test beds and prototype systems and demonstrate performance.

PHASE III: Finalize system that meets the operational requirements. Integrate, test and transition the resulting technology as appropriate.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology may also be used for navigation on commercial air, sea and ground vehicle systems, e.g. civilian manned and unmanned air vehicles. Because of the proliferation of low-cost GPS jammers, the FAA is becoming more concerned about the loss of GPS signals due to RF interference, such as recently occurred in the Newark airport area. In this case, GPS/INS deeply-coupled architectures provide significant AJ protection to allow continuation of the navigation function at higher RF interference levels, e.g. to maintain continuity of the navigation function during the critical approach and landing phase.

REFERENCES:
1. Parkinson, B., Spilker J., Axelrad, P. & Enge, P. (1996). Global Positioning Systems, Theory and Applications, Volume II. http://www.amazon.com/Global-Positioning-System-Theory-Applications/dp/1563471078

2. Embedded GPS/INS (EGI). http://www.globalsecurity.org/space/systems/egi.htm.

3. Gustafson, D., Dowdle, J. & Flueckiger, K. (2000). A High Anti-Jam GPS-Based Navigator. Proc. ION National Tech. Meeting. http://www.ion.org/search/view_abstract.cfm?jp=p&idno=60

4. Ohlmeyer, E. (2006). Analysis of an Ultra-Tightly Coupled GPS/INS System in Jamming IEEE Position Location and Navigation Symposium (PLANS). http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1650586&tag=1

5. Weatherington, D. (2010). Unmanned Aircraft Systems OUSD(AT&L)/PSA. http://www.dtic.mil/ndia/2010psannualreview/TuesdayWeatherington.pdf

KEYWORDS: GPS, Global Navigation Satellite Systems, GPS/INS, Navigation System, Anti-Jam Navigation System, Anti-Spoof Navigation System

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

N132-095 TITLE: Gallium Nitride Based Active Electronically Scanned Array (AESA) Technology for High Altitude Periscope Detection

TECHNOLOGY AREAS: Air Platform, Electronics

ACQUISITION PROGRAM: PMA 264

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 single integrated Gallium Nitride (GaN) transmit and receive (T/R) Monolithic Microwave Integrated Circuit (MMIC) system, and the corresponding array technology that enables a low cost, high performance, thin, efficient, low size, weight and power (SWaP), and high altitude submarine periscope detection capability.

DESCRIPTION: Commercial processes routinely produce GaN High Power Amplifiers (HPA), High Power Switches (HPS), and Low Noise Amplifiers (LNAs) as separate packaged parts. A main objective is to design a compact T/R MMIC system that performs all these functions in one small package to enable a very thin flat 2D Active Electronically Scanned Array (AESA) at C-band. GaN is capable of producing a fully integrated T/R MMIC, but has to be done in concert with the design restrictions of flat AESA approaches. In comparison to Gallium Arsenide, Gallium Nitride HPAs can operate at higher voltage and junction temperatures. The higher voltage enables higher efficiencies which along with higher junction temperatures and higher thermal conductivity enable easier thermal management design. Current GaN AESA thermal designs enable over 2 watts per square inch average transmit power relatively independent of frequency.

The GaN T/R MMIC system should be designed to optimally enable the design of a complete AESA radar. The system should include the AESA radiating surface and back end manifolds, analog Radio Frequency (RF) receivers, exciter, frequency source, beam steering, radar control, and Input/Output digitization. The system level interface to the AESA should be completely digital via Gigabit Ethernet or equivalent. Flat panel AESA system(s) and GaN devices should use industry standard modeling and design tools. Designs should consider the needs of the system and receiver/exciter for radar applications.

An innovative and integrated GaN MMIC and array technology enables a thin, efficient, low SWaP, low cost, high performance radar antenna that can then be easily installed on a large number of space constrained platforms.

PHASE I: Develop and prove feasibility of a GaN T/R MMIC based 2D C-band AESA for high altitude periscope detection.

PHASE II: Further develop and demonstrate a prototype of the system developed in Phase I.

PHASE III: Finalize testing and transition the technology to the appropriate platforms and the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology is directly applicable to both commercial communication/data link systems and radar systems.

REFERENCES:
1. Reese, E., Allen, D., Lee, C., & Nguyen, T. (2010). Wideband Power Amplifier MMICs Utilizing GaN on SiC. Richardson, Texas: TriQuint Semiconductor. Retrieved from: http://www.triquint.com/shared/pubs/symposiums/Eli%20Reese%20on%20GaN%20Wideband%20Amplifiers.pdf

2. Palmour, J.W., Hallin, C., Burk, A., Radulescu, F., Namishia, D., Hagleitner, H., Duc, J., Pribble, B., Sheppard, S.T., Barner, J.B., & Milligan, J. (2010). 100 mm GaN-on-SiC RF MMIC Technology. Microwave Symposium Digest (MTT), 2010 IEEE MTT-S International, 1226-1229. doi: 10.1109/MWSYM.2010.5515973

KEYWORDS: Radar, Phased Array, Gallium Nitride, Active Electronically Scanned Array, T/R Modules, Periscope Detection

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

N132-096 TITLE: Innovative Data Anomaly Detection and Transformation for Analysis Applications

TECHNOLOGY AREAS: Air Platform, Information Systems

ACQUISITION PROGRAM: 4.1 - Systems Engineering

OBJECTIVE: Develop a software toolset to extract and transform data from different database systems, and convert it into data packages that create model specific input files and build metrics that support future modeling, simulation, and analysis tasks.

DESCRIPTION: Effectively compiling and analyzing reliability, maintainability, and supportability data is essential to accurately project overall future system performance, identify problem areas, and identify solutions that offer the greatest impact to the weapon system availability. The databases used for Naval Aviation operations, maintenance, logistics, and other data are subject to human error, or employ techniques and/or procedures that change over time. The current method for processing large amounts of data is dependent upon a high level of human involvement to process the extracted data files and transform them into input datasets, probabilities, and/or probability distributions that can be directly applied with existing and future models, simulations, or analysis applications. The resulting data anomalies are corrected by human users, but the work is very tedious, time consuming, and prone to error. There is also an increasing need to utilize engineering design data in analyses and an emerging need to create composite datasets from both historical and/or engineering design and developmental sources which requires the merging of data into a consistent format. The effort to convert data from these sources into a usable format is completely manual.

A software toolset is required to automate the extraction and conversion of large amounts of data for input into a suite of analysis applications, and provide adaptability to accommodate the use of new data types in the future. The software tools should be designed so that the data transformation process is not tied to any specific data source and remains flexible. Additional capabilities such as the ability to merge data from different sources and simplify experimentation by providing a standard set of tools to adjust characteristics of data to support risk analyses is beneficial. An automated system that could mine the databases, collect and format the data into required datasets for the models, and perform error checking analysis would provide analytic answers in a shorter response time.

PHASE I: Design and determine the feasibility of a software toolset based upon the requirements in the Description. Outline the system's validation methodology and performance parameters.

PHASE II: Develop, demonstrate and validate an operational prototype of the Phase I design, and perform validation to demonstrate utility and establish the performance parameters.

PHASE III: Complete testing on the software toolset and transition the technology to the appropriate platforms and the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The toolset will have a range of applications to any product that has to deal with transforming and The software toolset will have a range of applications to any product that has to deal with transforming and reducing large amounts of data from multiple sources to produce analysis results, such as automotive reliability and maintainability data, medical data, and Health and Human Services. The software toolset can also be broadened in scope/capability and flexibility and deployed to a much wider section of the analysis community throughout NAVAIR, Center for Naval Analysis, Office of the Chief of Naval Operations (OPNAV) Assessment Division (N81) World Class Modeling, the Navy Modeling and Simulation Office, and it can be employed for a wide variety of data handling situations benefiting the Navy in all aspects of modeling and analysis.

REFERENCES:
1. Namey, E., Guest, G., Thairu, L., & Johnson, L. (2007). Data Reduction Techniques for Large Qualitative Data Sets. In G. Guest & K.M. MacQueen (Eds.) Handbook for Team-based Qualitative Research (pp. 137-162). Lanham: Altamira Press.

2. Driscoll, D.L., Appiah-Yeboah, A., Salib, P., & Rupert, D.J. (2007). Merging Qualitative and Quantitative Data in Mixed Methods Research: How To and Why Not. Ecological and Environmental Anthropology, 3(1), 19-28. Retrieved from: http://eea.anthro.uga.edu/index.php/eea/article/viewFile/26/36

3. O'Hara, J.J., Stump, G.M., Yukish, M.A., Harris, E.H., Hanowski, G.J., & Carty, A. (2007). Advanced Visualization Techniques for Trade Space Exploration. Retrieved from Applied Research Laboratory at the Pennsylvania State University, Trade Space Exploration Web site: http://www.atsv.psu.edu/webdocs/AIAA-2007-1878-108.pdf

4. NAMSM Input Data Set Preparation, April 15, 2013, 178 pages, uploaded in SITIS 6/3/13.

5. Graphic representation from TPOC on how the SBIR might work vs. how to system currently works, 2 pages, uploaded in SITIS 6/6/13.

KEYWORDS: Simulation, Modeling, Data Mining, Data Transformation, Probability, Statistics

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

N132-097 TITLE: Non-Destructive Inspection (NDI) for recrystallized grains in single crystal superalloys

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: JSF-Prop

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 that has the capability to detect recrystallized grains and measure their dimensions on the internal and external structures of turbine hardware.

DESCRIPTION: Much of the hardware found in Navy propulsion systems is made of advanced materials to resist the harsh temperatures and corrosive environments in which the fleet operates. An advanced material found in the turbine hot section is single crystal superalloys, and a problem unique to single crystal materials is recrystallization, which is a phenomenon that degrades material strength and durability.

Current means of detecting recrystallized grains in single crystal superalloys requires surface treatment and visual inspection. However, many turbine airfoils have internal features that can be prone to recrystallization. Inspection of these locations requires destroying the part which is costly and time consuming. A non-destructive inspection/evaluation/testing (NDI/NDE/NDT) method is needed that is capable of detecting and quantifying all recrystallized grains at locations of turbine airfoils that may not be visually accessible. An innovative system that has a suitable spatial resolution and has a Probability of Detection (POD) that results in the identification of all recrystallized grains, able to accommodate complex and varying part geometries while maintaining POD is needed.

Efforts to eliminate conventional detection methods and move toward a NDI/NDE/NDT method for recrystallization will result in fewer scrapped pieces of hardware and increased efficiency in identifying manufacturing defects. A higher inspection rate of production parts to improve quality assurance would provide cost savings and have the potential to eliminate parts from the population that have recrystallization and inferior strength capabilities.

PHASE I: Determine technical feasibility of NDI/NDE/NDT techniques for the detection of recrystallized grains in superalloys.

PHASE II: Develop, demonstrate, and validate an NDI/NDE/NDT prototype system that has the capability of detecting recrystallized grains in superalloys.

PHASE III: Transition the validated NDI/NDE/NDT system to appropriate platforms that utilize single crystal superalloys in their propulsion systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Single crystal superalloy materials are primarily limited to aerospace applications. Applications of this technology would contribute to the commercial aerospace sector, as well as power generation turbines.

REFERENCES:
1. Meng, et al. (2010), Recrystallization of a Nickel-Base Single Crystal Superalloy Under Compression, International Journal of Modern Physics, vol. 24, issue 15-16, pp. 2880-2885.

2. Li, et al. (2010), Recrystallization of Ni3Al Base Single Crystal Alloy IC6SX with Different Surface Mechanical Processes, Journal of Material Science Technology, vol. 26, pp. 883-888.

3. Bond, et al. (1984), Surface Recrystallization in a Single Crystal Nickel-Based Superalloy, Journal of Materials Science, vol. 19, no. 12, pp. 3867-3872.

4. Cox, et al. (2003), Recrystallisation of Single Crystal Superalloy CMSX-4, Materials Science and Technology, vol. 19, no. 4, pp. 440-446.

KEYWORDS: Turbine; Superalloy; Recrystallization; NDI; NDE; NDT

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

N132-098 TITLE: Ultra-Broadband, High Dynamic Range Receiver System

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA 234

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

OBJECTIVE: Design and develop an ultra-broadband, high dynamic range receiver system for signal capture, storage, and analysis.

DESCRIPTION: Recent technological advances have enabled downconversion and sampling of radio-frequency (RF) signals with high instantaneous bandwidth and fidelity. Applications include recordings of threat signals, jamming waveforms, civilian systems, and other signals of interest for detailed analysis and potential upconversion and playback at RF for replication of these in-the-field collected signals in a laboratory environment.

As bandwidth and fidelity of these recordings increase, the subsequent improvement in quality of the recordings has resulted in an increased relevance and potential applications in the test and evaluation arena. Especially of interest is the cost savings that stimulation of military receiver systems via playback of these high-fidelity recordings at RF can provide via optimization and testing in a laboratory environment vice far more costly open-air (flight) testing.

A system capable of providing up to 6 GHz of instantaneous bandwidth and at least 12 bit signal fidelity, thereby providing over 70 dB of spur-free dynamic range (SFDR), is desired. The bandwidth must be instantaneous, not a scan and tune architecture, in order to capture 100 percent of low-duty cycle signals. The resulting system should allow for the 6 GHz of instantaneous bandwidth to be centered, or tuned anywhere between 3 GHz center frequency (providing DC-6 GHz coverage) or 23 GHz center frequency (providing coverage from 20-26 GHz). The system should provide real-time recording capability of these signal bandwidths for durations of up to 15 minutes in open file format allowing the files to be ported to a workstation for analysis and manipulation.

The current state of the art is a DC-6 GHz bandwidth, 8-bit recording and playback system. Additionally there is a 12-bit system which has 1 GHz of instantaneous bandwidth, with the 1 GHz of bandwidth centered at a frequency tunable from 2 GHz to 26 GHz. That system can be equipped to record signals for over 1 hour but requires substantial hard drive storage.

Novel receiver architectures will be required in order to overcome the challenges in exceeding the currently state of the art with respect to the bandwidth-bits product figure of merit. Novel system designs are sought capable of tuning such a large bandwidth over such a large frequency range.

Identify and explore novel system and receiver hardware architectures capable of furthering the state-of-the-art, and what the potential state-of-the-possible is for each of the proposed approaches.

PHASE I: Identify and develop an approach, and determine technical feasibility through modeling and simulation or other means.

PHASE II: Develop and demonstrate a prototype system for capture and storage of an input RF environment. Demonstrate signals sufficiently diverse in signal strength and frequency simultaneously input to the prototype in order to exercise the limits stated in the description.

PHASE III: Acceptance testing of the developed system should be completed and the resulting technology transitioned to appropriate platforms and customers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This improvement in state-of-the-art for receiver bandwidth-fidelity product would radically increase capabilities in electronic surveillance for e.g. law enforcement applications. Communication links requiring high bandwidth and fidelity will benefit: applications include microwave links found in cellular backhaul links and cognitive radio applications which would benefit from the improved spectrum-sensing capabilities of the proposed receivers.

REFERENCES:
1. Tsui, J. (2004). Digital Techniques for Wideband Receivers (2nd Ed). Norwood, MA: Artech House, Inc.

2. Edde, B. (1992). RADAR: Principles, Technology, Applications. Upper Saddle River, NJ: Prentice Hall.

KEYWORDS: Instantaneous Bandwidth, Spur Free Dynamic Range, Tuning Frequency Range, Upconversion, Downconversion, Broadband, Signal Fidelity

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

N132-099 TITLE: Automatic Analysis of Legacy Software for Implementation within a Multi-thread, Multi-core Processor System

TECHNOLOGY AREAS: Air Platform, Information Systems

ACQUISITION PROGRAM: PMA 281

OBJECTIVE: Design and develop a software tool that automatically analyzes legacy software patterns and sequences and identifies segments of the code in which execution can be made more efficient through newer technological approaches such as multi-thread, multi-core systems.

DESCRIPTION: Currently, there is a significant amount of legacy code that was designed based on older processor legacy hardware. Current legacy code is difficult to reuse since it was primarily written and implemented in a single thread single core processor environment. These software tools and capabilities are unable to take advantage of new functionality like multi-core hardware and multi-threading software and other advanced trends in processor architecture. Several legacy systems based on the Microsoft Component Object Model (COM) architecture written in

C, C++, and VB6 are currently being maintained and are being considered for upgrade. These systems can be made available for development, evaluation and test purposes.

A software tool capable of facilitating the upgrade of existing software to exploit the benefits of newer processor technologies like multi-core, multi-threading functionality to improve throughput and timeliness of software intensive tasks is desired. This tool should provide an automatic recording of the output to help facilitate improved implementations, applying various innovative mathematical techniques, such as the ability to analyze and transform a centralized software system and allow it to operate with a series of parallel and simultaneous processes. Initial tool development should be directed toward the MS Visual Studio COM architecture for Phase I. However, the tool should be designed for ease of use and integration with other software languages.

Successful development of this tool will save programming time in upgrading existing legacy code and minimize developing of new software to replace legacy systems.

PHASE I: Design, develop and demonstrate the feasibility of a tool capable of analyzing legacy software and automatically identifying segments of code where performance efficiencies are possible.

PHASE II: Further refine and develop a prototype for a specific software language and demonstrate its effectiveness on legacy code, identifying sections of that legacy code that are apt for specific and concrete enhancements/improvements. Prototype evaluation and testing will be conducted using legacy code from existing programs.

PHASE III: Finalize tool development and implement where needed. Transition fully operational software tool to appropriate users.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Any business with legacy code that needs optimized and innovated software to exploit multi-core, multi-threaded operating system functionality would benefit from this product.

REFERENCES:
1. Scali’s Open Blog TM, (2012). Multi-core and multi-threading performance (the multi-core myth?). http://scalibq.wordpress.com/2012/06/01/multi-core-and-multi-threading/

2. Kissel K. (2007). Demystifying multithreading and multi-core. EETimes Design (09/26/2007). http://www.eetimes.com/design/automotive-design/4004762/Demystifying-multithreading-and-multi-core

3. Chen, J., Watson III, W. & Mao, W. (2007). Multi-Threading Performance on Commodity Multi-core Processors. http://www.nikipdf.com/readonline/multi-threading-performance-on-commodity-multi-core-processors.html

KEYWORDS: Legacy Code, Multi-Thread, Multi-Core, Analysis, Software Optimization, Throughput

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

N132-100 TITLE: Absorption and/or Scattering of Light by Small Particles

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA 272

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as

"Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Design, develop and demonstrate concepts for a material that acts as a spectral blocker, absorber and/or scatterer of light in the ultraviolet (UV) when dispersed in the atmosphere.

DESCRIPTION: The purpose of this effort is to design, develop and demonstrate a material, aerosol or other form of material, that, when dispersed, evolved, sprayed, released or in any other manner delivered into the atmosphere, results in an area of one or more of the following in the UV spectral region: negative refraction, unreflective, absorbing, scattering, blocking, optically thick and/or expanding. One concept might include a small package delivery device that starts a rapidly-generating, extended, dense cloud of such material. Material should not be reflective of sunlight. Concepts might include but are not limited to quantum dots, nanoparticles, metamaterials, aerosols or other form. Safety of life and property should be considered when proposing materials that could be considered unsafe or hazardous. Submissions should include some form of proof of concept such as modeling and simulation, material science theory, demonstration or laboratory evidence of proposed phenomenon.

PHASE I: Identify suitable concepts and materials and conduct proof of concept such as modeling and simulation, lab demonstration or other proof of the ability to create desired/proposed effect. Characterize all attributes of the material such as scattering/emission/absorption in UV and other regions of the spectrum (Visual and Infrared (IR)) and safety hazards (flammability, toxicity, environmental impact, etc.). Develop plans for packaging and integration into delivery systems. In Phase I option, down select most promising candidates for a functional demonstration.

PHASE II: Develop prototypes that deliver proposed material to the atmosphere. Government-furnished testing devices may be available for characterization of the effects of this test such as spectrometers.

PHASE III: Develop full-scale manufacturing process for proposed material and device. Participate in testing efforts of the proposed material.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The contractor will pursue commercialization of the various components developed for potential commercial uses in homeland defense applications.

REFERENCES:
1. Bohren, C.F., Huffman, D.R. (1983). Absorption and Scattering of Light by Small Particles; Wiley-Interscience: New York.

2. Bruce, D., Geiver, J. Statistical comparison of measured obscurant cloud images and radiative transfer model output, Proc. SPIE 1967, Characterization, Propagation, and Simulation of Sources and Backgrounds III, 278 (August 13, 1993); doi:10.1117/12.151050; http://dx.doi.org/10.1117/12.151050

KEYWORDS: Ultraviolet; Electromagnetic Spectrum; spectrum obscurity; cloud characterization; path radiance change; cloud density

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

N132-101 TITLE: <u>Thick Composite Crack Analysis</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA 276

OBJECTIVE: Develop methods within the realm of peridynamic theory to improve damage prediction and growth in thick composite parts for improving design and life predictions in rotary wing applications.

DESCRIPTION: Fiber-reinforced polymer (FRP) laminated composites exhibit directional stiffness and strength properties, and offer different fabrication architecture; thus, enabling advanced design concepts, structural tailoring, multi-functional features, and performance enhancements. Therefore, composites are an important part of vehicle structures and continue to replace traditional metal parts with increasing frequency. Considering their high specific strength and stiffness (relative to metals) they are attractive for aerospace applications. However, composites are inherently anisotropic and non-homogenous, and the strength and stiffness properties of the constituents (fiber and matrix) are extremely different. Strength of FRP composite laminates depends on fiber directions, type of fibers and resins, number of layers, stacking sequence, type of loading, environmental conditions, and random variation of material and strength properties due to manufacturing. The nature of damage initiation and its progression creates more complicated internal loading than would be experienced in traditional, metal parts. Their failure involves a progressive series of events with discrete failure modes such as matrix cracking, fiber-matrix shear, fiber breakage, and delamination. The presence of such failure modes results in stiffness degradation; thus, leading to load redistribution among the layers and constituents. Accurate computation of load redistribution and prediction of failure modes are critical to realistic simulation of composite laminate strength predictions.

In primary load path structures made from composite, damage must be closely monitored to ensure the safety and integrity of the vehicle. Advanced analysis tools are being developed to better model and predict the damage initiation and propagation experienced in laminated composites. As the Navy continues to incorporate more composite structure, accurate damage prediction using analytical methods continues to be an area where improvement is needed. Traditional finite element analysis (FEA) is inherently limited for predicting failure modes especially in fiber-reinforced composites without resorting to external criteria to guide the failure progression.

An alternative to traditional FEA is the peridynamic theory; it is a nonlocal extension of classical continuum mechanics that is based on integral-differential equations involving time and spatial coordinates. The peridynamic equation of motion contrasts with that of classical theory continuum mechanics, which is based on partial differential equations. Peridynamic theory has the capability to handle multi-scale modeling for both length and time, and address discontinuities and non-linearity. The peridynamic theory has the potential to serve as a basic model across all scales avoiding the difficulties inherent to multi-model coupling in addition to the ability to efficiently link with many microscale models including molecular dynamics.

Flexible analysis tools that better assess the effects of damage (impact, environment, fatigue) would be valuable to help predict life and improve design in rotary wing applications. The primary area of interest is rotor components that have been subjected to dynamic loading.

PHASE I: Develop an analytical method within the realm of peridynamic theory for predicting damage initiation and propagation in thick composite parts. Demonstrate the feasibility of the technology by performing analysis on a simulated thick laminate rotor component, subjected to high cycle loading.

PHASE II: Develop the methodology into a prototype analysis tool. Initiate validation through component testing.

PHASE III: Complete verification and validation. Transition the developed technology to appropriate platforms or end users.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: As composites make up a more significant portion of vehicular structure, the need for analysis and prediction tools will also increase. Commercial customers will demand more reliable and robust methods for ensuring the safety of their products. Better analytical understanding of damage initiation and propagation could also spur the development of new manufacturing methods to better suit the needs of users and their structural applications. The ability to model and simulate composite materials for strength prediction can reduce the time and cost for material testing and characterization; thus, provide the opportunity to use advanced material systems on critical military and commercial equipment in a timely manner.

REFERENCES:
1. Reddy, J.N. (2004). Mechanics of Laminated Composite Plates and Shells: Theory and Analysis. 2nd ed. Boca Raton: CRC.

2. Rao, B.N., & S. Rahman.(2001). A Coupled Meshless-finite Element Method for Fracture Analysis of Cracks. Int. Journal of Pressure Vessels and Piping, Vol. 78, pp. 647-657.

3. Xu, J., Askari, A., Weckner, O. & Silling, S. (2008). Peridynamic Analysis of Impact Damage in Composite Laminates. Journal of Aerospace Engineering, Vol. 21, pp. 187-194.

4. Kilic, B., Agwai, A. & Madenci, E. (2009). Peridynamic Theory for Progressive Damage Prediction in Centre-Cracked Composite Laminates. Composite Structures, Vol. 90, pp. 141-151.

5. Kilic, B., & Madenci, E. (2010). Coupling of Peridynamic Theory and Finite Element Method. Journal of Mechanics of Materials and Structures, Vol. 5, pp. 707–733.

6. Agwai, A. Guven, I. & Madenci, E. (2011). Predicting Crack Propagation with Peridynamics: A Comparative Study. International Journal of Fracture, Vol. 171, pp. 65-78.

7. Oterkus, E., Madenci, E., Weckner, O., Silling, S., Bogert, P. & Tessler, A. (2012). Combined finite element and peridynamic analyses for predicting failure in a stiffened composite curved panel with a central slot. Composite Structures, Vol. 94, pp. 839-850.

8. Oterkus, E. & Madenci, E. (2012). Peridynamic Analysis of Fiber Reinforced Composite Materials. Journal of Mechanics of Materials and Structures, Vol. 7, pp. 45-84.

KEYWORDS: Thick Composites; Structural Composites; Damage Prediction; Composite Damage; Delamination; Damage Growth

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

N132-102 TITLE: Modeling of interior nozzle flows for transient effects, realistic high performance nozzle physics and coupling to Large Eddy Simulation modeling of the jet plumes

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: JSF-Prop

OBJECTIVE: Design and develop new methods of modeling the interior of high performance turbine engine exhaust nozzle aerodynamics to include unsteady effects to a greater accuracy than is currently available. Of emphasis are effects due to throttle transients and due to the presence of walls particularly those in multiple exhaust streams.

DESCRIPTION: Technologies are needed for advancing the state-of-the-art in the Modeling & Simulation (M&S) of the interior flows in high performance turbine engine exhaust nozzles, including those for advanced engine architectures with multiple exhaust streams. The primary intent is to improve the (thrust) performance of those nozzle designs, as well as durability from the improved understanding of the structural loads on the nozzle components from throttle transients and multiple flow streams. A secondary intent is to employ the developed M&S tool to explore nozzles of low jet noise emissions.

It is recognized that significant advancements have been made, to date, in the LES modeling of hot, supersonic exhaust nozzles plumes for aerodynamics and acoustics. But such modeling has not been effectively extended to the nozzle interiors because of the inability of the LES methodology to handle wall effects. The remedies have included the coupling of Reynolds Averaged Navier Stokes (RANS) schemes to LES for wall/nozzle interior modeling, Detached Eddy Simulation (DES), or schemes that model the wall shear stress term directly.

But it is generally recognized these are more-or-less ad-hoc attempts and that need to be revisited for a more thorough examination of the mathematics involved. The general outlining mathematical problem is the coupling of non-linear operators. The derived iterative numerical scheme should efficiently converge the coupled operators in the overall solution domain that includes the nozzle walls, core and plume. It is also required that the developed scheme is efficiently parallelizable, e.g., in a domain decomposition fashion, to take full advantage of available state-of-the-art parallel supercomputers.

The developed methodology should seamlessly couple with fully transient analyses of nozzle plumes with the technique of Large Eddy Simulation (LES). It should be scalable to take advantage of state-of-the-art High Performance Computing (HPC) hardware and software and efficient with respect to clock turnaround times for a complete interior/exterior nozzle simulation. The new tool will be transitioned to NAVAIR Propulsion & Power as well as to Engine OEMs, if they choose to purchase/lease it.

PHASE I: Develop and demonstrate a simulation of one government-furnished nozzle geometry and boundary conditions and compare to existing experimental data. The simulation should include the interior of the nozzle and the LES of the exterior jet plume. Propose a methodology for the Phase II that incorporates transient effects, wall effects modeling, more realistic boundary conditions and full coupling to interior/exterior to the nozzle LES coupling.

PHASE II: Implement the proposed methodology and validate for high performance nozzle simulations that incorporates transient effects, wall effects modeling, more realistic boundary conditions and full coupling to interior/exterior to the nozzle LES plume.

Validate the developed scheme for a series of nozzle designs provided by the government.

Transition the beta version of the developed software to NAVAIR Propulsion & Power.

PHASE III: Transition the alpha version of the developed tool, appropriate platforms for design/implementation in "second generation" nozzles hardware for current/future aircraft programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Both military and commercial gas turbine engine nozzle design applications for increased durability and performance including identification of jet noise reduction concepts.

REFERENCES:
1. Schlueter, J.U., Wu, X., Kim, S., Alonso, J.J., & Pitsch, H. (2003). Integrated RANS-LES Computations of Turbomachinery Components: Generic Compressor/Diffuser. Center for Turbulence Research, 357-368.

2. Georgiadis, N.J., Alexander, J.D., & Reshotko, E. (2001). Hybrid Reynolds-Averaged Navier-Stokes/Large-Eddy Simulations of Supersonic Turbulent Mixing. AIAA Journal, 41(2) 218-229.

3. Gatski, T.B., Rumsey, C.L., & Manceau, R. (2007). Current Trends in Modeling Research for Turbulent Aerodynamic Flows. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 365(1859) 2389-2418.

4. Kawai, S., & Larsson, J. (2012). Wall-Modeling in Large Eddy Simulation. Physics of Fluids, 24(1). doi:10.1063/1.3678331

5. Piomelli, U., & Balaras, E. (2002). Wall-layer models for large-eddy simulations. Annual Review of Fluid Mechanics, 34 349-374.

6. Spalart, P.R. (2009). Detached-eddy simulation. Annual Review of Fluid Mechanics, 41 181-202.

KEYWORDS: High Performance Variable Cycle Engines Exhausts; Transient Nozzle Effects Modeling; Rans/Les Coupling; LES wall modeling; Computational Fluid Dynamics of Interior Flows; Aeroacoustics of Nozzle flows.

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

N132-103 TITLE: Advanced Wheel Bearing for High Acceleration and Deceleration Applications

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA 251

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 new wheel bearing for use in a highly loaded moving shuttle subjected to high acceleration and deceleration rates to reduce the maintenance and other resources required to maintain bearing components.

DESCRIPTION: There is a need for development of an advanced wheel bearing with long life under high loads, and high acceleration/deceleration rates. Currently, open and sealed wheel bearings are utilized, but both require greasing as frequently as every 25 launches. The high periodicity of greasing creates both environmental and operational burdens.

Life considerations should be paramount; graceful degradation, low maintenance and low replacement frequency are ideal. The proposed wheel bearing should not require periodic greasing. Proposed wheel bearings should have long life without exhibiting signs of degradation or loss of grease which would affect performance. Any bearing failure must remain contained to prevent having a Foreign Object Damage (FOD) hazard.

The wheel bearing technology should take into account Electromagnetic (EMALS) and Steam catapult requirements. The Electromagnetic armature has 6 wheels and the Steam catapult shuttle has 8 wheels in a vertical configuration on a horizontal axis.

Approximate requirements for the EMALS and Steam Catapult applications:

Application acceleration: 0 to 180 knots (kts), within 300 feet (ft)
Peak acceleration: 5.5 G’s
Application deceleration: 180 to 0 kts, within 20 ft Threshold(T), 5 ft Goal(G)
Maximum distance traveled per acceleration/deceleration cycle: (2x) 350 ft
Operating temperature range: -20 degrees Fahrenheit (F) to 160 degrees F (T), 250 degrees F (G)
Environmental: Humidity, rain, salt fog, salt water spray, contaminants, sand & dust, nuclear, biological, and chemical (NBC) decontamination, and magnetic environment
Basic dynamic load rating: 25,000 pounds (lbs) (T), 65,000 lbs (G) (based on basic life (L-10) of 1 million revolutions)
Basic static load rating: 150,000 lbs
Dimensions of bearing (approximately): 6.3 inch (”) Outer Diameter, 3.5” Inner Diameter, 2.4” width
Life (approximate cycles): 5,000(T), 25,000(G)

PHASE I: Develop and demonstrate feasibility of a long life wheel bearing technology that meets the key requirements and technical issues referred to in Description.

PHASE II: Design and develop a prototype based on the Phase I concept. Demonstrate the prototype performance during full speed launches with no loads on catapult test sites.

PHASE III: Finalize testing and transition the technology to the appropriate platforms and the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This wheel bearing development may be applied to many applications in the commercial sector as well as for other military agencies. This technology is important to the future of locomotives, aircraft, spacecraft, and electrical vehicles.

REFERENCES:
1. Dick, M.G., & Wilson, B.M. (2006). The Effect of Sustained Wheel Impacts on Tapered Roller Bearing Cages. Proceedings of the 2006 IEEE/ASME Joint Rail Conference, 189-195. doi: 10.1109/RRCON.2006.215309

2. Harris, T.A., & Kotzalas, M.N. (2006). Advanced Concepts of Bearing Technology (5th ed.). Boca Raton: CRC Press.

3. EMALS Bearing Interface Sketch, I page, uploaded in SITIS 5/20/13.

4. Advanced Bearing; additional info provided by TPOC, 6 pages, uploaded in SITIS 5/20/13.

KEYWORDS: Wear, Wheel Bearing, Dynamic Friction, Static Friction, Aircraft Launch Catapult, Bearings

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

N132-104 TITLE: Exploiting Small Boat Wake Signatures for Improved Threat Classification and Feature Aided Tracking

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA 290

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 method to exploit wake signature attributes for the small boat threat classification and feature aided tracking by airborne radar systems.

DESCRIPTION: Develop robust means to provide long-term tracking of small boats threats in congested littoral environments. Rather than focusing only on the hard-body signature of the boat itself, we seek to supplement that signature by exploiting the characteristics of boat generated wake detectable by airborne maritime surveillance and imaging radar systems. Boat hull design and dimensions, boat speed and loading all contribute to the wake signature attributes to be exploited. For example, it is well known that the wavelength of a boat's wake is based on its waterline length. Also, wake characteristics differ between flat bottom hulls, displacement hulls, round-bottom, v-bottom and tri-hull boats. Qualitatively the wave resistance of a displacement hull resonates with a wave that has a crest near its bow and a trough near its stern, because the water is pushed away at the bow and pulled back at the stern. A planing hull simply pushes down on the water under it, so it resonates with a wave that has a trough under it. These differences should be exploitable by radar systems. In addition, the amplitude characteristics of the wake may provide information regarding the loading of the boat. The expanded hard-body and wake feature set increase the likelihood that small boats can be fingerprinted and observed over extended periods of time to develop a pattern of life assessment in the area of operations. Understanding patterns of life is a valuable means to provide earlier indications and warnings of threats.

PHASE I: Perform a detailed physics-based analysis and modeling effort to identify exploitable wake signature attributes away from the target detection, detectable by radar as a function of hull type, dimensions, speed and loading to include both cross-range movement and movement in multiple directions relative to the primary surface wave field.

PHASE II: Significantly increase the fidelity of wake exploitation methods. Develop and demonstrate an end-to-end prototype radar signal processing system. Evaluate and improve the system using experimental data obtained in a real-world littoral environment.

PHASE III: Transition the developed technology to appropriate platforms and interested commercial entities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a growing need for accurate, real-time instrumentation of the sea surface for safe navigation of vessels in and around harbors and shipping lanes.

REFERENCES:

1. Meadows, G.A., & Wu, Z. (1992). Estimation of a Moving Ship's Hull Shape from its Wave Spectra. International Geoscience and Remote Sensing Symposium, 2, 1321-1324. doi:10.1109/IGARSS.1992.578442

2. Wu, Z. (1991). On the Estimation of a Moving Ship's Velocity and Hull Geometry Information from its Wave Functions. Arlington, VA: University Research Initiative of the Office of Naval Research. Retrieved from: http://www.dtic.mil/dtic/tr/fulltext/u2/a251152.pdf

3. Wu, Z. & Meadows, G.A. (1991). A Remote Sensing Technique for the Estimation of a Moving Ship's Velocity and Length from its Wave Spectra. Ocean Technologies and Opportunities in the Pacific for the 90's, 2, 810-817. doi:10.1109/OCEANS.1991.627954

KEYWORDS: Radar Scattering; Radar Sea Clutter; Maritime Surveillance; Small Maritime Targets; Target Detection; Hull Type Discrimination

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

N132-105 TITLE: Plateau Burning Composite Propellant with Minimized Temperature Sensitivity

TECHNOLOGY AREAS: Materials/Processes, Battlespace, Human Systems

ACQUISITION PROGRAM: PMA 201

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 composite propellant which has an extended plateau region in its burning rate vs. pressure relationship curve, as well as minimized variation in ballistic performance as a function of temperature change.

DESCRIPTION: Double base (nitrocellulose & nitroglycerine based) propellants widely used in Navy aircraft ejection seat systems experience degradation and depletion of the stabilizers used in the formulation over time with exposure to high operational and storage temperatures. This degradation results in safety risks due to the possibility of inadvertent spontaneous deflagration of the propellant. Current composite propellants typically do not have a pronounced plateau in their burning rate vs. pressure curves, and have a wider variation in performance with changes in temperature as compared to double base propellants.

An innovative composite propellant to replace the current double based propellants used must be nitrate ester free and thermally stable across an operating temperature range from -65°F to +200°F. Ideally the propellant burning rate in the plateau region at ambient temperature would be approximately 1.0 inches per second at 2000 pounds per square inch (psi), followed by a negative slope in the burning rate curve, extending through at least 4500 to 5000 psi, and dropping by at least 0.4 inches per second. The temperature sensitivity coefficient (Sigma sub p) would ideally be sp = 0.1 %/ K or less. Such a composite propellant would have performance characteristics similar to a plateau burning double base propellant, currently in use in Naval ejection seat systems, but without the limited life inherent in propellants containing nitrate esters.

This formulation would be developed and validated through adjustments to the propellant composition, followed by burning rate testing to demonstrate the effects of adjustments made. The burning rates of the final formulation supplied to the Navy will be measured at -65F, ambient temperature, and +200F across the pressure range of 500 to 5000 PSI. The formulation must contain ingredients which have been tested to demonstrate compatibility with each other. Mechanical properties testing, as well as basic propellant safety and characterization tests in accordance with NAVSEAINST 8020.5C are to be conducted, so a Department of Defense Interim Hazard Classification can be obtained for the propellant. The tests would be conducted on zero-time and propellant samples aged for 64 days at 200F, and the results supplied to the Navy.

PHASE I: Determine the feasibility of the composite propellant developed in accordance with the identified parameters.

PHASE II: Further develop and demonstrate through testing, a formulation which meets the performance objectives for burning rate and temperature sensitivity across the pressure range on zero-time and aged propellant samples. Characterization tests, scale up of the propellant manufacturing process, and manufacture of a quantity of propellant samples, one to two kilograms, for delivery to the Navy would also be performed in Phase II.

PHASE III: Conduct the complete propellant characterization testing per NAVSEAINST 8020.5C and manufacture and transition a quantity of propellant samples for delivery to the Navy for testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A composite propellant developed under this effort could be used in commercial mining, blasting, oil and gas exploration cartridge applications where consistent performance is required across a wide variation in temperature.

REFERENCES:

1. Ide, K.M. (2002). Composite Propellants with Bi-Plateau Burning Behaviour (DSTO-GD-0344). Edinburgh, South Australia: Weapons Systems Division, Systems Sciences Laboratory. Retrieved from http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA414445

2. Steinz, J. A., Stang, P. L., & Summerfield, M. (1967). Effects of Oxidizer Particle Size on Composite Solid Propellant Burning: Normal Burning, Plateau Burning and Intermediate Pressure Extinction (Aerospace and Mechanial Sciences Report No. 810). Princeton, NJ: Department of Aerospace and Mechanical Sciences, Princeton University. Retrieved from http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA952028

3. Garman, N. S., Picard, J. P., Polakoski, S., & Murphy, J. M. (1973). Prediction of Safe Life of Propellants (Technical Report 4505). Dover, NJ: Picatinny Arsenal. Retrieved from http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=AD0763879

4. Peletski, C. (2000). Qualification and Final (Type) Qualification Procedures for Navy Explosives (NAVSEAINST 8020.5c). Arlington, VA: Navy Insensitive Munitions Office. Retrieved from http://engineers.ihs.com/document/abstract/HDFFABAAAAAAAAAA

KEYWORDS: Combustion; Composite Propellant; Burning Rate; Plateau; Temperature Sensitivity

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

N132-106 TITLE: <u>High-Power 3 Micron Fiber Based Laser System</u>

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: JSF-MS

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 fiber based laser system operating at room temperature at 3.0 micron that emits high average and peak powers.

DESCRIPTION: A power-scalable, compact mid-IR fiber laser platform at approximately 3 micron spectral ranges for various Naval tactical applications is needed. The 3 micron optical wavelength is a very interesting and crucial wavelength because the optical absorption coefficient of water peaks at 3 micron and is 10,000 times stronger than absorption peaks at the near-infrared 1micron wavelength. Therefore, optical efficiency of using a 3 micron laser to impart optical energy into water is up to four orders of magnitude more efficient than those at the near-infrared wavelength range where conventional solid-state and fiber laser technologies are much more mature and the lasers are much more readily available commercially.

While the coherent light sources at or near 3 micron spectral range have tremendous potential for various DoD applications, the availability of reliable, high-power fiber-based laser sources in this wavelength range of interest is very limited. Recently, Erbium doped Fluoride fiber lasers incorporating low and high reflectivity Bragg gratings have been demonstrated with continuous wave (CW) lasing over 5 Watts (W) [1] and 14 W [2] at 2.94 micron, respectively. Although these results show promise for the coherent emissions in the 3 micron wavelength range the average power is still below that of conventional bulk Erbium-doped solid state laser systems. However, these solid-state systems are still rather complex and as such require complex pump and cooling schemes to maintain beam quality and system efficiency.

The payoff in terms of size, weight and performance (SWaP) would be substantial if able to exploit the paradigm of combining the unique Erbium doping properties of solid state systems and the recent advances, ruggedness and compactness of fiber-based lasers or amplifiers based on single crystal fibers (SCFs) [3]. Recently, Sangla et. al. [4] has shown laser emission from Yb-doped Yttrium Aluminum Garnet (Yb:YAG) SCF with a micro-pulling technique. These results showed decent beam quality with lasing at 1031 nanometers (nm) and more than 2 Watts of continuous wave (CW) power. Zaouter [5] also showed direct amplification of ultra-short pulses using Yb:YAG SCF with a gain of 30 in a double pass configuration. It is expected that similar results can be achieved using Er-doped (Er:YAG) SCF. In this case, the SCF structure can serve as an amplifier for a semiconductor seed source or as an oscillator using properly designed high reflectivity and low reflectivity gratings or mirrors. Therefore, the main objective of this topic is to investigate and demonstrate the feasibility of using novel diode-pumped Er-doped fiber for generation of high-power output at approximately 3 micron with near diffraction-limited beam quality or M2. It is desired to develop a compact and robust fiber laser system for 3 micron emission wavelength, operating at room temperature, and capable of producing at least 10 W in CW mode with beam quality of M2 < 1.3. The design should be further refined to increase the CW output power level to greater than 100 Watts with beam quality M2<1.3.

PHASE I: Determine and demonstrate the feasibility of designing a compact and robust fiber laser system with the parameters requested in the description. Further refine the concept by determining the feasibility of increasing the CW as also requested in the description and provide a well-thought out (and realistic) development plan that clearly describes the power scaling architecture output power level to greater than 100 Watts. Provide a well-thought out (and realistic) development plan that clearly describes the power scaling architecture of which the power and beam quality must be at least 100 watts in CW mode and M2<1.3, respectively.

PHASE II: Design, develop and demonstrate a prototype of the fiber laser system. Assess the manufacturing yield and product reliability of the fiber laser system. Based on the experience and lessons learned provide a revised well-thought out (and realistic) development plan that clearly lays out the power scaling architecture for such a system for output with 100 W at CW mode and M2 < 1.3.

PHASE III: Fully develop and transition the high-performance semiconductor laser system and/or power-scaled architecture for maritime sensing, naval aviation LIDAR, and advanced chemical sensor applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial sector can significantly benefit from this technology development in the areas of detection of toxic industrial gases, environmental monitoring, and non-invasive medical health monitoring and sensing.

REFERENCES:

1. Faucher, D., Bernier, M., Caron, N. & Vallee, R. (2009). Erbium-doped all-fiber laser at 2.94 µm. Opt. Lett., 34(21) 3313-3315.

2. Faucher, D., Bernier, M., Androz, G., Caron, N. & Vallée,, R. (2010). 20 W passively cooled single-mode all-fiber laser at 2.8 –µm. Optics Lett. 36, 1104.

3. Sangla, D., Aubry, N., Didierjean, J., Perrodin, D., Balembois, F., Lebbou, K., Brenier, A., Georges, P., Fourmigue, J., & Tillement, O. (2008). First Demonstration of Laser Emission from an Yb:YAG Single Crystal Fiber Grown by the Micro-Pulling Down Technique. in Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science Conference and Photonic Applications Systems Technologies, OSA Technical Digest (CD) (Optical Society of America), paper CThFF4.

4. Nubling, R. & Harrington J. (1998). Single-crystal LHPG sapphire fibers for Er:YAG laser power delivery. Applied Optics, 37, 4777-4781.

5. Nubling, R. & Harrington J. (1997). Optical properties of single-crystal sapphire fibers. Applied Optics 36, 5934-5940

KEYWORDS: 3 Micron, Fiber Laser, Fiber Amplifier, Sensor, Solid-State Laser, Erbium

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

N132-107 TITLE: Radar Imaging Guidance

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: PMA 280

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 radar algorithm to allow simultaneous tracking and imaging for Pulse Doppler radar systems.

DESCRIPTION: Future radar guided precision munitions and radar sensor suites would benefit from the ability to use radar tracking data developed from Moving Target Indication (MTI) detections and high resolution imaging waveforms for Automatic Target Recognition (ATR) on High Range Resolution (HRR), Synthetic Aperture Radar (SAR), and Inverse Synthetic Aperture Radar (ISAR) images. Currently radar seekers must take time away from the tracking function to image the target. This causes the quality of the track information to be degraded. The time required to generate radar images varies as a function of wavelength and radar sensor speed and angular rate, and can vary from a few seconds to tens of seconds depending on the system application. For radar seekers utilizing radar Intelligence, Surveillance, and Reconnaissance (ISR) of highly valued moving targets in dynamic environments, losing track data for several seconds could cause a loss of target track. Waveforms and algorithms are needed that can simultaneously develop tracking data from the high resolution ATR quality target images.

PHASE I: Develop and demonstrate the feasibility of a concept for Radar Imaging Guidance. Design the system architecture content, waveform and high level algorithm.

PHASE II: Develop and demonstrate a prototype Radar Imaging Guidance system on an existing seeker testbed. Develop a PC based simulation that exercises the algorithms.

PHASE III: Finalize the technology and transition to the appropriate platforms and the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Simultaneous MTI and radar imaging can benefit all-weather border control and perimeter surveillance applications.

REFERENCES:
1. Dunn III, R.J., Bingham, P.T., & Fowler, C.A. (2004). Ground Moving Target Indicator Radar and the Transformation of U.S. Warfighting (Analysis Center Papers). Northrop Grumman. Retrieved from http://www.es.northropgrumman.com/solutions/f16aesaradar/assets/gmti.pdf

2. Nathanson, F.E. (1969). Radar Design Principles: Signal Processing and the Environment. New York: McGraw-Hill Book Company.

KEYWORDS: Radar Imaging, Radar Signal Processing, Synthetic Aperture Radar (SAR), Inverse Synthetic Aperture Radar (ISAR), Radar Track, Track Fusion

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

N132-108 TITLE: Automated Method for Developing Concept Level Cooling Distribution Systems

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: NAVSEA 05T, NAVSEA Energy Office, Energy Efficiency Program.

OBJECTIVE: This topic seeks innovation to develop an automated ship-system synthesis software tool for creating preliminary ship design models of auxiliary cooling distribution systems.

DESCRIPTION: Integrated Electrical Power Systems and high-energy defense and combat weapon systems that are planned for future Navy Surface Ship platforms will require unprecedented thermal management solutions.

Typical auxiliary cooling distribution systems currently in-service have undersized performance capacities when compared to the projected need expected from future platform configurations (Ref 1). The current technology available in the Advanced Ship and Submarine Evaluation Tool (ASSET) and Leading Edge Architecture for Prototyping Systems (LEAPS) is limited in scope. These tools estimate auxiliary cooling distribution systems using algorithms and empirical data that are derived from dated ship information. These tools lack a predicted distribution system by way of a physical representation, which would be useful for initially understanding ship impact and integration requirements.

An Automated Distribution System Development Tool (ADSDT) to automate methods for developing and assessing concept level cooling distribution systems to address these concerns is needed for conducting systems engineering analysis, trade, and feasibility studies during the concept evaluation stage of future ship design. Leveraging such a method early in the acquisition lifecycle is the most efficient course to take to properly scope, qualify, quantify, and design such distribution systems as a thermal management solution. An automated tool with this capability will increase the efficiency of developing such systems for evaluation purposes, will have the potential to identify a comprehensive design space of system configurations that are feasible for optional consideration, and will allow optimized solutions to be realized for future ship design models due to the increased fidelity provided. This technology has the potential to reduce the cost associated with preliminary and detail design as well as the impending cost associated with operation of the ship when applied during the Material Solution Analysis Phase of the acquisition lifecycle. Ultimately, the optimized solutions derived during this phase from the application of the synthesis tool in systems engineering trade and feasibility studies should directly represent the most energy efficient configurations available for ship operation due to the robust range of engineering metrics offered by the tool.

Next Generation Surface Combatant ship design requires an automated ship system construction software tool that is able to develop comprehensive and well defined design models of auxiliary cooling distribution systems for Navy use. This competency as a resource (Ref 2) is necessary for integration with commercial and other Navy developed software toolsets to improve the overall fidelity of future ship design models.

The central requirement of the new software synthesis package is to address the gaps identified by having the ability to technically model cooling distribution systems that are feasible (Ref 3) and that are derived from a comprehensive state-of-the-art database of machinery and components. In addition to this basic operational requirement, the software tool must be designed to have a versatile environment, allowing characteristic properties, parameters, and criteria to be varied, and change to rules, regulations, and specifications to be easily accommodated. The auxiliary distribution system should optimize survivability, electrical load, heat transfer, size, weight, and cost system performance requirements. Model visualization that provides a dynamic three-dimensional representation must be a performance feature of the new software package. Finally, the new synthesis software tool must have an open architecture.

PHASE I: The company will develop a concept for a ship construction software tool to design auxiliary cooling distribution systems that meet the requirements outlined above and that can be feasibly developed into a useful product for the Navy. The concepts for construction of an ADSDT shall be demonstrated by way of modeling and simulation, performing a feasibility analysis. The company will develop a Phase II development plan that addresses technical risk reduction and provides performance goals and a schedule of key technical milestones.

PHASE II: The small business will develop, demonstrate, and verify an ADSDT prototype for evaluation through analytical modeling and simulation over a required range of parameters including numerous system configurations and scenarios. The prototype will be assessed and evaluated to determine its compatibility with ASSET and LEAPS and its capability in meeting performance goals defined in the Phase II development plan. Evaluation of results will be used to refine the prototype package into an initial design that will include a beta version of the software package that demonstrates an open architecture. The company will provide validation and verification of the software and a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the ADSDT technology for Navy use in future ship system studies. The company will develop an ADSDT for evaluation to determine its effectiveness in an operationally relevant environment. 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 software synthesis tool that is automated, dynamic, and versatile in its capability to construct auxiliary cooling distribution system models for use in system engineering trade studies, and for use in preliminary and detail design, offers benefit in the acquisition lifecycle for both commercial and naval shipboard applications. Similarly, the product has potential, as well, in the civil engineering domain with regard to the preliminary design of land-based facilities. Overall, the basic technology would be appropriate for all types of distributed systems, such as electrical, air, hydraulic, and others, due to the inherent flexibility of the software.

REFERENCES:
1. Frank, M., Helmick, D., “21st Century HVAC System for Future Naval Surface Combatants – Concept Development Report”, Naval Surface Warfare Center – Carderock Division, Ship Systems Engineering Station, Philadelphia, NSWCCD-98-TR-2007/06, 06-Sept-2007. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA473662

2. Kassel, B., Cooper, S., Mackenna, A., “Rebuilding the NAVSEA Early Stage Ship Design Environment”, American Society of Naval Engineers, 2010.
https://www.navalengineers.org/SiteCollectionDocuments/2010%20Proceedings%20Documents/ASNE%20Day%202010%20Proceedings/AD2010_Paper_Kassel_Cooper_MacKenna.pdf

3. Gunaratnam, M., Alva-Argaez, A., Kokossis, A., Kim, J.K., Smith, R., “Automated Design of Total Water Systems”, American Chemical Society, Industrial and Engineering Chemistry Research, Vol. 44 (3), 2005: pp. 588-599. http://pubs.acs.org/doi/pdf/10.1021/ie040092r

KEYWORDS: Automated ship system synthesis software tool; auxiliary cooling distribution systems; concept level ship design models; thermal management; engineering optimization of cooling distribution systems, HVAC system for ships

N132-109 TITLE: Development of Environmental Models for Surface Radar Training Systems

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMS 339, Surface Training Systems Program Office

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: This topic seeks innovation to allow multiple surface ship radar training systems to replicate various radar environmental effects, including geographical and atmospheric conditions, so as to provide accurate and realistic operator training.

DESCRIPTION: Radar's performance is impacted by the environment in which it is being used, including geographic and atmospheric conditions. Existing training systems used to teach radar operators lack the ability to replicate different environmental conditions to support sensor management training and demonstrate radar performance and considerations such as ducting and clutter. Therefore, training objectives, such as managing the radar controls to compensate for environmental conditions, cannot be met using current technology. The inability of operators to properly manage the radar can result in delayed or missed detections of threat targets (such as manned aircraft, cruise missiles, submarine periscopes, and fast attack craft) and operators could detect false threats by misinterpreting radar clutter. To mitigate this risk, radar operators are trained live, in the operational environment. Live training is very costly and of limited effectiveness, as it is impossible to train in all possible environmental conditions. If these skills could be taught during pipeline training, it would eliminate the need for live training, resulting in workload reduction costs. At the same time, the ability to train in a simulated environment will allow for more repetitions and more scenarios for the trainee, which results in better retention and performance. An innovative solution is needed to enable multiple, existing radar-training systems to replicate environmental effects.

Some radar simulators have environmental effect models. However, these have been built for radar system development and testing purposes (rather than for implementation in training systems) and are typically only applicable to a single radar system that often uses proprietary software. In addition, many of these systems only have environmental models for one specific aspect, such as weather. These are "stovepipe" simulators, which would not be a viable solution for use in multiple radar training systems. What is needed is a system, which will provide multiple training systems the inputs needed to display various environmental conditions for any geographic location in the operational environment.

Existing technology for Submarine training systems uses a parallel concept during sonar training. The All World Environment Simulation (AWESim) can simulate ocean-acoustic phenomena in the Submarine Multi-Mission Team Trainer (SMMTT) (Ref 1). However, it will be more challenging to develop a system for surface ship radar training, as radars have more complex environmental variables, and integration with multiple training systems will be more challenging than integration in SMMTT.

Radar operators need to be trained on many types of surface radars: AN/SPY-1 (B/B(V)/D/D(V)), AN/SPQ-9B, AN/SPS-67 and AN/SPS-73. All of these training systems need to be able to demonstrate environmental effects to support effective training. It will take an innovative solution to create a system that will be flexible enough to be used in differing training systems and will also have high fidelity to meet training objectives. The Navy is seeking environmental models and algorithms to determine how clutter should be modeled and integrated into the solution.

The proposed system should use an open-source, open-architecture computing environment so that it can be integrated with various training systems and provide common services and operating environments. The solution should allow the training system to input the desired environment based on geographical location and season, and the system should return the appropriate seasonal environmental conditions to the training system such as topography, land radar reflectivity, predicted atmospheric conditions, sandstorms, and sea states.

Radar environmental modeling has been investigated and several models exist which could be applied in an innovative way to develop a solution. These models include, but are not limited to, Billingsley and Larrabee's database of land clutter at low angles (Refs 2-4), Littoral Clutter Model (LCM) (Ref 5), Sea Clutter Models (Ref 6), and Weibull distribution. In addition, weather and geographic data using such as Digital Terrain Elevation Data (DTED) and historic weather data must be included. The Navy is seeking innovation to create a scalable system to interface with existing (and future) training systems, which will model the environmental effects of a chosen location and season to demonstrate impacts to radar performance.

PHASE I: The company will develop concepts for environmental models that can function with various radar-training systems based on an input of geographic location and season. The company will demonstrate the feasibility of the concept in meeting Navy training needs and will show that the concept can be feasibly developed into a useful for Navy. The company will provide system architectures, implementation approaches for achieving training goals, and an analysis of predicted performance. The company will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype environmental model to be integrated with the Open Architecture Simulation System (OASIS) system for evaluation at the Center for Surface Combat Systems (CSCS). OASIS is one of the systems used to train Radar operators. The prototype will be evaluated to determine its ability to meet the performance goals defined in the Phase II development plan, including the ability for the system to generate the training system's radar output with the input of a chosen geographic location. Evaluation results will be used to refine the prototype into an initial design to meet Navy training requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for schoolhouse use. The company will develop the full training module to be implemented at CSCS in multiple radar training systems including OASIS, AEGIS Simulation Test and Training System (ASATS), Synthetic Combat Operating Trainer (SCOT), and Next Generation Simulator (NGS). The company will support the Navy and CSCS for test and validation to certify the system for use and ensure that it meets training objectives.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for dual use of an open architecture system that has models to create environmental conditions has many applications that can be used with various radars. This includes potential use in other DOD radar training systems. Radar training is done by the naval aviation community and by other DOD branches such as the Coast Guard, Army, and Marine Corps. In addition, commercial industry has radar-training devices that could use this technology. The algorithms could also be used for various radar system requirement analysis, system development, and testing. It has the potential to save radar developers expense by using a software-based environmental simulator instead of performing testing in a live environment, which is cost prohibitive.

REFERENCES:
1. Haines, Carl, Jimmy Lee, Bill Beatty, and Carlos Tavares. "SMMTT Submarine Multi-Mission Team Trainer: A Revolutionary Step Forward in Submarine Attack Center Team Trainers." Undersea Warfare. Fall 2009, Issue No. 41. Accessed 8/21/12 <http://www.navy.mil/navydata/cno/n87/usw/fall_2009/smmtt.html>

2. Billingsley, J. B., and J. F. Larrabee. "Multifrequency Measurements of Radar Ground Clutter at 42 Sites," MIT Lincoln Laboratory Technical Report 916, Volume 1, November 15, 1991.
<http://www.dtic.mil/dtic/tr/fulltext/u2/a246711.pdf>

3. Billingsley, J. B., “Ground Clutter Measurements for Surface-Sited Radar.” MIT Lincoln Laboratory Technical Report 786, Revision 1, February 1, 1993. <http://www.dtic.mil/dtic/tr/fulltext/u2/a262472.pdf>

4. Billingsley, J. B., “A Handbook of Multifrequency Land Clutter Coefficients for Surface Radar.” MIT Lincoln Laboratory Technical Report 958, 1 August 1995. <http://www.dtic.mil/dtic/tr/fulltext/u2/a297680.pdf>

5. LeFurjah, George, Donald de Forest Boyer, and Terry Foreman. “Comparison of a Trans-Horizon Littoral Clutter Model with Shipboard Radar Data.” Radar Conference Paper, IEEE International, May 2005. <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA503655&Location=U2&doc=GetTRDoc.pdf>

6. Gregers-Hansen, Vilhelm and Rashmi Mital. “An Improved Empirical Model for Radar Sea Clutter Reflectivity.” Report number NRL/MR/5310—12-9346, 27 April, 2012. <http://torpedo.nrl.navy.mil/tu/ps/pdf/pdf_loader?dsn=14019175>

KEYWORDS: radar simulator; radar training systems; radar environmental modeling; radar atmospheric effects; radar clutter; submarine attack center team trainers

N132-110 TITLE: Electro-Optic and Infrared Situational Awareness Display

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS 340, Naval Special Warfare (SEALS) Program Office.

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: This objective seeks innovation to improve Situational Awareness displays that optimizes human interface for Navy personnel, ships, and crafts.

DESCRIPTION: This topic proposes an innovative display that conforms to operator space such that the sensors ultimately become an extension of the operator’s visual experience. In a situational awareness (SA) system, the software, controls, and sensors are currently available and progressing; the limiting factor of system is the display. The sensors are moving toward replicating and exceeding human vision, while displays have gaps. Human vision, sensors, and displays are defined by resolution and field of view (FOV). The resolution of human vision is defined as 512 mega pixels (MPs) which similar to packing the resolution of approximately 246 high definition televisions into a display. The human vision FOV is 180-230 degrees in the horizontal direction and 120-135 degrees in the vertical direction. The EO/IR sensors provide a virtual reality of color and full motion video that the operator must see as if in the natural world. The SA sensors have an omni-directional FOV of which the operator needs to be able to resolve the details to detect, track, classify, identify, and target threats. The display must accommodate the natural function of the eye such that eyestrain is minimized, just as in the natural world. Threats exist in both the natural and virtual threat world. Having a spatial awareness of the natural physical surroundings is necessary during mission conflicts while performing operator functions; togging between virtual reality and reality is essential to both job function and survival (Ref 4). The display configuration allows the user to persistently scan the entire threat area in a more natural way than available with existing display technologies while accommodating space limitations and viewer equipment such as night vision goggles and eye glasses (Ref 1, 2, 3).

Another way that human vision, sensors, and displays are defined is Instantaneous Field of View (IFOV) across the entire FOV of the omni-directional areas; which is defined in radians of a sphere instead of degrees. The IFOV can refer to a wide FOV (WFOV) similar to taking in the entire scene and narrow FOV to focus on a particular point or threat. Sensors are moving toward the IFOV range of 600 microradians and roadmapped to 100 microradians for

WFOV and a narrow FOV of less than 10 microradians; all in high resolution formats. Sensors with these wide FOVs require partner displays.

While an EO/IR sensor system may collect information that is beyond the human vision FOV range, the display must have accommodations for an operator to see information in a natural way, as if turning the head around like an owl or toggling between different scenes much as a person glances over their shoulder to see what is behind them. The orientation of the sensor virtual world to the physical world must be accommodated to avoid confusion about the direction of potential threats.

Elimination of a display altogether is not an option as automatic target recognition algorithms miss targets, thus necessitating an operator in-the-loop. Today's plethora of displays is not adequate for current and future sensor operations, especially in resolution and FOV, thus becoming the limiting factor in a system (Ref 2). Eliminating color triples the resolution in displays such as the Coronis Fusion 10 MP (Ref 5); however, SA displays require both color and even higher resolutions. Current industry solutions of increasing display size and/or tiling the displays to support WFOV and high-resolution SA imagery (Ref 3) do not fit into operator workspaces. Tiling micro-displays in head mounted displays (HMD) and waveguide visor technologies such as the BAE Systems LiteHud (Ref 6) creates weight issues. FPDs and flexible body displays, such as the Raytheon's Aviation Warrior (Ref 6), produce fatigue from keeping the body position stable and have line-of-sight gaps that limit persistent SA. See-through visor displays, FPDs, and HMDs are designed for augmented reality (symbology over natural background); they do not accommodate SA virtual reality over natural background as the combined color and shapes cancel the ability to distinguish threats. These limitations affect warfighter SA by presenting only a subset of sensor information (Ref 4).

The envisioned system will fill the gaps between current practices while supporting the solved issues such as latency (displays contribute minimal latency to a sensor system), sunlight readability, full motion video without blur, readable with night vision equipment, inherently rugged to survive in military environments or have the ability to be ruggedized, compatible with multiple commercial standard and military controllers, color, and programmable to scan, glance, focus on objects. The envisioned display system will support software configurations for zoom windows for target areas of interest from the WFOV sensor and one or more separate Narrow Field of View (NFOV) EO/IR sensor systems. The envisioned display system will also support menus, standardized symbology, automatic track boxes, target cues from the combat system or other sensors, and orientation information providing the user with SA such as sensor line-of-sight/FOV relative to the platform heading, etc.

This project will explore the optimal choice or integrated combination of conventional panel-mounted displays and head/helmet-mounted displays (HMD) (Ref 1) or other proposed solutions. We will evaluate appropriateness of HMD usage for unity magnification, head or eye-tracked line-of-sight (LOS) imagery presentation, and as a heads-up pilotage and fire control targeting visual aid. We will also examine optimal methods of addressing spatial orientation mismatch between the operator and imagery line-of-sight (e.g., rear-view imagery). In addition, we will assess exploitation of innovative sensory presentation, cues and alerts such as pseudo-color overlays, sound, haptic feedback, etc. to bring out key features and minimize display clutter. The ability of a display's fit into confined spaces while displaying the resolution and field of view (Ref 3) in a tradespace with power, and weight will also be assessed. A size, weight, and power combination that meet consumer energy star standards will result in a solution to this topic in a lighter weight form factor than current fielded solutions. The display will be assessed in phase I for the ability to build a prototype in phase II; phase III is a transition of technology for naval use and therefore manufacturing issues must be evaluated and minimized.

PHASE I: The company will develop a concept for an EO/IR SA Display System that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be successfully developed into a useful product. Feasibility will be established through analytical modeling, simulation of the Graphical User Interface (GUI) using simulated or real imagery, and/or prototype evaluation and demonstration using representative material samples. The small business will provide a Phase II development plan that must address technical risk reduction and provide 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 a functional prototype for evaluation, demonstrating the full performance level. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the EO/IR SA Display System. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters. The EO/IR SA Display System will be demonstrated and evaluated using an interfacing panoramic WFOV EO/IR imaging system and accompanying high definition narrow FOV EO/IR imaging system that work together in tandem to supply the WFOV and NFOV Zoom imagery. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to a Navy program.

PHASE III: The company will be expected to support the Navy in transitioning the technology to Navy use. The company will refine the EO/IR SA Display System according to the lessons learned from Phase II development for evaluation to determine its effectiveness in an operational environment. The company will support the Navy in test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private Industry commercial products can benefit from this research in applying resulting concepts to develop higher performance and less expensive higher resolution and wider FOV displays. EO/IR systems are used extensively in the commercial sector all of which require display and all are moving toward the Human Vision sensor inputs which are dual-use applications.

Multiple commercial, industry, and military applications benefit from the implementation of this SBIR topic. Video game players' needs are similar in terms of resolution, FOV, and the need to toggle quickly between physical and virtual reality (4). Medical requirements would gain from resolution, physical to virtual toggles, and confined spaces (such as a surgeon in an operating room). Other industry and commercial applications are facilities security, CAD (Computer Aided Drafting) development, training, simulators, virtual tours, law enforcement, border patrol, auto industry, and the film industry.

REFERENCES:
1. Melzer, James E. "HMDs as enablers of situation awareness: the OODA loop and sense-making" SPIE 8383, 01 May 2012, <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1354291>

2. Fulton, Jack E. "Display technology gaps used with electro-optic sensors" SPIE 8042 13 May 2011, <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1265536>

3. Petty, Gregory J., Seals, Ean J., Fulton , Jack E. "Display challenges resulting from the use of wide field of view imaging devices" SPIE 8383 1 May 2012, <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1354298>

4. Nicholson, Gail M. "Alternatives to flat panel displays in vehicle turrets" SPIE. 8042 13 May 2011, <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1265517>

5. Warwick, Graham. "BAE Offers Slim fit HUD for Advanced Cockpits". Military.com. Aviation Week's DTI. 23 July 2012. 16 November 2012. <http://www.military.com/features/0,15240,247858,00.html>

6. Tam, Donna. "Pilot of the Future: U.S. Army gets wearable tech for the battlefield". CNET, News, Military Tech. 23 July 2012. 16 November 2012. <http://news.cnet.com/8301-13639_3-57468131-42/pilot-of-the-future-u.s-army-gets-wearable-tech-for-the-battlefield>

KEYWORDS: 360 degree display; Electro-Optics situational awareness display; high resolution wide field of view display; panoramic displays; flexible display; night vision display; high resolution wide field of view head mounted display; high resolution wide field of view helmet mounted display; high resolution WFOV display; high resolution wide field of view visor

N132-111 TITLE: Alternative Power Supply for Uninterruptible Power Supply (UPS) Systems

TECHNOLOGY AREAS: Ground/Sea Vehicles

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

OBJECTIVE: This topic seeks innovation to develop an alternative power supply for an Uninterruptible Power Supply (UPS) system that is capable of extended operational capacity, extended shelf life, and reduced life-cycle maintenance.

DESCRIPTION: The Navy is seeking innovation to increase power densities, increase endurance, and eliminate the need for additional fuel in UPS systems. Currently the best available system uses lead acid batteries (Ref 1).

The lead acid battery power supply for the US Navy UPS System only provides the maximum power required for 15 minutes and reduced power for up to 45 additional minutes. Power failures during catastrophic events currently cause shipboard communication to end after about 15-45 minutes, putting people and equipment at risk for survivability and additional damage.

An affordable alternative power supply with the same footprint and the capability to supply power for up to 24 hours is needed for shipboard operations. The technical challenges for a useful alternative power supply for shipboard UPS applications are the ability to resist degradation due to repeated cycling of the system, the ability to continue operation in the presence of salt and other ambient air contaminates, the ability to supply power within specified time constraints, and the ability to be easily recharged onsite. The current lead acid battery backup system has extensive maintenance requirements and poses a safety and health hazard (Ref 2). Eliminating lead acid batteries will reduce costs associated with hazardous waste handling requirements for maintenance and storage of the lead acid batteries

A significant acquisition priority is replacement of lead acid batteries with an advanced technology that is capable of providing longer full power operation of the shipboard internal communication system during a power outage, while also eliminating the need for hazardous waste handling of lead acid batteries. The goal is an alternative power supply that is a comparatively priced, high performance system that provides 5-50 kWh, 24 volt, 48 volt and 120 volt DC output for use in US Navy UPS systems that meets or exceeds all form, fit, and functional requirements of the current lead acid battery powered UPS system. Emerging technologies that may be able to effectively replace the lead acid battery UPS power supply could be new and improved battery technologies, fuel cell technologies, or hybrid combinations of each.

PHASE I: The company will develop concepts for an improved Alternative Power Supply for Uninterruptible Power Supply (UPS) Systems that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by analysis of system energy density, power density, size, weight, start-up times, anticipated maintenance requirements, and ability to withstand a shipboard environment. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype UPS power supply for evaluation. The prototype will be evaluated to determine its ability to meet the performance goals defined in the Phase II development plan and Navy requirements for UPS Systems. The small business will demonstrate proposed installation, maintenance, repair, and recharging methods. The company will develop a cost benefit analysis, perform testing and validation, and prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an UPS Systems according to the Phase II development plan for evaluation to determine its compatibility for Navy ships. The system for shipboard use will be installed and evaluated on a DDG-51 Class destroyer. 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: The potential for commercial application and dual use includes all commercial and military marine applications that use lead acid batteries within Uninterruptible Power Supply systems to provide power redundancy of vital electrical systems in the event of power failure. Cruise liners, commercial shipping companies, and the offshore oil and mineral industry could also benefit from this technology.

REFERENCES:
1. Chiang, Yet-Ming, "Building a Better Battery", Science, 10 December 2010: Vol. 330 no. 6010, pp. 1485-1486, http://li.mit.edu/Archive/Papers/10/Science-2010-Chiang-1485-6.pdf

2. Barsali, Stefano and Massimo Ceraolo, "Dynamical Models of Lead-Acid Batteries: Implementation Issues" IEEE Transactions on Energy Conversion, Vol. 17, No. 1, March 2002, http://ebookbrowse.com/dynamical-models-of-lead-acid-batteries-implementation-issues-pdf-d219112275

3. Additional reference for building a better battery is available at --
http://batteryuniversity.com/learn/article/whats_the_best_battery

KEYWORDS: replacing lead acid batteries; increasing power densities; improving uninterruptible power supply; alternate power supply for shipboard applications; improving battery chemistry to extend shelf-life; reduced battery maintenance

N132-112 TITLE: Ship Energy Use Monitoring and Analysis

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: This topic supports the Power & Energy Future Naval Capability (FNC).

OBJECTIVE: The objective is innovative shipboard energy use monitoring and analysis to quantify energy use by all ship systems and equipment.

DESCRIPTION: This topic proposes development of an energy monitoring and analysis tool meta-model to support all Navy stakeholders in understanding ship energy use. This meta-model will describe the analysis, construction and development of the frames, rules, constraints, models and theories applicable and useful for modeling Navy energy usage. This innovation will be used to develop a Shipboard Energy Use and Analysis system consisting of a shipboard component to capture energy use data interfacing with a shore-side analysis system.

The Secretary of the Navy has set a goal to provide half of the Navy's total energy consumption with alternative sources by 2020. The CNO policy pamphlet of October 2010, "A Navy Energy Vision for the 21st Century" identified a goal of reducing ship fuel consumption 15% by 2020 (Ref 2). Fundamental to achieving these goals is the understanding of how ships use energy. Currently no system exists to pull large quantities of data from classified sources, process this data into unclassified energy usage reports and metrics, and provide this data to multiple shipboard and shore-based stakeholders. This innovative software solution would be critical to helping the Navy understand, manage and track Maritime energy usage.

This product will provide the data and analysis tools to enable ship acquisition managers to make more accurate assessments of product improvements and technology insertions. Knowing the energy demand of existing ship systems, the acquisition manager would be able to more thoroughly assess the life cycle cost of such ship modifications. Further, this data and analyses can justify pursuing ship modifications that improve energy efficiency. Ultimately, improved energy efficiency increases the ship's mission capability .through increased range and time on station). Such data can also be used to substantiate the electrical load analysis of particular ships which is generally never verified. Understanding the true electrical loads on a ship is critical to evaluating the ship impact of adding new systems.

In order to meet energy reduction goals, the energy use of ship systems and equipment needs to be measured and calibrated to the ship's mission, ship's readiness condition, and ship's operational profile. Once data is collected and correlated, recommendations for operational policy changes, operational procedure changes, technology improvements or maintenance actions can be evaluated (Ref 1). Existing shipboard energy monitoring systems lack the ability to store, integrate, and assess shipboard energy use data. There is inadequate integration with other shipboard systems, and no capability to provide mission maintenance assessment. Commercial smart thermostats, such as 'Nest', provide a portion of this functionality, but only for residential heating and cooling systems (Ref 4). Industrial versions are available for buildings which expand control to lighting, but again fall short of full functionality. Maritime systems are being developed to meet new energy International Maritime Organization rules (Ref 5) that will meet a majority of the functionality. However, the maritime systems, for commercial and cruise ships, would need to be modified to include the unique warfare systems of naval platforms.

The innovation provided by this topic also will allow energy use predictions by allowing the user to vary the energy use of particular systems or equipment to help evaluate the benefits of technology improvements. Current technology assessments are performed with class standard information, which may or may not be current.

This product will provide the data and analysis tools to enable ship acquisition managers to make more accurate assessments of product improvements and technology insertions. Knowing the energy demand of existing ship systems will enable the acquisition manager to more thoroughly assess the life cycle costs of ship modifications. Understanding the true electrical loads on a ship is critical to evaluating the ship impact of adding new systems. Shipboard energy use analyses can justify pursuing modifications that improve energy efficiency. Ultimately, improved energy efficiency increases the ship's mission capability by enabling ships to travel further with the same fuel capacity, reduce fuel costs, and reduce their carbon footprint. Such data can also be used to substantiate the electrical load analysis of particular ships.

To reduce the amount of monitoring equipment required, it is envisioned that energy use surveys will be conducted on a statistically representative sample of ships within the same ship class. Establishing the appropriate set of ships to survey is critical to establishing a representative energy usage database (Ref 3).

Once the appropriate energy use data is collected and correlated to specific ship missions, it can be analyzed to determine how energy can be used more efficiently. The techniques developed under this topic will be used to analyze energy use across similar ships performing similar missions. The techniques will identify system and equipment operational variations. For example, one ship may operate with a particular system secured while another similar ship performing the same mission may run that system, even though it is not necessary for the mission. Currently, software does not exist that can store, integrate, and assess shipboard energy data. Although individual parts may exist, they are lacking in overall functionality: they do not provide a complete meta-model storage environment, do not allow themselves to be easily integrated with other systems, or provide a mission maintenance assessment of the optimum operating configuration and identify deviations to that configuration. The software, to be resident on the ship for real-time analysis and to be interfaced to a shore based system, will also compare the energy use of the same systems and equipment across similar ships to identify excessive energy use due possibly to a required maintenance action or inefficient setting. The shore-based system will provide a repository for the class data and allow analysis of the data on shore.

PHASE I: The company will develop a concept for a Shipboard Energy Monitoring and Analysis System that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides 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 a prototype Shipboard Energy Management and Analysis system for evaluation and conduct energy use surveys on a statistically representative sample of ships within the same ship class for evaluation of the software. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the Shipboard Energy Monitoring and Analysis System. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop the Shipboard Energy Monitoring and Analysis System according to the Phase II development plan for evaluation to determine its effectiveness in an operationally relevant environment. 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: This product has potential application across a variety of commercial sectors. The commercial shipping industry can take advantage of energy use analysis to determine the most cost-effective modes of ship operation. The data monitoring and storage elements of this product have application to many industrial scenarios where multiple systems or equipment are operating. The analysis portion of this product may need to be customized to a unique industry. However, any industry or government entity can use this product to establish energy use baselines enabling analyses aimed at reduction of energy use and operating costs.

REFERENCES:
1. Mabus, Ray; "Naval Energy A Strategic Approach"; Naval Energy Office, Office of the Secretary of the Navy, Washington, DC. October 2009; <http://www.onr.navy.mil/naval-energy-forum/~/media/5EFD428CFEB0412391CC321DCAF67138.ashx>

2. Roughhead, ADM Gary; "A Navy Energy Vision for the 21st Century", The Chief of Naval Operations, Washington, DC; October 2010. <http://greenfleet.dodlive.mil/files/2010/10/Navy-Energy-Vision-Oct-2010.pdf>

3. Eastlack, Edward; "The Future of Marine Propulsion: Gas Hybrid Power Plants", Kings Point, NY; May 2012; <http://www.maritime-executive.com/files/EM681_Thesis_E_Eastlack.pdf>

4. "Nest Learning Thermostat Efficiency Simulation: Update Using Data from First Three Months", Nest Labs, April 2012. <http://downloads.nest.com/efficiency_simulation_white_paper.pdf >

5. "Amendments to the Annex of the Protocol of 1997 to Amend the International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1078 relating thereto." 15 July 2011, International Maritime Organization, MEPC 62/24 Addendum 1, Annex 19. <http://treaties.un.org/doc/Publication/Cumulative%20Index/UNTS%20Volume%20No%202301-2350/cumindex.chrono.en.pdf>

6. Improving Maintenance Management Tools and Data Collection to Increase Surface Ship Fuel Efficiency by Rose Gaffney et al., https://www.navalengineers.org/SiteCollectionDocuments/2011%20Proceedings%20Documents/FMMS2011/Papers/Gaffney.pdf
(Added to topic on 5/15/13).

7. Structural Health Management in the NAVY by Ignacio Perez et al., http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA522795 (Added to topic on 5/15/13).

KEYWORDS: Shipboard energy use monitoring; ship systems energy use; ship system monitoring; energy use analysis; marine energy management; ship energy efficiency analysis.

N132-114 TITLE: Advanced Fiber Optic and Electrical Cable Diagnostics

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS 400F, Surface Combatants Program Office

OBJECTIVE: This topic seeks innovation to develop advanced diagnostics for shipboard fiber optic and electrical communication cable plants to decrease installation and troubleshooting cost and time.

DESCRIPTION: Navy ship overhauls and upgrades have proven to be a very cost effective means for providing warfighters with the advantages of the most state-of-the-art equipment and systems available. In almost all upgrades and alterations, the ship's cable plant undergoes a complete retrofit to support new communications, weapons, and sensor systems. The cable plant is the central nervous system of the ship, as all data and controls are routed through several terminal boxes, creating hundreds to thousands of discrete termination points. With such high connection counts, advancement is needed to allow efficient and effective means to test and debug the accuracy and integrity of the connection points within the many terminal boxes in the ship's cable plant.

During installation, the cables are routed manually through cableways and terminated with connectors that mate to the various component and system boxes. However, one end of the cables is often tied into terminal boxes, which allow the sub-channels of the cable to be split out to connect with a number of other cables within the network. These terminal boxes become very complex when the cable plant is completed and provide thousands of connection points. This topic focuses on improving the efficiency and quality of cable plant installations. (Ref 1).

Because so many cables tie to the terminal box and connect to other cables in the network, a problem with one of the cables can affect other cables in the network that are tied to the same terminal box. This interdependency exponentially increases the time and complexity of testing and debugging the cable plant. The goal of this effort is to develop a technology and process to reduce the time to test and debug shipboard terminal box installations by around 70% and reduce installation costs similarly.

The most troublesome problem is a ground fault where there is a short to ground on one of the cables (Ref 2). In these cases, the effort associated with identifying the root cause is extremely time-consuming and difficult due to the large number of cables that tie into the terminal box. It currently requires a trial and error approach to finding the issue because the cables share the same ground where they are tied together in the terminal box. The installers have to systematically isolate each cable to find the fault in the network (Ref 3). This effort can take several man-days to complete, has unknown and unexpected costs depending on the severity, and can delay the turn-over of the ship back to the Fleet for operation.

This topic seeks to develop an advanced diagnostic capability for shipboard fiber optic and electrical communication cable plants to decrease installation and troubleshooting cost and time, while enabling the use of automated troubleshooting to detect faults and improve overall system quality. Development of automated or semi-automated means for investigating installed cable plants to identify ground fault issues after connection to the terminal box will provide significant improvement in both time and cost over current techniques. The solution should not require disassembly of the installed cables from the terminal boxes as part of its process. Increasing efficiency and reducing labor hours required for ship alterations will reduce Total Ownership Costs (TOCs) for the Navy, while simultaneously increasing the quality and readiness of the platform. To increase the efficiency and quality of cable plant installations, development of portable tools and equipment for cable testing on the waterfront is required.

PHASE I: The company will develop concepts for efficient and automated testing and diagnostics of cable installations to identify ground faults after connection to terminal boxes within cable plants during and after cable installations. The company will analyze the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. The company will develop a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the conceptual approach developed in Phase I, and the Phase II development plan, the company will develop and demonstrate a prototype of required equipment and components for cable testing and diagnostics. The equipment and components for the automated cable testing and diagnostic system will be evaluated to determine if it meets the performance goals identified in the Phase II development plan. Evaluation results will be used to refine the prototype into an initial design that will meet for Navy use. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will support transition of the automated cable testing and diagnostic system to Navy use for ship upgrades, alterations, and construction activities. The system will be demonstrated in a qualified shipyard that currently performs naval ship cable installations. The Navy will evaluate the technology for effectiveness in an operational environment. 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: Any large equipment or structure that uses a high degree of electronics for control and communications could benefit from this technology. Examples of commercial applications that could benefit from an automated cable plant test and diagnostics system include commercial aircraft, oil platforms and rigs, and large power generation and utility plants.

REFERENCES:

1. Mishra, Ashim and Soni, Ashwani. “Leakage Detection Using Fiber Optics Distributed Temperature Sensing.” 6th Pipeline Technology Conference 2011. <http://www.pipeline-conference.com/sites/default/files/papers/Mishra.pdf>

2. Woodward, W.R. “Detecting and measuring interconnection reflectance in fiber optic cable assemblies with a video microscope.” Avionics, Fiber-Optics, and Photonics Technology Conference, 2008 IEEE. <http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4653188&tag=1>

3. Rodriguez-Valdez, C.D. “Method for Line-Ground Fault Detection in Variable Frequency Drives.” Petroleum and Chemical Industry Conference (PCIC), 2011. <http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6085882&tag=1>

KEYWORDS: cable plant; Automated Test Equipment (ATE); fiber optic cable faults; electrical communication cable faults; shipboard terminal box; shipboard cable plants

N132-115 TITLE: Android Security Toolkit

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: PMS450, VIRGINIA Class Submarine 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: This topic seeks innovation to develop a library of hardened and tested modules to fortify the security weaknesses of the Android Operating System (OS) and its related mobile applications.

DESCRIPTION: Technologies affected by this topic are commercial in nature and are focused on reducing the impact of short life cycles for commercial mobile devices. Personal Electronic Devices (PED) often has a shelf life of one year or less, and once they have reached end-of-life, they cannot be procured in a reasonable manner. Additionally, the Android operating system, as well as commercially developed applications, is refreshed at a high rate in order to increase hardware performance. There is tremendous opportunity to leverage the vast commercial investment in hardware and software development. By following a refresh cycle similar to that in commercial practice, the Navy will be able to keep pace with industry and use the vast improvements that are being delivered to commercial customers. However, there are logistical challenges associated with moving towards commercial hardware and software based PEDs. A major constraint is the security concerns of the Android OS and its applications. In order to facilitate a wide- spread deployment and use of commercial PEDs, these security vulnerabilities must be addressed (Ref 2). A secure Android-based mobile platform would allow the Navy to capitalize on commercial industry’s investment in Android-based hardware and software applications within the Non-Tactical arena.

Commercially available hardware based technologies employed to aid in securing Android-based mobile platforms are closed and proprietary in nature. They often rely upon unsophisticated brute force attempts to lock-down mobile devices in order to prevent rogue code being executed on the device or unapproved people for accessing data. However, such methodologies greatly impact the device’s utility and makes it extremely difficult for the sailor to use one device to support multiple mission objectives. Emerging software-based security technologies are flawed in similar ways and also artificially and sub-optimally prevent device utility.

The tools and methodologies developed under this topic should support users in their day-to-day activities. The goal of this topic is to reduce the current workload of the Warfighter, rather than create new functionality or capabilities. This topic is focused on novel or innovative methods that will alleviate Android OS and application security concerns and serve as enabling technology for deploying modern Android devices in a DOD environment. While the technology is highly applicable to VIRGINIA Class Submarines, it will also apply to other modern Navy shipboard platforms.

The Navy seeks innovation in kernel hardening (Ref 1), process monitoring, and application management to augment the security of the Android-based PED and its applications by providing reusable and distributable software libraries that address one or more specific security concerns, and can be leveraged by third-party developers to create new applications. Suggested areas of research include, but are not limited to; data encryption (at-rest and in-motion), location awareness, remote device management, peer-to-peer networking and network traffic monitoring, remote locking, application installation restriction, and blocking of unauthorized access (Ref 2). The specific goal is to provide a set of security libraries that will allow multiple Navy programs to address their specific security needs while remaining interoperable with security requirements of other programs that may use a common hardware device.

PHASE I: The company will develop concepts for a library of hardened library modules to fortify the weaknesses of the Android OS and mobile applications developed for Android-base devices. Concepts must address the known security vulnerabilities in Android OS. The company will provide recommended security focus points. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by conceptual security module library testing and analytical modeling. The company will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop security module libraries for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for this topic. Performance will be demonstrated through prototype evaluation in which compatibility with the Android OS and suitable applications must be demonstrated. Evaluation results will be used to refine the prototype into a design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an Android Security Toolkit for evaluation to determine its effectiveness in an operationally relevant environment. 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: While products envisioned by this topic have broad applicability outside of the Navy, and many of the security layers might be commercially available, the exact deployment and operation of the products for the Navy's implementation must be kept unique. However, aspects of the Android OS security toolkit can be used commercially and would be useful to any organization that requires the use of mobile COTS communication devices that require a high degree of information security. Private sector interest may reside in business sensitive, personal information integrity, and financial operations.

REFERENCES:
1. Kenyon, Henry; "Army program for secure Android kernel technology gets attention of NSA and White House;" Defense Systems; 11 Oct 2011; <http://defensesystems.com/articles/2011/10/11/ausa-secure-android-kernel-technology.aspx>

2. Hernon, Mike; 500000 Apps (and Nothin' On), Will Mobile Apps Get Serious in 2011?; Department of the Navy Chief Information Officer; 21 Jan 2011; <http://www.doncio.navy.mil/ContentView.aspx?ID=2094>

KEYWORDS: personal electronic devices in a secure environment; peer to peer networking; remote locking of PEDs; software for PEDs; hardened application development; android operating system; remote PED management

N132-116 TITLE: High Performance, Low Phase Noise Semiconductor Lasers

This topic has been removed from the solicitation.

N132-117 TITLE: Unmanned Surface Vehicle (USV) Tow Point Surge Reduction for Towed Body Stabilization

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS406, Unmanned Maritime Systems Program Office, Unmanned Influence Sweep

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: This topic seeks innovation that mitigates tow point surge fluctuations on a Fleet Class Unmanned Surface Vehicle to provide a more stable tow for a sonar towed body.

DESCRIPTION: The Navy (PMS 406, Unmanned Maritime Systems) intends to add a minehunting capability to the USV in the Unmanned Influence Sweep System (UISS) (Ref 1). This addition will provide USV Increment 2 with minehunting, in addition to mine sweeping, capability. The USV Increment 2 towed minehunting system is currently expected to be the AN/AQS-20A sonar (Ref 2). As described below, USV tow point motions can negatively affect towed sonar performance in a seaway, and a system that can mitigate the tow point disturbances is needed to meet minehunting system performance requirements.

Minehunting sonars housed in towed bodies require stability in order to achieve the required sonar performance. Towed body motions can result in degraded sonar imagery, leading to potentially missed detections, and difficulty in accurate mine classification. Towed body motions can also reduce area coverage rates because sonar swath overlap must be increased between tracks to maintain an adequate probability of detection. Due to their size, Fleet Class USVs (Ref 3) operating in the mission-required environment through Sea State 3 can have motions that will negatively impact towed body motions, and therefore, the performance of towed sonars. The primary input to towed body motions occurs at the tow point on the USV. Heave (vertical) and sway (lateral) motions are generally damped out by the cable catenary, but surge motions typically are nearly in line with the cable at the tow point. These surge motions can translate with high efficiency directly down the cable to the towed body as fluctuations in the cable tension. Depending on the geometry of the towed body and the depth at which it is operating, the cable tension fluctuations can translate to a disturbance of the towed body pitch. In addition, due to hydrodynamics of the towed body, pitch disturbances can also translate into yaw and roll disturbances. The active control system of the towed body will work to minimize the disturbances, but some motion will always occur, and, if the disturbances are large enough, the controller can become saturated, leading to larger motions. Theoretical predictions of boat motions are described (Ref 4) and the translation of these motions to the towed body (Ref 5).

Towed body testing to date with a surrogate UISS USV has demonstrated possible challenges in maintaining towed body sonar steadiness in increased sea states due to surge motions being translated from the USV to the towed body. During these periods of unsteadiness, the sonar images may become degraded, impacting the Minehunting Mission. Heave (vertical) and sway (lateral) motions are generally damped out by the cable catenary, but surge motions are not. The active controller in the tow tries to compensate motions induced by input from the tow cable, but the compensation may not be fully successful in all minehunting modes.

Current state of the art cable tension and motion compensation systems are larger systems found on larger ships and are unsuitable for application to USVs with their limited footprint and payload capacities. Advertised commercially available USV towed sonar bodies do not provide the full capabilities of the AN/AQS-20A.

The Navy is seeking an innovation that will mitigate the tow point surge motions of the USV, allowing full performance of the towed sonar. The system must be of sufficiently small size and weight to fit in the limited aft deck area of a Fleet Class USV. The system may include adaptive dynamic control of the cable scope, adaptive control of

USV speed, a dedicated mechanism, or a combination of those and other innovative solutions. Reference 6 provides additional information on technical requirements of the system. Proposed modifications to, or new designs for, craft hull-forms or towed bodies will NOT be considered.

The system is expected to reduce operational cost by improving minehunting performance. Specifically, a more stable tow body will have a wider effective path-width, thus improving hunting efficiency by increasing the time on station and area covered in a sortie for a given fuel load. Increased time on station will also have the benefit of reducing sortie rates, thus reducing the USV's host platform manning requirements by reducing the number of sortie turnarounds required.

PHASE I: The company will develop concepts for a tow point surge reduction system that meet the objectives described above. The company will demonstrate the feasibility of the concepts in meeting the needs described above and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be demonstrated by analysis, modeling, and/or simulation and documented in a final report. The company will provide a Phase II development plan with performance goals and key technical milestones that address surge reduction performance, space, and weight, and technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a surge reduction prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the tow point surge reduction system. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including various seaway conditions. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a tow point surge reduction system for evaluation to determine its effectiveness in an operationally relevant environment. 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: The technology developed under this topic will have applications in various areas of undersea exploration where USV towing sonars are or can be used and high fidelity sonar images are desired. Such fields would include environmental remediation and underwater archeology.

REFERENCES:

1. "Unmanned Influence Sweep System (UISS) Fact Sheet." Department of the Navy Research, Development, and Acquisition Website. Accessed 02 August 2012. <https://acquisition.navy.mil/rda/home/organizations/peos_drpms/peo_lcs/pms_406>

2. "AN/AQS-20A Minehunting Sonar System." Department of the Navy Research, Development, and Acquisition Website. Accessed 4 October 2012. <http://acquisition.navy.mil/rda/home/organizations/peos_drpms/peo_lcs/pms_403>

3. "The Navy Unmanned Surface Vehicle (USV) Master Plan." 23 July 2007. U.S. Navy. Accessed 29 February 2012. <http://www.navy.mil/navydata/technology/usvmppr.pdf>

4. Martin, Milton. "Theoretical Prediction of Motions of High Speed Planing Boats in Waves." April 1976. David W. Taylor Naval Ship Research and Development Center. Accessed 24 September. 2012. <http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA031847>

5. Patton, Kirk T. and Schram, Jeffrey W. "Equations of Motion for a Towed Body Moving in a Vertical Plane." Defense Technical Information Center (DTIC), 15 June 1996. Accessed 02 August 2012. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=AD0635214

6. "Additional Guidance for USV Tow Point Surge Reduction for Towed Body Stabilization." (Document to be provided on SITIS after the Solicitation pre-release.)

7. Images of Winches provided by TPOC, 2 pages, uploaded in SITIS 6/12/13.

KEYWORDS: Towed Body Surge Reduction; Unmanned Surface Vehicle; Towed Body Stability; Minehunting Sonar; Unmanned Influence Sweep System; Towed Body Motion Compensation

N132-118 TITLE: Electronic Circuit Anti-Tamper Conformal Coating

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 1.0, Integrated Combat 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: The objective is to develop an innovative conformal coating for integrated circuits that achieves a higher anti-tamper (AT) level of protection without compromising circuit performance.

DESCRIPTION: Department of Defense (DoD) weapon system managers identify critical program information (CPI) that is closely held. When CPI is found in the software that resides within the weapon system's components then it is referred to as critical technology (CT). CT found in weapon systems used by the United States Navy (USN) and allies (through foreign military sales) is required to be protected from theft, exploitation or unintentional transfer through the implementation of Anti-Tamper (AT) technologies. AT technology is technology that prevents or delays exploitation of United States (U.S.) weapon system CT (ref 1). The use of AT technologies prevents or slows an adversary's attack on a U.S. weapon system by increasing the time it takes for them to reverse engineer and design a counter to the system. This enables the weapon system's capability advantage to remain intact for a longer period of time improving performance and capability.

Current weapon systems computers containing CT use hardware and software techniques to protect against reverse engineering. Today CT is protected by software encryption or containers that prevent physical access to the equipment where the CT is stored. These solutions are inadequate to counter recent reverse engineering advances such as most indirect electronic probing attacks. Modern protective coatings used in industry are unable to defend against these recent advances without affecting circuit performance. An improvement to the current AT methods is sought to physically protect the CT at the board or individual component level (such as a circuit card or microchip) through the use of a conformal coating. The conformal coating would be applied to the circuit board or to the discrete components found on the board.

Ideally this coating would not be detectable by visual means and would not affect performance of the electronic device or board that it covers. A significant technical hurdle is overcoming the heat dissipation requirements of the affected electronic circuitry (ref 2). Most coatings designed for circuit board application have heat transfer characteristics that negatively impact performance of the encased devices.

The coating will need to meet certain parameters. It must be able to detect reverse engineering activities. This includes direct mechanical and electronic probing activities that are intended to reveal circuit designs. Examples of these techniques include x-ray, scanning electron microscopy and focused electron and ion beam utilization (ref 3). Indirect reverse engineering attacks also need to be prevented. An example is a simple power analysis; in which a device's low-level self-radiated energy is sensed and analyzed, thus giving insight to the operation of that electronic component. The conformal coating will block this type of attack. It must also be capable of shielding, hiding, or isolating the board's radiated RF energy (ref 4). Upon detection of a tamper event the coating will be capable of sending an alert signal to a monitoring electronic component. The coating will be capable of attaining all required parameters without the need for an external power supply.

Current industrial printed circuit board coatings in use today include silicone- , urethane- and acrylic-based films (ref 5). These films impede adequate heat transfer making them undesirable for the uses envisioned for this topic. They are also incapable of detecting reverse engineering activities. Technology areas of interest would be in recent advances of nano-structures or related material deposition techniques.

With this solution in-place, critical USN warfighting advantages and capabilities are preserved for longer periods of time because the adversary is delayed or prevented from developing successful defenses. The desired solution will not diminish the performance of the electronics; so indirectly, performance is improved since other solutions would likely reduce performance of a weapon system.

PHASE I: The company will develop a feasibility concept for an anti-tamper conformal coating of electronic circuits that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established through material testing and analytical modeling. The small business will provide a Phase II development plan that must address technical risk reduction and provides 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 a prototype for evaluation. The prototype will be evaluated to determine its capability to meet the performance goals defined in the Phase II development plan. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an Electronic Circuit Anti-Tamper Conformal Coating according to the Phase II development plan for evaluation to determine its effectiveness in an operationally relevant environment. 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: Electronic systems throughout DoD and the commercial sector frequently process classified, sensitive, or proprietary information. Consequently private industry also has an interest in protecting its electronic data from tampering activities. Banking, research & development, and computer manufacturing are just some examples of where this technology would be used in the commercial sector.

REFERENCES:

1. “Defense Acquisition Guidebook: Section 8.5.3.” Defense Acquisition University. 2012. Department of Defense. 19 September 2012 http://at.dod.mil/docs/DefenseAcquisitionGuidebook.pdf.

2. Licari, James J. and Hughes, Laura A. Handbook of Polymer Coatings for Electronics: Chemistry, Technology and Applications; Second Edition. Park Ridge NY: William Andrew Publishing, LLC, 1990.

3. Utke, Ivo; Moshkalev, Stanislav & Russell, Phillip; Editors. Nanofabrication Using Focused Ion and Electron Beams: Principles and Applications. New York: Oxford University Press, 2012.

4. Mangard, Stefan; Oswald, Elisabeth & Popp, Thomas. Power Analysis Attacks: Revealing the Secrets of Smart Cards. New York: Springer Science+Business Media, LLC, 2012.

5. Horrocks, Hal. "Conformal Coating Removal Techniques." NEPCON West. 1997. 3 December 2012 <http://www.paryleneengineering.com/pdf/conformal_coating_removal_techiques.pdf>.

KEYWORDS: Anti-Tamper Circuits; Conformal Coatings for integrated circuits; Reverse Engineering of electronics; Nano-structured Coatings; Coating Deposition Techniques; Critical Program Information in software

N132-119 TITLE: Graphical Processing Unit (GPU) Software to Accelerate Underwater Acoustic Autonomous Modeling and Processing.

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS485, Maritime Surveillance Systems, Distributed Sensors Group – Shallow

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: This topic seeks innovation to develop a massively parallel architecture for autonomous acoustic processing to increase significantly the processing capability for new Navy autonomous underwater sensing systems.

DESCRIPTION: The Navy seeks to reduce operating and maintenance costs of high-endurance autonomous platforms, which have tremendous potential for persistent monitoring of surface and subsurface acoustic targets. The Navy already has the capability of collecting large volumes of passive acoustic data; however, the data is not analyzed until weeks after collection.

Today, tactical and strategic capabilities would benefit not only from immediate processing, classification, and reporting capabilities, but also from reducing the cost of highly skilled manpower associated with evaluation of passive acoustic data. To adequately process low-frequency passive acoustic data in a way that matches the actual three-dimensional (3-D) physical environment, past processing methods either relied on high- power, large footprint hardware systems or gave up physical resolution to enable lower power, smaller footprint distributed-type systems. Various hardware architectures have been used to maximize computations per watt, including field-programmable gate arrays (FPGAs) ("reconfigurable computing"), Digital Signal Processing (DSP) chips, Application Specific Integrated Circuits (ASIC), and hybrids of each. Such architectures often present implementation challenges, leading to high cost of initial implementation and limited flexibility to add incremental capabilities.

Parallel processing is well known to be a practical way to optimize GFLOPs/watt, (G for Giga or billions; FLOPs for floating point operations per second), but requires innovative algorithmic approaches to fully exploit the new parallel architectures, particularly in orchestrating the movement of data through a hierarchy of large, slow, off-chip memory to small, fast, on-chip memory (see Ref. 1). Programming Graphical Processing Units (GPUs) for scientific computations used to require coding in graphic shader languages (see Ref. 2 for an early example of a parabolic equation model, implemented with shaders). However, GPUs developed to meet the needs of the Personal Computer (PC) gaming world have emerged as a disruptive technology in high performance computing. These include the advent of new high-level language software interfaces to GPU hardware, such as Compute Unified Device Architecture (CUDA) or Open Computing Language (OpenCL) (see Refs 3 and 4).

Massively Parallel Processing is a multiprocessing architecture that uses many processors and a different programming paradigm than the common symmetric multiprocessing (SMP) found in today's computer systems. Today's GPUs are massively parallel computers that are ubiquitous in modestly priced desktops, laptops, and even mobile phones and tablets. This greatly increased computing power offers the potential for realizing innovative new capabilities in Navy underwater acoustic modeling and processing, previously infeasible due to the limitations of having only a few processing cores to commit to the task. To realize this potential will require development of a new multiprocessing architecture and creative adaptation of existing algorithms (acoustic signal processing and automation or acoustic modeling) to take advantage of the distinct and evolving software and hardware architecture being developed for GPUs.

This effort seeks to significantly increase (by a factor of at least 5) the amount of computations performed, while maintaining or decreasing the power requirement as compared to conventional processing hardware for either acoustic signal processing and automation or acoustic performance prediction modeling. Examples of such applications that are pushing acoustic signal processing and automation include adaptive beam forming, environmentally adaptive signal processing, broader frequency bandwidths, and multiple detection surfaces, matched field processing, and increased frequency resolution. Similarly, such applications that are pushing the acoustic performance prediction modeling envelope include broader frequency bandwidths, higher and lower frequencies, range-dependence, 3D waveguides (bathymetric canyons, internal waves), multi-static reverberation, platform and scattering surface motion. All of these phenomena have a significant impact on sonar system performance (Ref. 5).

The Navy is seeking innovative multiprocessor architectures and processing that is enabled by the increased computational power provided by GPUs. The specific effort would be focused on developing a massively parallel processing architecture and then adapting acoustic signal processing and automation or acoustic performance prediction modeling algorithms for this architecture and then implementing them to run on GPU hardware. Goals are to 1) accelerate the selected application by at least 5-times (unit-processor execution time/parallel execution time); and 2) demonstrate the scalability (the ability to maintain performance gain when system and problem size increase) of the solution.

PHASE I: The company will develop concepts for autonomous acoustic signal processing for contact classification or acoustic performance prediction modeling that exploits the parallelism provided by GPUs. The company will develop the concepts for functional and physical implementation in multiprocessor architectures using one or more Commercial-of-the-Shelf (COTS) GPUs. Feasibility of this architecture to meet the technical requirements listed previously will be verified via analysis and modeling. The company will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype autonomous acoustic processing system implemented in a multiprocessor architecture using one or more Commercial-of-the-Shelf (COTS) GPUs identified in Phase I. The company will demonstrate it with Government furnished data. The company will evaluate the system to determine its capability to meet the performance goals defined in the Phase II development plan. The company will also prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: In Phase III, the company will support transitioning the technology to Navy use. The company will continue to refine the GPU processing suite and algorithms for evaluation in an operationally relevant environment. Specifically, the prototype developed in Phase II will be integrated with a suitable surveillance sonar system and used in a proof-of-concept test to determine overall systems effectiveness including power consumption, form-factor, reliability, and persistence.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Many of the acoustic processing tasks that will be successfully accelerated on GPUs through this SBIR effort will find use in the commercial sector in physics based modeling, gaming theory, and visual rendering.

REFERENCES:
1. Kirk, David and Hwu, Wen-mei. Programming Massively Parallel Processors: A Hands-on Approach. Burlington, MA: Morgan Kaufmann Publishers, 2010. http://laurel.datsi.fi.upm.es/_media/proyectos/gopac/programming_massively_parallel_processors.pdf

2. Gunderson, Steinar. "GPUwave." 19 Jan. 2007. 13 Nov. 2012. <http://gpuwave.sesse.net/>.

3. “NVIDIA CUDA Zone”. NVIDIA Corporation. 13 Nov. 2012. <http://developer.nvidia.com/category/zone/cuda-zone>.

4. “OpenCL – the open standard for parallel programming of heterogeneous systems”. Khronos Group: Connecting Software to Silicon. Khronos Group. 13 Nov. 2012. <http://www.khronos.org/opencl>.

5. Jensen, Finn; Kuperman, William; Porter, Michael; and Schmidt, Henrik. Computational Ocean Acoustics, Second Edition. New York, NY: Springer Science and Business Media, June 14, 2011.

KEYWORDS: Graphical Processing Unit; passive acoustic processing; parallel processing; field-programmable gate arrays; OpenCL; acoustic performance predictions; bathymetric canyons

N132-120 TITLE: Advanced Littoral Combat Ship Common Mission Module Handling Device

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS501, Seaframe Construction

OBJECTIVE: The Navy seeks innovation to develop a shipboard module handling device compatible with Littoral Combat Ship (LCS) Mission Modules and common to all LCS configurations.

DESCRIPTION: Navy Littoral Combat Ships (LCS) are lightweight high-speed vessels designed to perform a variety of missions, currently including Mine Countermeasures (MCM), Surface Warfare (SUW), and Anti-submarine Warfare (ASW). Reference (1), slide 4, provides a graphic representation of the following description of LCS Mission Packages and Mission Modules. An LCS Mission Packages (MP) is designed to execute a specific ship mission, such as MCM. A Mission Package includes multiple Mission Modules that, together, constitute the equipment necessary to perform the specific mission. All Mission Packages consist of several support Modules that are International Organization for Standards (ISO) twenty-foot equivalent unit (TEU) containers or flat racks, ISO bases without walls or top. A Mission Package can also consist of off-board air vehicles; and the Navy is seeking innovation to develop an advanced mission module handling device for LCS seaframes to move off-board underwater or surface sea vehicle modules when they are onboard the LCS seaframes

Mission Modules are brought on board an LCS seaframe prior to deployment to equip the ship for a specific mission. The handling and movement of modules on a seaframe can occur both in port and at sea. Safe, efficient, and timely movement of Mission Modules is critical to mission objectives.
Current LCS Seaframes use three types of equipment to move off-board sea vehicles and to support Mission Modules shipboard, with no commonality between the two seaframe designs (Freedom and Independence variants). The current equipment, selected to be compatible with specific seaframe designs and features, are corner casters, used on the Freedom variant; overhead gantry crane, used on the Freedom variant; and straddle carrier, used on the Independence variant. These technologies do not provide a Module handling system common to both seaframe variants and adaptable to handling a variety of Modules. In addition, each of these pieces of equipment has limitations that bear on its usefulness to handle modules. The limitations are in areas such as omni-directionality of movement, side and height clearances, and deck-point loading. Reference 2 identifies similar limitations in deck point loading and omni-directional capability for Navy-wide cargo movement on board ship, indicating that the desired device potentially has application beyond the LCS and that no commercially available device is presently available.

Reference 3 shows the three pieces of current Mission Module handling equipment and their applications and limitations. The reference also contains additional information on the development of an advanced Module handling system solicited by this topic.

Supporting three separate systems that perform essentially one function is not cost effective. The use of multiple types of Mission Module handling equipment increases crew training requirements and logistic support costs and contributes to overall ship weight. Meeting weight requirements is a significant challenge for LCS seaframes. Moreover, the variety establishes each piece of equipment as a critical failure point since there is no redundancy. If a piece of equipment fails, Modules cannot be moved. A single, versatile Module handling device common to both seaframes could replace the current equipment. A seaframe either could carry two devices or, if developed to be easily and quickly repaired, a store of spare parts.

The Navy seeks innovation for an affordable, easily maintained, lightweight Mission Module handling device that can be used, with minimal staffing, on either seaframe variant to perform the functions described in the next paragraph, which are presently handled by the three pieces of equipment. Reference 3 provides the desired objectives for the device. Reference 4 provides the current requirements for Module handling which can be used for information. However, the design of the desired device should not be restricted by these requirements.

In port, the device will move Modules into place on an LCS once they are loaded on the ship. At sea, the device will move Modules into position so they can accomplish their mission and move them back into place when the mission is completed. At-sea handling presently applies to offboard sea vehicles, which must be moved into position to be launched and moved back to their lock-down positions after retrieval. (Launch and retrieval capabilities are not within the scope of the desired device, and proposals for such equipment will not be considered under this topic.) ISO support Modules are currently not moved at sea. For both seaframe variants, the deck interface to lock both off-board sea vehicle Modules and ISO support Modules into place is designed to ISO twist-lock standards. This common deck interface provides a good basis for a common handling device. The device should be compatible with commercial ISO architecture and meet applicable Navy shipboard material requirements; for example, shock, environmental, and fire requirements. Innovation is needed to develop a remotely controlled, lightweight, affordable device capable of omni-directional movement of a Module, of spreading load across the deck while maintaining load security in sea-states, within the constraints imposed by competing requirements for module clearances, deck load, maneuverability, size and weight, and manning. The design should allow for the handling of a variety of shapes weighing up to 12,500 kg accounting for future Modules as yet unspecified.

PHASE I: The company will develop a concept for an advanced Mission Module handling device common to both LCS seaframes. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the proposed handling device can be feasibly developed into a cost effective, useful product for the Navy. Feasibility will be established by analytical modeling, establishing the suitability of the materials proposed for ultimate fabrication of the device, and cost analysis. The small business will provide a Phase II development plan that addresses technical risk reduction and provides 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 a prototype Mission Module handling device for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy objectives for the handling device. System performance will be demonstrated through prototype evaluation in scenarios based on actual shipboard configurations and using equipment representative of full or near full scale Mission Modules. In addition, analytical methods maybe used to extrapolate performance across entire range of operating parameters. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a Mission Module handling device according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. 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: The Mission Module handling device would have applicability in the commercial shipping industry, due to its lightweight and compatibility with ISO commercial standards, which would facilitate handling of ISO containers in austere locations. In terms of other potential markets beyond the Navy, it should be applicable to other Department of Defense organizations such as the Army and Marine Corps that use ISO containers in austere locations.

REFERENCES:
1. Whitfield, Cecil; Volkert, Richard; Jackson, Carly. “Navy Warfare Centers as Lead System Integrators: Lessons Learned from Mission Module Development.” 13th Annual NDIA Systems Engineering Conference, 27 October 2010. <http://www.dtic.mil/ndia/2010systemengr/WednesdayTrack6_11445Volkert.pdf downloaded 15Apr12>

2. “Technology Roadmap Meeting the Shipboard Internal Cargo Movement Challenge Consensus Recommendations of the U.S. Shipbuilding Industry.” National Shipbuilding Research Program. NSRP Report #AMT-RG01112-4001. Sections 5.1.15 and 5.1.19. January, 2004. Accessed 5 October 2012. <http://seabasing.nsrp.org/documents/Technology_Roadmap.pdf >

3. "Information Applicable to the Development of Advanced Littoral Combat Ship Mission Module Handling Device." (Not publicly available at this time as of 5/9/13.)

4. "Overview of Interface Control Document (ICD) for Littoral Combat Ship (LCS) Flight Zero Reconfigurable Mission Systems," 11 May 2006, 69 pages. (Reference 4 uploaded in SITIS on 5/9/13).

KEYWORDS: Littoral Combat Ship; Mission Modules; Twenty-Foot Equivalent (TEU) ISO container; shipboard cargo handling; remotely controlled handling system; offboard sea vehicles

N132-121 TITLE: Aerodynamic Dome Manufacturing Cost Reduction

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA 259 AIM-9X

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: Improve the process of manufacturing hard ceramic infrared-transmitting domes with aerodynamic shapes such as a tangent ogive with a precise optical figure to reduce manufacturing cost and time.

DESCRIPTION: Aerodynamic infrared-transmitting domes reduce drag and increase the ability of a missile to survive flight through rain. The goal of this project is to improve precision optical manufacturing processes to reduce the cost and time of manufacturing such domes. Proposals might address the processes of making dome blanks, optical fabrication, metrology, or any combination of these activities.

A generic aerodynamic dome shape is a tangent ogive with a base diameter of 125 mm, a height of 175 mm, and a thickness of 3 mm. Actual shapes will be chosen by mutual agreement with the Government. Finished domes are expected to have a root-mean-square transmitted wavefront error of 200 nm or less. The baseline material is infrared-transparent polycrystalline alumina. Other hard ceramic materials could be selected by mutual agreement with the Government.

PHASE I: Evaluate approaches to reduce dome manufacturing cost and time and increase accuracy of optical figure. Demonstrate proof of principle of proposed approach and estimate how much time or cost would be reduced when the process is fully implemented.

PHASE II: Refine and implement manufacturing processes. In the case of dome blank fabrication or optical fabrication, demonstrate production of 4 domes by the improved procedure. If the effort focuses on metrology, demonstrate reduction in measurement time and/or improved accuracy in metrology. Demonstrate suitable feedback of metrology into iterative figure correction of an aerodynamic dome.

PHASE III: Implement manufacturing or metrology processes for commercial production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Processes developed for aerodynamic dome manufacturing have potential to reduce the cost of manufacturing aspheric optics for civilian and space applications.

REFERENCES:
1. M. V. Parish, M. R. Pascucci, N. Corbin,, B. Puputti, G. Chery, and J. Small, "Transparent Ceramics for Demanding Optical Applications," Proc. SPIE 2011, Volume 8016, paper 80160B.

2. J. D. Nelson, A. Gould, D. Dworzanski, C. Klinger, B. Wiederhold, and M. Mandina, "Rapid Optical manufacturing of Hard Ceramic Conformal Windows and Domes," Proc. SPIE 2011, Volume 8016, paper 80160O.

3. S. Bambrick, M. Bechtold, S. DeFisher, and D. Mohring, “Ogive and Free-Form Polishing with UltraForm Finishing,” Proc. SPIE 2011, Volume 8016, paper 80160P.

4. S. DeFisher, M. Bechtold, and D. Mohring, “A Non-Contact Surface Measurement System for Freeform and Conformal Optics,” Proc. SPIE 2011, Volume 8016, paper 80160W.

5. M. Gutin, O. Gutin, X.-M. Wang, and D. Ehlinger, “Interferometric Tomography – A New Tool for Metrology on Conformal Optics,” Proc. SPIE 2011, Volume 8016, paper 80160X.

KEYWORDS: aerodynamic dome; optical fabrication; metrology; ceramic fabrication; aspheric optics; infrared dome

N132-122 TITLE: <u>High Precision Conformal Sensor Window</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS)

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: Improve the process of manufacturing conformal sensor windows to achieve visible (not just infrared) optical tolerances.

DESCRIPTION: Electro-optic sensor windows that conform to the local shape of an airframe are desirable for future aircraft and missiles. Conformal shapes might have no symmetry or just a plane of symmetry, depending on their location. Durable, multispectral materials such as spinel are candidates for conformal windows. The size and curvature of a window will be limited by the availability and cost of a suitable blank.

The goal of this project is to improve the precision of the optical manufacturing processes to provide windows that meet visible optical tolerances in addition to infrared optical tolerances. For example, a tenth-wavelength root-mean-square transmitted wavefront error corresponds to a precision of 300 nanometers for infrared operation, but only 60 nanometers for visible operation. Tolerances become even tighter for high off-normal angles of incidence. Proposals might address precision optical fabrication and/or metrology. Metrology solutions capable of measuring objects whose two surfaces deviate more than 5 degrees from being parallel are particularly solicited.

A generic conformal window is a toroid with a radius of curvature R in one direction and a radius of curvature 2R in the orthogonal direction. The thickest practical blank material determines the maximum curvature that can be obtained in a demonstration window. Designs with other profiles, such as a parabolic cross section and varying curvature along the perpendicular axis might be provided for demonstrating the capability to make complex shapes.

PHASE I: Demonstrate proof of principle of the proposed approach to make a toroidal window with visible optical tolerances. A fused silica toroid with a thickness of 5 mm, footprint of 100 mm x 100 mm and orthogonal radii of curvature of 500 and 250 mm is a candidate demonstration shape. Other shapes and other materials may be proposed. The target root-mean-square wavefront error measured at normal incidence is one tenth wavelength measured at 0.633 microns over an 85% clear aperture area. Proposals may address fabrication (including metrology) or just metrology. A fabrication proposal should state what metrology will be used in Phase I. A metrology proposal should state what artifacts will be used to validate the metrology. Metrology solutions capable of measuring surfaces deviating more than 5 degrees from being parallel are particularly solicited.

PHASE II: Demonstrate a conformal window(s) made of spinel with a footprint of at least 150 x 150 mm and thickness of 5 mm. The shape will be chosen by mutual agreement with the Government. The threshold target root-mean-square wavefront error measured at normal incidence is one tenth wavelength measured at 0.633 microns, with one twentieth wavelength being a stretch goal.

PHASE III: Implement manufacturing and/or metrology processes for commercial production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Processes developed for conformal window manufacturing have potential to reduce the cost and widen the scope of manufacturing precision aspheric optics for civilian and space applications.

REFERENCES:

1. S. Bambrick, M. Bechtold, S. DeFisher, and D. Mohring, "Ogive and Free-Form Polishing with UltraForm Finishing," Proc. SPIE 2011, Volume 8016, paper 80160P.

2. J. D. Nelson, A. Gould, D. Dworzanski, C. Klinger,, B. Wiederhold, and M. Mandina, "Rapid Optical Manufacturing of Hard Ceramic Conformal Windows and Domes," Proc. SPIE 2011, Volume 8016, paper 80160O.

3. Removed.

4. M. Gutin, O. Gutin, X.-M. Wang, and D. Ehlinger, "Interferometric Tomography – A New Tool for Metrology on Conformal Optics," Proc. SPIE 2011, Volume 8016, paper 80160X.

5. http://www.imo.org/ourwork/environment/pollutionprevention/airpollution/documents/technical%20and%20operational%20measures/resolution%20mepc.203(62).pdf

KEYWORDS: conformal window; freeform optics; optical fabrication; optical metrology; metrology, aspheric optics

N132-123 TITLE: Infrared-Transparent Electromagnetic Shield

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS)

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

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

DESCRIPTION: Electromagnetic shielding of electro-optic sensor electronics in military systems is currently provided by electrically conductive metal grids applied to the sensor window or dome. Grids provide excellent electrical shielding, but compromise the optical system through geometric blockage, diffraction, and undesired reflection of light. In addition, grids are difficult to deposit on curved shapes. Grids are poorly resistant to erosion damage by rain and particle impact on the external surface of a window or dome. A continuous thin-film coating that has both electrical conductivity and optical transparency could provide adequate electromagnetic shielding and superior optical performance. The conductive layer must be part of a stack of layers to minimize reflection losses and provide erosion resistance. It is desirable that most of the optical loss comes from reflection, not absorption.

Experimental evidence for the plausibility of any material that is chosen for the conductive layer must be provided. In general, previous attempts to use graphene or carbon nanotubes to make a transparent, conductive layer did not provide adequate transparency when they had enough electrical conductivity. Proposals to use graphene, carbon nanotubes, or metal nanowires will need strong experimental justification to be considered.

PHASE I: Demonstrate an infrared-transparent, electrically conductive coating with strong potential to achieve at least 90% transmission in the 3-5 micron wavelength region and a sheet resistance less than 10 ohms per square. The coating should be deposited on an infrared-transparent substrate such as sapphire or silicon to allow infrared optical properties to be measured. Silicon can be used only if it is chemically inert under the film deposition conditions. Measure the optical constants n and k so a case can be made for the potential of the coating to meet the optical requirements of the solicitation when incorporated into an anti-reflection stack.

PHASE II: Optimize the coating for simultaneous maximum optical transmission and maximum electrical conductivity. Design and demonstrate an anti-reflection structure to provide >90% transmittance in the 3-5 micron wavelength region. Incorporate hard layers in the anti-reflection stack to provide erosion resistance. Conduct sand and rain erosion testing of the coating. Demonstrate stability of the coating in the atmosphere and in sunlight. Criteria for erosion and environmental testing will be established by mutual agreement with the Government.

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

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

REFERENCES:
1. L. F. Johnson, M. B. Moran "Infrared Transparent Conductive Oxides," Proc. SPIE 2001, Volume 4375, p 289.

2. H. Kawazoe, M. Yasukawa, H. Hyodo, M. Kurita, H. Yanagi, and H. Honsono, "p-Type Electrical Conduction in Transparent Thin Films of CuAlO2," Nature, 1997, Volume 389, p. 939.

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

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

KEYWORDS: conductive coating; optical coating; electrically conductive coating; electromagnetic shielding; transparent conductive coating

N132-124 TITLE: Corrective Optics Manufacturing for Aerodynamic Infrared Domes and Conformal Sensor Windows

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA 259 AIM-9X

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: Improve the process of manufacturing corrective optical elements to be used in conjunction with aerodynamic missile domes and conformal sensor windows. Implement procedures to increase the optical precision of corrective optics and reduce the cost and time for manufacturing.

DESCRIPTION: Future infrared and electro-optical sensor domes and windows with aerodynamic and conformal shapes will require corrective optical elements to counter the optical distortion produced by the shape of the dome or window. The goal of this project is to improve precision optical manufacturing processes to reduce the cost and time of manufacturing optical correctors. Proposals might address precision optical fabrication and/or metrology.

A generic corrector arch for an aerodynamic dome is 100 mm tall with a width of 25 mm. The exact shape, which will be provided after contact award, does not have rotational symmetry and might have no symmetry. The curvature and cross section of the arch are expected to vary in a continuous manner along the length of the arch. Correctors will be made of infrared-transparent materials such as magnesium fluoride and zinc sulfide. Finished correctors are required to have a root-mean-square transmitted wavefront error of 200 nm or less. Methods are sought to reduce the cost of manufacturing optical correctors and improve their optical precision. Proposals can address optical fabrication or precision metrology or both of these challenges. Metrology solutions capable of measuring objects whose two surfaces deviate more than 5 degrees from being parallel are particularly solicited.

PHASE I: Evaluate approaches to reduce manufacturing cost and time and increase optical accuracy of corrective optical elements. Demonstrate proof of principle of proposed approach and estimate how much time or cost would be reduced when the process is fully implemented.

PHASE II: Refine and implement manufacturing or metrology processes. Demonstrate production of four corrector arches made of one or more selected materials. If the effort focuses on metrology, demonstrate reduction in measurement time and/or improved accuracy in metrology. Demonstrate suitable feedback of metrology into iterative figure correction of a corrector arch.

PHASE III: Implement manufacturing or metrology processes for commercial production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Processes developed for optical corrector manufacturing have potential to reduce the cost of manufacturing aspheric optics for civilian and space applications.

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

2. D. J. Knapp, J. P. Mills, R. G. Hegg, P. A. Trotta, and C. B. Smith, “Conformal Optics Risk Reduction Demonstration,” Proc. SPIE 2001, Volume 4375, p. 146.

3. P. H. Marushin et al., “Demonstration, of a Conformal Window Imaging System: Design, Fabrication, and Testing” Proc. SPIE 2001, Volume 4375, p. 154.

4. S. Bambrick, M. Bechtold, S. DeFisher, and D. Mohring, “Ogive and Free-Form Polishing with UltraForm Finishing,” Proc. SPIE 2011, Volume 8016, paper 80160P.

5. S. DeFisher, M. Bechtold, and D. Mohring, “A Non-Contact Surface Measurement System for Freeform and Conformal Optics,” Proc. SPIE 2011, Volume 8016, paper 80160W.

6. M. Gutin, O. Gutin, X.-M. Wang, and D. Ehlinger, “Interferometric Tomography – A New Tool for Metrology on Conformal Optics,” Proc. SPIE 2011, Volume 8016, paper 80160X.

KEYWORDS: Optical fabrication; metrology, aspheric optics, freeform optics; aerodynamic dome; conformal window

N132-125 TITLE: Spinel Reconnaissance Window

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: Unmanned Carrier-Launched Surveillance and Strike Aircraft (UCLASS)

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: Scale up the ceramic densification process to make monolithic, strong, optical quality spinel windows with finished dimensions of 28 x 30 x 0.6 inches. Measure mechanical strength, optical transmittance, refractive index homogeneity, and birefringence of the window.

DESCRIPTION: Spinel is a prime candidate for airborne and shipboard electro-optic sensor windows that will operate at midwave infrared (3-5 microns) and shorter wavelengths. Spinel has higher transmission than the competing materials, sapphire and aluminum oxynitride. All three materials are highly resistant to erosion by rain and sand. Spinel and ALON can be made in larger sizes than sapphire. Large windows are required to maximize the area that can be viewed. The goal of this topic is to increase the size of monolithic, optical quality spinel for sensor windows. Optical quality includes low absorption by impurities, low optical scatter, homogeneous refractive index, and low birefringence. A disadvantage of spinel is that it is not as strong as sapphire and aluminum oxynitride. It is critical in scaling up the size of spinel to maintain the highest possible mechanical strength. One potential development challenge in this project is to maintain the optical and mechanical quality of spinel when the pressure available to hot press a large window might not be as great as the pressure available to make a smaller window. Another challenge is to obtain uniform material that maximizes the, high quality area of a blank. Consolidation methods based on sintering, rather than hot pressing, would be considered because sintering obviates the need for a large hot press.

PHASE I: Demonstrate on a less-than-full scale that the conditions that will be used to consolidate and hot isostatically press a full size window will produce strong material of high optical quality. For example, if hot pressing pressure for a full size window is limited, do not exceed that limited pressure when making smaller windows in Phase I. If powder preparation for a large plate will be different from that for a small plate, use the method that applies to the large plate. If sintering will be used instead of hot pressing, demonstrate the sintering process. Fabricate and polish spinel window(s) of at least 8 x 8 x 0.6 inches by the same methods that will be used for a full size window in Phase II. Measure the refractive index homogeneity and birefringence of one or more plates. Measure the transmittance (from ultraviolet through infrared wavelengths) of the plates or of representative samples taken from the plates. Measure the flexure strength of well-polished disks (approximately 5 inch diameter x 0.25 inch thick) taken from the plate(s).

PHASE II: Optimize the fabrication of fully dense spinel blanks capable of producing windows with finished dimensions of 28 x 30 x 0.6 inches. If there is a practical reason (such as the size of available dies) to make different sizes, the proposal should state what size will be made. Produce two inspection polished windows and measure the refractive index homogeneity and birefringence of each window. Extract at least 12 disks representing different regions of one window to make well-polished mechanical test specimens (approximately 5 inch diameter x 0.25 inch thick) and measure the flexure strength. Measure the transmittance (from ultraviolet through infrared wavelengths) of the plate or of representative samples taken from the plate. Provide representative polished coupons to the Government for measurement of transmission and optical scatter.

PHASE III: Demonstrate commercial production capability for large spinel windows.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Large spinel windows will be used for transparent armor (bulletproof windows) for commercial customers, as well as for the military. The transparent armor market dwarfs the demand for high quality sensor windows.

REFERENCES:
1. A. Krell, K. Waetzig, and J. Klimke, “Effects and Elimination of Nanoporosity in Transparent Sintered Spinel (MgAl2O4),” Proc. SPIE 2011, Volume 8016, p 801602.

2. J. L. Sepulveda, R. O. Loutfy, S. Chang, and S. Ibrahim, “High Performance Spinel Ceramics for IR Windows and Domes,” Proc. SPIE 2011, Volume 8016, p 801604.

3. J. L. Kutch, E. A. LaRoche, L. Renomeron, L. Fehrenbacher, L. Shaffer, and J. A. Randi, “Large Area Electro-Optic Spinel Windows – Advances in Manufacturing,” Proc. SPIE 2011, Volume 8016, p 801606.

KEYWORDS: spinel; sensor window; electro-optical window; reconnaissance window; infrared window

N132-126 TITLE: Modeling of Strong Vortex Interactions

This topic has been removed from the solicitation.

N132-127 TITLE: Compact, Lossless, Ruggedized, Electromagnetically Shielded Connectors for Power and Signals

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: FNC P&E-FY14-01: Efficient and Power Dense Elec Arch and Component Dev.

OBJECTIVE: The objective of this topic is to develop a compact, lossless, ruggedized, electromagnetically shielded electrical connector design and conduct a demonstration of the connector.

DESCRIPTION: As the Navy progresses into more advanced, modularized, higher power density, power electronics and efficient distribution architecture onboard ships and other platforms, the need for more efficient, compact, and reliable connections between devices and cables becomes ever more critical. Thermal output, efficiency and safety are all concerns that are impacted by the quality of electrical connectors.

One key objective of this topic is to understand and model the various impedance and degradation phenomena associated with electrical connectors in high-power electronics. The second key objective is to develop a connector design(s) and demonstration that drastically improves upon impedance, electromagnetic shielding, survivability, corrosion resistance, and connector diameter relative to cable diameter. Such connectors should be designed for cables transmitting various DC and AC power variants in tandem with communication signals. Many applicable scenarios include highly transient loads. One key metric will be a reduction of connector impedance to micro-ohms.

PHASE I: Perform a feasibility study and develop physics-based models in order to produce a design which meets the capabilities outlined in the description. The deliverable is a model that can serve to provide design specifications for connectors.

PHASE II: Development of a prototype based on Phase I work for demonstration and validation. The prototype should be delivered at the end of Phase II, ready for testing in a live circuit.

PHASE III: Integrate the Phase II developed connector into the P&E-FY14-01 FNC program for transition to the ESO acquisition program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of a compact, lossless, ruggedized, electromagnetically shielded electrical connector would directly impact power distribution and devices in every possible civilian and commercial application imaginable. It would enable more efficient, reliable, and user-friendly systems in portable electronics, vehicles, power grids, and so on.

REFERENCES:
1. C. Peter Cho et al.; Energy Losses in Magnetic Lamination Materials of a Novel Integrated Motor/Pump System; Jul. 22, 1997; Proceedings, Twenty-sixth Annual Symposium, Incremental Motion Control Systems & Devices, pp. 325-333.

2. Naval Ships' Technical Manual, Chapter 320, "Electric Power Distribution Systems", S9086-KY-STM-010, Tmders Incorporated: N65540-04-TC09, N65540-04-SA09, N65540-04-TC43, This Chapter Supersedes Chapter 320 Dated 30 May 2002. Distribution Statement A: Approved For Public Release. Distribution Is Unlimited, Published By Direction of Commander, Naval Sea Systems Command.

3. Jerome H. Collins, 9th Joint FAA/DoD/NASA Aging Aircraft Conference "The Challenges Facing U.S. Navy Aircraft Electrical Wiring Systems", Wiring Systems Branch (AIR-4.4.5.3), Naval Air Systems Command.

4. Society of Automotive/Aerospace Engineers. AS22759 Wire, Electrical, Polytetrafluoroethylene/Polymide Insulated, Light Weight, Tin Coated, Copper Conductor, 150°C, 600 Volts. Warrendale, Pennsylvania.

KEYWORDS: Electrical Connector; Efficiency; Energy Security; Thermal Performance; Resistance; Impedance

N132-128 TITLE: Concept Maps from RDF (Resource Description Framework)

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PMW-120, PMMI (DCGS-N, DCGS-MC); FNT 14-03 Exchange of Actionable Intelligence

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

OBJECTIVE: The objective of this topic is to develop a capability to propose concept maps from very large RDF data stores. To meet this objective, the need exists to construct visual graphs, reorganize nodes/edges to increase readability, remove irrelevant data and prioritize content with respect to user needs.

DESCRIPTION: The military requires affordable means to convert text and image based data to knowledge. Commercial tools exist to semantically tag entities and relationships. The focus of this topic is to take the next step and automate building of concept maps from large RDF data stores to clearly show meaningful relationships such as human networks and behaviors/activities. The goal of this topic is to develop machine based processes to assist human operators in making sense of large graphs derived from the content of documents and video. A concept map is a graphic tool for exploring knowledge and also gathering and sharing information [1]. They can include concepts, shown as component entities enclosed in circles, and relationships between concepts indicated by a connecting line. Products can take the form of a graph, graph with hyperlinks or website pages [2]. Concept map structures are dependent on a user supplied context frame or focus question. Of particular interest for this topic is assisting military operators with handling large quantities of data through automated visual representations, with reduced clutter and prioritize content to meet the needs of specific users.

Thought has to be given to the knowledge desired to meet the needs of user based on mission and tasking. Intelligence knowledge desired can take the form of know-what, know-how, know-who, and know-why questions [3]. Structured Models, Approaches and Techniques (SMATs) can be used by intelligence analysts to identify elite leaders, locate high value individuals, map organizational structures, filter raw data for semantic content and read messages to track incidents. Automated construction of concept maps would provide a valuable tool to assist intelligence analysts in answering these types of questions. The topic's research objective is to automate construction of concept maps to show the significance of entities and relationships extracted from series of structured and unstructured text reports and video. Entity and association extraction has evolved to the point that the large data problem has become a large graph challenge. Each document and video of an already large corpus, once structured, is represented by a graph containing hundreds or thousands of nodes through entity and association extraction. A capability to move from large graphs to meaningful concept maps is critically needed. Technical challenges include the development of graph processing (RDF) techniques that consider context (time, place and the nature of an association) and the meaning of a filtered graph relative to a concept. The maturation of multi-dimensional clustering and word frame technologies may be relevant. The technical risk involves development of an appropriate data store/ taxonomy, graph simplification through frame clustering, inferring concept maps through artificial intelligence automatically. Natural language and video processing tools are able to structure the content of documents and video through the recognition and extraction of proper nouns (e.g. people, places) and selected other parts of speech or context. Structure and grammar frames have been used to classify the meaning of a sentence and/or image. Combining the two techniques to enable a large data scalable machine understanding capability, that clearly shows meaningful relationships, can now be worked. A successful prototype would automatically translate large RDF graphs into the stories they tell.

PHASE I: Develop processes and techniques to create an automated concept map; document the heuristic, machine learning and/or other methods used and show basis in scientific literature. A phase I effort should identify key technical risks associated with the development of a prototype and track risk reduction progress through the measurement of key technical parameters. A Phase I effort should end with a proof of concept demonstration that bounds the size of a graph considered and the types of concept maps generated. The results should be put in a report and if time allows a conference or journal publication. The final Phase I brief should show plans for Phase I Option and Phase II if selected.

PHASE II: Prototype a system that can take a question, input RDF from documents and video and output a concept map. The prototype system will be able to automatically process, display a graph and provide links to sources (pedigree). The system should work with little burden on operators but provide means to refine process decisions. The performer should profile a prototype system that is effective against a bounded set of information questions and data sources (graphs of at least 10 million nodes). The selection of questions and data should be consistent with those of interest to the target transition program. It is possible that operational RDF of interest to the transition program will be classified secret.

PHASE III: Produce a system capable of deployment and operational evaluation that is relevant to multiple user domains and can operate against RDF graphs of at least 100 million nodes. The system should address topics or themes that are specific to use cases favored by the transition program and commercial application. Machine based processing steps, metadata tags and heuristics should be accessible by operator in human understandable form. Data input/outputs and software environment should be modified to operate in accordance with guidelines provided by the transition sponsor.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The private-sector internet market is always interested in new ways to make sense of tagged data. Currently search engines are available that allow for the discovery of information based on user generated tags. This topic would expand future search capabilities to discover based on machine generated tags and machine generated concept maps. Tagged data has caused the large data problem to become a large graph problem. This topic will support research to translate big graphs to relevant stories.

REFERENCES:
1. Joseph D. Novak and Alberto J. Cañas, "The Theory Underlying Concept Maps and How To Construct and Use Them", Institute for Human and Machine Cognition, 2006.

2. Plotnick, Eric, "Concept Mapping: A Graphical System for Understanding the Relationship between Concepts", ERIC Digest, 1997. http://www.ericdigests.org/1998-1/concept.htm

3. Victor H. Ruiz, "A Knowledge Taxonomy for Army Intelligence Training: An Assessment of the Military Intelligence Basic Officer Leaders Course Using Lundvall’s Knowledge Taxonomy", 2010 https://digital.library.txstate.edu/bitstream/handle/10877/3440/fulltext.pdf?sequence=1

4. John Jones, "When Robots Write", digital Media and Learning (DML) Central, April 14, 2011 http://dmlcentral.net/blog/john-jones/when-robots-write

KEYWORDS: Concept Maps, RDF Stores, Knowledge Bases, Cognitive Science, Machine Understanding, Tagged Data

N132-129 TITLE: Compact, Repetitive Pulsed Power Driver Design for Emerging High Power Radio Frequency Sources

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: ONR Code 352: High Power Radio Frequency (HPRF) Basic Research

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 high voltage, solid state, compact, repetitive pulsed power driver optimized for emerging high power radio frequency sources capable of high repetition rates, 10-100 kHz and above.

DESCRIPTION: A variety of high power radio frequency (HPRF) sources have been developed recently, including several novel, solid-state, compact sources that produce very high peak power levels (10s of MW with potential to GW). These HPRF sources have the potential to enable solutions for applications of interest to the U.S. Navy such as small vessel mounted and man-portable directed energy weapons. Substantial progress has been made to reduce the size, weight, and power requirements of these HPRF sources. However, less attention has been given to the pulse conditioning driver components crucial for operation of these devices. Pulsed power drivers are oftentimes significantly larger than the RF source itself. The current state of the art is primarily based on spark gap technology, which has inherent repetition rate limitations, and common topologies such as Blumleins, Marx generators or pulse forming networks which tend to be large and/or bulky. Additionally, these standard voltage multiplying circuits typically produce an output pulse with limited flexibility due to the inherent RC time constants of the fixed circuit elements such as capacitors and inductors. Advanced switching technologies can dramatically reduce the size of the driver elements, increase overall efficiency and improve performance parameters such as jitter which is critical in an arrayed system. For HPRF systems to become viable for more challenging employment options, pulsed power drivers must be developed that are just as compact as the RF sources they support. The goal of this research initiative is the development of a compact pulsed power driver (includes prime power, pulse conditioning driver, thermal management if required, and controls) for HPRF sources capable of 10's of kHz repetition rates in burst mode for one minute or less, a prime power requirement of 5-25 kW, a volume of less than a half cubic meter, weighing less than 100 pounds, with an output power of 10's of megawatts for a pulse of peak amplitude of 40-50 kV and pulse-width of 5-500 ns. Given the ongoing development of these HPRF sources, driver flexibility will also be a key factor as more flexible driving pulses may significantly improve the RF output from the source. This flexibility could take the form of, for example, variable output characteristics or modularity for driving multiple HPRF source arrays. The pulsed power driver therefore needs to provide a high voltage pulse with varying rise time, pulse width and peak amplitude to allow full exploration of the capabilities of the RF sources of interest. This pulse waveform shaping flexibility is difficult to achieve with standard lumped element capacitive discharge circuits, so a novel pulse conditioning driver design will likely be required.

PHASE I: Conceptualize, design, and model key elements for an innovative compact, repetitive, pulsed power driver for HPRF sources. The design should establish realizable technological solutions for a device capable of producing 5 to 50 nanoseconds pulses at 30 to 50 kV of varying shapes, repetition rates of 10's of kHz in burst mode for up to 1 minute, and a minimum peak output power greater than 5 kW contained in a one cubic meter volume weighing 250 lbs or less with a predicted lifetime of 10^7 shots. The proposed design should be an 80% complete solution. The design should include circuit modeling and analysis of various driver output waveforms and how those waveforms could impact or improve RF source output and/or efficiency. Additional modeling and simulation should be performed to determine the driver efficiency, prime power and thermal management requirements. An overview of the current state of the art for each of the key driver elements along with manufacturer information should also be provided, focusing on solid state switching components required for this application. Cost analysis as well as material development should be included so as to ascertain critical needs not yet fully developed or readily available given current technology.

PHASE II: Construct and demonstrate the operation of a laboratory scale, breadboard HPRF pulsed power driver prototype based on Phase I work. The prototype does not have to explicitly meet the size or weight requirements, but should meet the other performance specifications, while being as compact as possible. The driver should also be capable of operating in a dry outdoor environment and be environmentally enclosed. Data packages on all critical components will be submitted throughout the prototype development cycle and test results will be provided for regular review of progress. The prototype should have the flexibility to produce various output waveforms and analysis of RF source (or dummy RF source) response to these waveforms should be conducted to help establish optimal waveform parameters (i.e. rise and fall time, pulse width). The use of actual hardware and empirical data collection is expected for this analysis. A refined design package should also be submitted that meets the objective size of half a cubic meter and weight of 100 lbs. or less and be capable of 10s to 100's of kHz operation in burst mode for up to one minute and provide output pulses of a minimum of 20 kV with a goal of 50 kV.

PHASE III: Finalize the design from Phase II and construct and demonstrate a brassboard HPRF driver prototype optimized for a specific RF source. The final design should be based on the RF response and waveform analysis data collected during Phase II. The RF source for which the driver is to be optimized for may be designed/built by the company and/or provided by a sub-contractor. If the company does not have information on the candidate RF source technology, government furnished information will be provided. The subsequent prototype should represent a complete solution and will be tested to ensure it meets all performance specifications. Data packages on all critical components and subcomponents will be submitted throughout the development cycle and test results will be submitted for regular review of progress. The prototype should be ruggedized for, at a minimum, testing in a shipboard environment across a temperature range of 0 to > 70 degrees, MIL-STD shock and vibration and be environmentally enclosed.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential commercial applications include a variety of communications, sensor and medical applications requiring compact, high power RF systems.

REFERENCES:
1. J. Gaudet, E. Schamiloglu, J.O. Rossi, C. J. Buchenauer, and C. Frost, "Nonlinear Transmission Lines for High Power Microwave Applications – A Survey," IEEE Proc. IPMHVC 2008, pp. 131-138.

2. J. W. Braxton Bragg, J. Dickens, and A. Neuber, "Investigation Into the Temperature Dependence of Ferrimagnetic Nonlinear Transmission Lines," IEEE Transactions on Plasma Science, Vol. 40, No. 10, pp. 2457-2461.

KEYWORDS: Pulsed power driver, pulse forming line, solid-state, high power radio frequency / microwave, directed energy weapons

N132-130 TITLE: <u>Rapid Synthetic Environment Tool for Virtual Battlespace 2 (VBS2)</u>

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: Squad Immersive Training Environment (SITE) (IV) and ADSUDM FNC CMP-15-09

OBJECTIVE: Develop tools for Marines and Sailors to produce and modify VBS2 compatible simulation terrain databases, including building interiors, using government or commercial geospatial data or other means; e.g. Light Detection and Ranging (LIDAR) systems.

DESCRIPTION: VBS2 is a Commercial Off the Shelf (COTS) simulation system used by the USMC, the Navy and the Army. VBS2 comes with a tool called Visitor 4 that can take data such as Digital Terrain Elevation Data (DTED), Imagery, and Shapefiles and output a VBS2 formatted database. This tool and other commercially available ones are much too difficult for non-simulation developers to use and some of them are expensive to license. We need a powerful tool to create VBS2 databases that can be used by Marines with limited technical expertise. In addition to building databases, we need tools that will allow instructors and trainees to modify terrain databases to reflect what they see on the ground. This is particularly important for the interior layouts of buildings, which are not typically available from DoD sources. In addition, buildings are often damaged or destroyed in military operations and the database should be able to rapidly reflect that.

PHASE I: Develop approaches to enable Marines and Sailors to rapidly build geospecific terrain databases for use in VBS2. In addition to importing available geospatial data, the tools should allow warfighters simple methods to improve and tailor the databases to their needs. This can be software applications, handheld hardware, or a combination.

PHASE II: Develop, demonstrate, and validate the capabilities identified in Phase I. Submit appropriate and necessary regulatory documents for testing using human participants. Validate the ability to import geospecific terrain into VBS2 and tailor the terrain and associated databases within a reasonable period of time through empirical evaluations with Marines with limited technical expertise.

PHASE III: The tools will either be stand-alone software or integrated into VBS2. It is expected that these tools will be used as part of ADSUDM and SITE to build realistic real-world terrain for training.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These technologies can be applied to the gaming industry to make development of games faster, less expensive, and more realistic. They may also be applied as a future mapping technology.

REFERENCES:
1. Synthetic Terrain Generation: Best Practices, v.99 Final Draft
http://c4i.gmu.edu/researchPgms/pdfs/SIMCI%20Terrain%20Best%20Practices%20June%202012.pdf

2. Geospatial Data Use in M&S, Stanzione, T, Proceedings of the June 15, 2010 NDIA Systems Engineering Modeling and Simulation Committee,
http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Documents/Committees/M_S%20Committee/2010/June%202010/NDIA-SE-MS_2010-06-15_Stanzione.pdf

KEYWORDS: VBS2; DTED; Synthetic Natural Environment; Terrain; simulation; modeling

N132-131 TITLE: <u>Scalable, Secure Associative Database</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Human Systems

ACQUISITION PROGRAM: FNT-FY12-02 Autonomous Persistent Tactical Surveillance, DCGS-N ACAT IAM

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

OBJECTIVE: Develop and demonstrate an open-source, non-proprietary, scalable, and secure associative database for enhanced discovery of relationships, clues, and evidential insights that are hard to find in a range of missions that address asymmetric threats and unlawful activities.

DESCRIPTION: Analysts supporting naval missions have to develop actionable intelligence from an extensive amount of data that require a multi-disciplinary approach for automated processing of structured and unstructured data types from an expanding array of sensors and information sources. Such automated technologies will significantly reduce the time to develop appropriate measured response when involved with rapidly evolving events or missions such as counter-terrorism activities, counter-narcotics operations, or reconnaissance of agile enemy forces. Associative database techniques provide analysts with high-performance discovery tools for rapid entity and evidence extraction, relationship discovery, and semantic analysis. In multi-agency and multi-level security environments, where extremely large-scale datasets exist, the need for associating relevant data to certain relationships to a mission in hand or handling an unexpected event is ever more critical and challenging.

The associative model of data is an alternative data model for database system design. Other data models, such as the relational model and the object data model, are record-based, whereas in an associative database management system, data and metadata (data about data) are stored as items and links, which supports enhanced discovery by making connections not easily available from traditional database designs. Associative databases deliver enhanced discovery while minimizing CPU cycles, so performance on large datasets can be an important issue.

At this time there are no known open-source and nonproprietary associative database products available; expensive commercial hardware and software products are available for use but these are based on proprietary design and implementations. However, a number of fundamental enabling technologies contribute to the essential core of associative database design, including graph theory, resource description framework (RDF) triple storage and processing, attribute-value systems and entity-relationship modeling. Many of these supporting technologies have commercial big data applicability and cloud-computing open-source implementations are often available. It is envisioned that this effort will result in an associative database capability based upon both current state-of-the-art technologies and new methodologies and approaches that can be integrated in innovative ways to deliver enhanced capability across very large datasets in a multi-level secure environment.

This effort will produce an open-source and nonproprietary associative database prototype architecture that is scalable across multi-petabyte datasets and incorporates security features applicable to deployment and suitable for a multi-agency, multi-level secure environment.

PHASE I: Investigate and evaluate the existing associative database published papers, techniques, and products. Identify the most promising approaches and perform tradeoff studies amongst those approaches for associative database concepts. Determine the technical feasibility for the creation of an open source and nonproprietary associative database architecture that would be scalable to petabyte stores, providing the required multi-level security access features, compatible with DoD Cloud data structures, and allowing for the plug and play of proprietary code.

Through modeling and simulation determine the technical feasibility of the most promising candidate associative database design concept. Verify and validate the performance through implementation and demonstration of the basic proof-of-concept prototype that supports enhanced discovery on petabyte datasets suitable for multi-level security access features. Then document and report the results.

PHASE II: Based on the trade-off studies and analysis performed in Phase I amongst the competing concepts and approaches, determine the best possible approach to design and build a well-defined deliverable prototype system for the associative database and the ability to link to a cloud computing environment relevant to a mission of interest. Implement approaches for exploring the potential automation of the extraction of relationship (triple store – entity – relationship - entity) data that could be facilitated through the use of language processing techniques on entity text strings identified through the use of associative processes. The final design must be robust to noisy data and scalable. The final prototype system also needs to be tested and performance demonstrated and validated at a government facility to show that the prototype scales to a multi-petabyte datasets across hundreds of nodes. The final report must include a detailed design of the system, technical documentation, and user manuals.

PHASE III: Incorporate the associative database technology in an existing or planned operational test environment at a designated Naval or a Joint Interagency Intelligence Analysis Center. Prepare plans to conduct numerous experiments with wide-ranging security and policy restricted requirements. Demonstrate the associative database system working in a cloud computing environment for a mission of interest and showing scalability to Petabyte stores. Demonstrate the automation of the extraction of relationship (triple store – entity – relationship - entity) data within a cloud enabled workflow using associative data processes. Collect performance data from field experiments to validate improved performance, scalability, and robustness of the system under extreme conditions that will include uncertain/incomplete intelligence data streaming in real-time. It is expected that the outcomes from each experiment will be measured and contrasted against the performance of the existing state-of-the-art database systems in place at the facilities. Prepare plans to garner acceptance and commitment from the multitudes of end-users, which requires tight coordination and collaboration with the analysts, operational communities, and subject matter experts. The associative database technology will pull-in sensitive data from various data sources, therefore the end-user commitment for implementation, training, and maintenance of the technology is required. Develop guidelines and documentation for transition including underlying applications, implementation procedures, and maintenance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology has broad applications for knowledge management and relationship extraction in both government and private sectors. In government it has numerous applications in military, intelligence communities, law-enforcement, homeland security, state and local governments to deal with asymmetric threats, deploy first responders, crisis management planning, and humanitarian aid response.

The technology is equally compelling in commercial sector applications as it provides an environment to rapidly infer relationship and connect the right consumers to appropriate suppliers for wide-ranging services. In essence the associative database system enables rapid understanding of highly complex events and situations by “connecting the dots” in an environment that involves high data volume and quick response.

REFERENCES:
1. Williams, S., The Associative Model of Data, Lazysoft, 272p

2. Homan, Joseph V., Kovacs, Paul J., A Comparison of the Relational Database Model and the Associative Database Model, http://iacis.org/iis/2009/P2009_1301.pdf

3. The Associative Database in Support of Lean and Agile Database Design,
http://www.decisionsciences.org/Proceedings/DSI2008/docs/354-9596.pdf

KEYWORDS: Associative Database, graph theory, resource description framework (RDF), triple stores, Petabyte, entity-relationship

N132-132 TITLE: Cognitive Modeling for Cyber Defense

TECHNOLOGY AREAS: Information Systems, Battlespace, Human Systems

ACQUISITION PROGRAM: Capable Manpower FNC: CMP-FY15-02 Environment Designed to Undertake Counter

OBJECTIVE: Develop and validate a computational model of the cognitive processes from cues to actions of the attackers, defenders, and users to create a synthetic experimentation capability to examine, explore, and assess effectiveness of cyber operations.

DESCRIPTION: Cyber networks in the US are being successfully attacked. Battlespace boundaries are ill-defined temporally and spatially. The enemy is co-evolving and ethereal. Current defensive strategies are reactive in nature, meaning that the defender is forced to follow behind exploits to close holes rather than reducing the potential space in which the attacker can move. The relationship between network characteristics, attacker goals and exploit selection is not well understood. Defense has focused on modifying user behavior via training, warnings and restrictions on capabilities. Defenders must process large volumes of complex, high tempo data; yet ground truth with respect to the presence and/or actions of an attacker are rarely known. Metrics of user policy compliance do not include the impact of policy on productivity. Adding to the complexity of the problem is a lack of understanding or visualization of the cues, features and characteristics that are used by attackers to select targets and lack of cognitive models of attacker decision processes of how these cues combine with attacker goals to yield the exploit that is used on a network. This topic will explore the potential to reduce the cyber battlespace by identifying the relationship between system characteristics, attacker goals and exploit selection.

The results of a recent workshop by Sandia National Laboratory concluded that research and development in cyber warfare is needed to capture key processes that mediate interactions between defenders, users, adversaries, and the public (see [1]). While attackers have multiple methods to influence user and defender behavior to their advantage, defenders lack the tools to influence or predict attacker behavior; as a result, security policies often limit user behaviors. However, limiting the actions of users can have the unintended consequence of limiting the effectiveness and utility of the system to the users. Many defense strategies have focused on new technology to prevent access or training of users rather than development of cognitive models of the attacker to bound potential actions the attacker could take, which would reduce the potential battlespace. Recent work in modeling of complex cognitive processes, as well as in the nature of cyber defense, can be leveraged to allow modeling of attacker actions and behaviors.

We seek cognitive models that link the cues, features and characteristics monitored and used by attackers in terms of their relation to attacker goals and exploit selection. These models should link to how system cues prompt defender and user actions.

PHASE I: Phase I should develop a model for attacker-defender decision making, such as a simulation or computational model (e.g., ACT-R, SOAR, EPIC or other model) that links system characteristics to attacker exploit selection. Proposals should focus on the human role in cyber security rather than solely on new technological solutions.

Areas of interest for Phase I include:

• The roles of users, defenders, attackers and policy makers to create an extensible collection of use cases for scenario development and modeling.
• The different jobs and functions within cyber defender teams and the associated knowledge, skills and abilities needed to fulfill these functions;
• Cognitive processes involved in typical tasks and associated measures of performance both as a basis for selection and training and operational performance assessment.
• The use of modeling to develop a multi-purpose environment for test and evaluation of alternative tactics, procedures and policies for network defense.

In developing the concept, model the decision making process of attackers in order to identify points in the decision making process which would allow defenders to select actions that could disrupt the decision process. Models or simulations that enable exploration of alternative tactics, procedures and policies would increase the effectiveness of defender strategies, and allow bounding of the battlespace. Models that focus on the links between network characteristics and vulnerabilities, attacker goals and attacker selection of exploits would further bound the potential battlespace, allowing defenders to be more precise in their selection of tactics. Exploration of the allocation of functions between humans and machines, including opportunities to augment human performance through specific technological developments, would be useful.

The focus supports a constructive simulation that extends to team interactive virtual experiments. The constructive simulation would assess tactics against process models. Tactical action officers and analysts can optimize processes and refine models with iterative simulation. Human players can be inserted for a collaborative synthetic environment whereby humans interact with agents in a simulated scenario.

PHASE II: Leverage the concept developed in Phase I in support of a multi-purpose environment for test and evaluation of tactics, procedures and policies. Develop and test a model or prototype in simulation. 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 models and simulated environment and quantifiably demonstrate their benefit in improved tactic and policy selection.

PHASE III: Leverage the models to develop tools to assist defenders and users who support network security. 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 simulation environment that can be used to assess alternative tactics and policies on network defense. Conduct testing to validate the models and simulation environment. Implement models in a field experiment. Develop guidelines and documentation for transition to an operational setting. Field test the models and resulting tools in an operational setting to validate the improvement in security.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector products could utilize modeling and simulation tools and techniques to assess and reduce vulnerabilities in systems. These might include system security software improvements, reduction in reliance on policy for network security, and increased detection of network intrusions.

REFERENCES:
1. Forsythe, J. C., Silva, A., Stevens-Adams, S., & Bradshaw, J. (2012). Human Dimensions in Cyber Operations Research and Development Priorities. SANDIA REPORT SAND 2012-9188. Unlimited Release.

2. McNeese, M., Cooke, N., Amico, A., Endsley, M., Gonzalez, C., Roth, E., and Salas, E. (2011). Perspectives on the Role of Cognition in Cyber Security. Proceedings of the Human Factors and Ergnomics Society 56th Annual Meeting.

3. Hernandez, J. (2010). The Human Element Complicates Cybersecurity. Defense Systems. Available at http://defensesystems.com/Articles/2010/03/11/Industry-Perspective-1-human-side-of-cybersecurity.aspx?Page=1.

4. Bonabeau, E. (March 24, 2011). Cyber-Security Can't Ignore Human Behavior. The Atlantic. Available at http://www.theatlantic.com/technology/archive/2011/03/cyber-security-cant-ignore-human-behavior/72826/

5. Bowen, B., Ramaswamy, D., and Stolfo, S. (2011). Measuring the Human Factor of Cyber Security. Homeland Security Affairs, Supplement 5, www.hsaj.org

6. Joint Publication 3-13 Information Operations.

7. Wikipedia. Proactive Cyber Defence. Available at http://en.wikipedia.org/wiki/Proactive_Cyber_Defence

KEYWORDS: Cybersecurity; Modeling; Decision Making; Simulation; Human Performance; Information Security

N132-133 TITLE: Advanced Helo Display for Zero-Zero Shipboard Landings

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: Shipboard Automated Launch and Recovery System (SALRS) INP-LA program.

OBJECTIVE: Develop and demonstrate cockpit head-down display symbology that will enable a helicopter pilot to safely, efficiently and easily land on a moving ship deck without outside visual cues.

DESCRIPTION: The technical challenges are: (1) provide display symbology that is easily interpretable for rapid and low workload pilot response, and that is unambiguous and confidence inspiring; (2) take into account the maneuverability of a helicopter representative of the MH-60R/S, and the response time of a pilot; (3) provide guidance to a pilot to bring the helicopter onto the flight deck so that the helicopter and ship motions at touchdown are synchronized; (4) provide continuous and appropriate indication of limits and safety margins; (5) utilize a display representative of those in existing MH-60R/S helicopters. Assume that accurate relative navigation between the ship and the aircraft is available. Explore the need for lead time and accuracy in deck motion prediction by varying these two parameters and analyzing the results. Demonstrations include piloted simulation (Phase I) and landing of an RC helicopter onto a moving platform by a pilot with no visual observation of the helicopter or the platform (Phase II).

PHASE I: Define approaches to developing helicopter flight director/pilot guidance symbology for degraded visual environments or other limited visibility landing approaches. Develop proof of concept symbology using a display representative of an advanced military helicopter multi-function head-down display. Assume that the following information is available in the helicopter:

1. Aircraft state
2. Accurate (within 1 ft spherical error probable) relative position from a small deck naval ship (destroyer or frigate) landing area

3. Ship deck motion with 50 msec of lag
4. Ship graphic model data or photographic templates

Develop a conceptual design of the display symbology and demonstrate feasibility in simulation using an available pilot station, helicopter model, and moving landing platform model. Key metrics are deck motion and pilot workload.

PHASE II: Refine the symbology and data display. Conduct pilot surveys and simulation events to get feedback on and improve the design. Incorporate a helicopter and ship model representative of the MH-60R/S Seahawk and the DDG-51 destroyer, and an airwake model into the simulation and demonstrate feasibility. Conduct a flight demonstration using a remote controlled model helicopter (at least 4 ft. rotor diameter) landing on a platform moving in pitch, roll, and heave, flown by a pilot with no visual observation of the helicopter or the landing platform. Key metrics are deck motion, time to land, and pilot workload.

PHASE III: Conduct a flight demonstration using a manned helicopter landing on a moving platform representative of the DDG-51. Display configuration and relative navigation systems will be representative of or the same as those in use or being developed for use by Naval MH-60 helicopters. Ultimately, the capability will be offered for transition to the PMA-299 Seahawk Multi-Mission Helicopter Program Office for incorporation in fleet MH-60's.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability could be used for helicopter landings in degraded visual environments on oil platforms and commercial ships, as well as shore-based sites.

REFERENCES:
1. Evaluation of DVE landing display formats; Hans-Ullrich Doehler; Patrizia M. Knabl; Sven Schmerwitz; Thorsten Eger; Ofer Klein; Proc. SPIE 8360, Airborne Intelligence, Surveillance, Reconnaissance (ISR) Systems and Applications IX, 83600P (May 1, 2012); doi: 10.1117/12.922459

2. BAE systems brownout landing aid system technology (BLAST) system overview and flight test results; Brian Sykora; Proc. SPIE 8360, Airborne Intelligence, Surveillance, Reconnaissance (ISR) Systems and Applications IX, 83600M (May 1, 2012); doi:10.1117/12.918506

KEYWORDS: helicopter; sea-based; landing; display; pilot; shipboard

N132-134 TITLE: <u>High Power Radio Frequency (HPRF) Dynamic Surface Engagement Modeling and Simulation Tool</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Battlespace, Weapons

ACQUISITION PROGRAM: ONR Code 352: High Power Radio Frequency (HPRF) Basic Research

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 High Power Radio Frequency (HPRF) dynamic surface engagement modeling and simulation (M&S) tool for predicting weapon effectiveness in realistic engagements.

DESCRIPTION: To assess the utility of potential High Power Radio Frequency (HPRF) systems for surface Navy applications, a tool is required to simulate dynamic aspects of vessel versus vessel engagements. The prototype tool should cover a wide range of RF parameters to include narrow-band and wide-band technologies in the range of 0.1 - 10 GHz. The tool should enable graphic visualization of one vs. one and one vs. many engagements across a range of sea states, including a graphical depiction of the beam spot size and target coverage over the course of many tens of seconds of operation. In addition to capturing RF propagation, the tool should enable probability of effect predictions for the engagement using empirical target vulnerability data. Probability of effect predictions should include confidence bounds for extrapolation empirical effects data and/or a functional representation of effectiveness versus RF waveform parameters (frequency, pulse-width, pulse-repetition rate, etc.). This engagement tool should have the flexibility to cover a variety of ranges of interest for this application from 100s of meters to 10s of kilometers.

HPRF weapons are being developed for the US Navy. Deployment of such weapons will require evaluation of their effectiveness and the development of optimum concepts of employment. Such development may be aided by the use of modeling and simulation software capable of modeling the engagement of the HPRF platform and the threat in surface engagement scenarios. The modeling tool should free the analyst of the burdens of software configuration and allow effort to be concentrated on the development of the scenario and the analysis of the outputs expected from the tool. Results should be heavily described by graphical displays of tracked information. Control of the scenario should be through natural language and employ military terminology. The tool should employ a Graphical Unit Interface (GUI) for both scenario development and output analysis. Such utility will enable the operational warfighter to run "what if" scenarios to assess plans and weapon combinations and effectiveness.

The user should be able to specify ranges of parameters of interest or specific scenario parameters that could be varied in repeated runs of the scenario. The tool should provide an indication of the statistical significance for the number of runs required to be executed for a statistically significant result. The tool should also be able to optimize the scenario based on one or more parameters, either for defense or offense. This will free the user from repeated scenario development to obtain optimum performance. The tool should be able to interpolate outcome if parameters are changed, based on previous runs. The code should also be calibrated against real world data.

The HPRF system should be described in terms of source power, antenna gain, pulse repetition rate, pulse width and polarization. The model should have the capability to limit the transmission time possible with the source, so as to mimic a battery operated system with limited energy storage. Propagation of the HPRF beam through the environment of the scenario should be included in the model. Though free space propagation may be trivial, the propagation to a surface target will need to include approximations for the effect of multipath. This may be a complex process for near surface targets such as small boats; ranges of interest for this application are from 100s of meters to 10s of kilometers. The time required to take an HPRF weapon from standby to firing should be included in the model.

The simulation tool should account for environmental conditions. This includes sea state, fog, and rain that could influence the propagation of the HPRF beam as well as mobility and visibility. Such conditions could be significant contributors to the utility of a system.

The HPRF platform types in the simulation tool should initially include large vessels, small vessels and unmanned surface vehicles and with future inclusion of unmanned aerial vehicles. Each should include the ability to account for the effect of the size, weight and power (SWaP) of the platform carrying the HPRF system.

Threats to be included in the scenario should include small vessels and in later stages consideration for UAVs. The modeling should account for one on one, one on many and many on many conditions. HPRF systems may also be employed on a ship, a single small boat, a USV, or defensive swarms that may be prepositioned on a ship or patrolling about a high valued target.

Also of interest, but not required, consideration could be given for an engagement tool for comparison between HPRF systems and conventional weapons. In addition, the enhancement of conventional weapons when HPRF is included in the mix could be investigated. This conventional weapons aspect would be added in stages. Conventional ship weapons (guns, cannon, etc.) would be included in the modeling. The range, magazine size, rate of fire, and effectiveness would be part of the modeling. The capability to include the occulting of weapons by ship structures would be included.

Unless proven otherwise, the modeling should be a combination of user driven and agent based simulation (ABS) control of objects and events. Agents are objects in the simulation that accept input of the evolving scenario through sensors and respond accordingly as specified by the scenario developer. The behavior of the agents is guided by a set of parameters unique to that agent that guides its behavior for each time cycle and the environment around it. Offerors should take advantage of existing Agent based simulation software and not build a system from scaratch.

Agents communicate with other agents, are guided by objectives and have specified capabilities. Based on the input from the evolving scenario an agent may make decisions that affect the action. Vector based location is preferred. Model latency should be specified and smaller than smallest event time duration. The ABS approach executes a scenario from a specified start point through the combined behavior of individual autonomous actors. This results in often unexpected behavior as a scenario progresses through all the possibilities.

Computer hardware that will be used run the tool should be commercially available hardware and the software should be easily ported. The developer should scope out the hardware required for the full employment of the requirements identified here. This should include run time assessment and graphics needed.

To aid in the degree of realism and the rapid conveying of engagements, realistic objects need to be included in the simulation. A library of 3-Dimensional objects to be used in the simulation should be included. This includes boats, ships, ports, UAVs, and USVs. Software for the conversion of 3D models to the type used in the simulation tool should be included in the software suite so that available models from other libraries may be imported into the simulation tool. In addition, software enabling the inclusion of topology from freely available sources such as Google maps or other sources should be part of the software suite. The tool should also have the ability to modify this topology.

Innovative research and development is needed in ABS methodology to develop the capability to accurately explore the statistical space for the user. This is crucial for proper examination of a scenario. The ABS, given a starting scenario should be able to optimize the scenario based on selected parameters. For example, given an attack by multiple small boats on a large vessel protected by USVs, a potential optimization parameter could be the positioning of the USVs in a picket formation. The attackers could have multiple options for attack so the model should be able to run the simulation and develop the optimum locations PHASE I: The basic ABS system involving a ship and small boat attackers shall be developed using existing ABS software. The HPRF system shall be implemented and shall include the RF multipath effect. The tool shall permit the installation of HPRF systems on the ship or on USV defenders. This requires setting of the HPRF weapon agent's effective range and effect. The weapon should be paired with a sensor agent on the ship that controls the detection of threats. The key part in Phase I is describing the proposed optimization algorithms that will be developed in the next Phases. The methodology should be described and demonstrated sufficiently to be able to estimate the computer resources that will be required for full implementation. This phase should also include the development of user friendly GUIs that employ natural language and military terminology for scenario development. It is not expected that the natural language function be completely implemented, but that the capability is demonstrated sufficiently so that estimates may be made of the computer resources required for full implementation. Scenarios to be tested include (1) attack by a single exploding boat, posing as a noncombatant, and (2) a swarm of 5 attacking boats. Displays should be able to show planar view of developing movements at selected timescale. Views from selected agents are also useful. Simplified agent models may be employed but capability of expansion to full capability modeling needs to be demonstrated. The optimization algorithm will be demonstrated. Recommended hardware to host the development package shall be described. Estimates of computer resources for the full model shall be conducted. Successfully demonstrating feasibility in this restricted model will be the criteria for Phase II selections.

PHASE II: The performer will scale up the concept developed during Phase I to include small boat attackers and USVs numbering up to 50 agents each. The simulation tool should include environmental conditions. The optimization capability shall be fully developed in the model. Ship movement shall be included. Full development of the scenario development controls will be added. Full analysis capability will be included. The optimization model will be exercised and tested by users to ensure its ease of usability to extract topological data from sources such as Google maps shall be included. Conversions software for importing 3D models of other types will be added to the software. Estimates of computer resources for the full model shall be conducted. Documentation shall be provided for the hardware and software systems. Conventional weapons for comparison purposes could be included where possible.

PHASE III: The performer will apply the knowledge gained during Phase II to build a complete model that provides all required functionality. The library will be populated with functional models of Naval vessels, USVs, and UAVs. The optimization capability should be fully enabled with the ability for optimization up to key parameters. Documentation shall be completed for the full model.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: RF propagation modeling and simulation for over water and land environments is of use in a variety of communications and sensor bases systems where electromagnetic interference needs to be considered and planned for shielding and proper operation.

REFERENCES:
1. Robust Defense Against Small Boat Attacks, Ka-Yoon Wong, Masters Thesis Naval Post Graduate School, December 2010

2. Small Boat And Swarm Defense: A Gap Study, Andre N. Tiwari, Masters Thesis Naval Post Graduate School, September 2008.

3. Modeling Force Response To Small Boat Attack Against High Value Commercial Ships, David J. Walton, Proceedings of the 2005 Winter Simulation Conference, M. E. Kuhl, N. M. Steiger, F. B. Armstrong, and J. A. Joines, eds., p 988.

4. Military Applications Of Agent-Based Simulations, Thomas M. Cioppa et al, Proceedings of the 2004 Winter Simulation Conference, R .G. Ingalls, M. D. Rossetti, J. S. Smith, and B. A. Peters, eds., p 180.

5. Analyzing Anti-Terrorist Tactical Effectiveness Of Picket Boats For Force Protection Of Navy Ships Using X3d Graphics And Agent-Based Simulation, James W. Harney, Masters Thesis, Naval Postgraduate School, March 2003.

6. Exploring The World Of Agent-Based Simulations:Simple Models, Complex Analyses, Susan M. Sanchez, Thomas W. Lucas, Proceedings of the 2002 Winter Simulation Conference, E. Yücesan, C.-H. Chen, J. L. Snowdon, and J. M. Charnes, eds., p 118.

7. Modeling Robot Swarms Using Agent-Based Simulation; Alistair Dickie, Masters Thesis, Naval Post Graduate School, June 2002.

8. Recent Developments in the agent based model MANNA, Gregory MacIntosh, et al., The Scyth, Issue 1, p 38

KEYWORDS: Agent-Based Simulation; HPRF; Small Boat Attack; Swarm; HPM; Engagement

N132-135 TITLE: Fusion in a Cloud

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: DCGS-N and MC; EC Candidate FNT FY15-02 Data Focused Naval Tactical Cloud

OBJECTIVE: The objective of this topic is to develop a distributed fusion engine that can reason using information in cloud environments to inform decision tools. To meet this objective, the need exists for hybrid processing (time delayed cloud/real time non-cloud), development of services capable of maintaining data and belief net models across distributed nodes, and the development of inferencing algorithms that can be implemented as map reduce jobs to assemble fused products tailored to user needs (i.e. area, time and interests).

DESCRIPTION: Due to the large quantities of data, it is now beyond the abilities of humans, without machine assistance, to assimilate data sets and create analytic products. Cloud architecture offers a means to share data and services across nodes. Hadoop and MapReduce open standards enable data to be structured for parallel processing [2]. Accumulo, based on Google's Big Table design, is being studied for use by many agencies [3]. These standards could serve as a basis for distributed data fusion to address information requirements across all warfighting functions. The challenge is developing a complex data fusion methodology that works within a cloud technology [4]. While cloud architectures offer unprecedented access to large data, legacy applications, such as fusion algorithms which were developed to run on single servers, will not easily be rehosted as distributed applications. To replicate past success, technology is needed that can maintain data models, reason about patterns and belief nets and enable machine learning all across geographically separated cloud nodes. A goal of this topic is to develop technology to contextually filter content for a specific area and time of interest in support of a fusion engine that can address user specified contextual questions. Challenges exist, however, in architecting algorithms that can run as standalone and distributed services. Data fusion algorithms are key to translating raw data to a disambiguated data layer and situational understanding, but maintaining data models and belief nets across a cloud are research challenges that must be addressed in order to realize the power of the cloud for the tactical warfighter.

The key technical challenges inherent to the topic include how to maintain a common data model when data enrichment (e.g. entity extraction) is occurring across many distributed nodes and how to implement probabilistic reasoning as a map reduce task. Applications currently authored as map reduce jobs generally do not require deep collaboration between nodes. For example, a state of the art map reduce task characterizes the data content of each node as n-grams (static ontology) and performs searches as map reduce jobs that do not require feedback to the distributed nodes (independent node searches). This topic will expand the state of the art by enabling distributed nodes to work together on a data model and probabilistic reasoning. A successful prototype would have implemented both level 1 fusion (entity and metadata disambiguation) and level 2 (inferencing) fusion algorithms across a set of cloud nodes.

PHASE I: Develop techniques to implement data fusion algorithms in a cloud environment; identify key technical risks associated with the development of a prototype; implement a design strategy to measure algorithm performance over time. Technical approach should address the challenges of maintaining data models, inferring patterns and enabling machine learning. Identify a specific application and use case for a customer (military and commercial) and outline a plan for going forward with research. The final Phase I brief should include a proof of concept demonstration and show plans for a Phase II.

PHASE II: Produce a prototype system that is capable of running level 1 (data resolution) and level 2 (inference) fusion algorithms across geographically separate cloud nodes, each holding different data sources, some streaming. The prototype system should be able to maintain data models and inferences about behavior while allowing machine learning from a distributed cloud architecture. Validate level 1 and 2 fusion results derived from at least two small computer clusters similar to what is possible from a single node having access to all the data. The prototype should present context and pedigree of information used by the fusion engaging for operator review, independent of which cluster it was sourced from. During the phase II effort, the transition path should be strengthened by focusing on data and use cases of interest.

PHASE III: Produce an application or set of applications that are capable of being generalized to N number of cloud nodes with relevance to Navy and Marine Corps use cases. The phase III product(s) should be capable of running on program of record cloud systems such as DCGS-N using existing services to run against operational data. Developed applications must have relevance to amphibious, anti-submarine and integrated air-missile defense warfare mission areas. During this phase the performer should concentrate on operational relevance and transition.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The use of cloud architectures is becoming prevalent in both the DoD and private sector. Law enforcement and news services are private sectors that also have a need to move beyond capabilities that enable data discovery in distributed clouds to systems that can implement complex data fusion algorithms. Data stored in clouds are already being used by these sectors to assess trends and discover events and activities of interest.

REFERENCES:
1. Sustaining US Global Leadership: Priorities for the 21st Century Defense, Jan 2012, http://www.defense.gov/news/Defense_Strategic_Guidance.pdf

2. Hadoop and MapReduce, http://hadoop.apache.org/map reduce/

3. Accumulo, http://accumulo.apache.org/

4. Scott C. McGirr, "Buiding a Single Integrated Picture Over Networks", MSS National Symposium on Sensor and Data Fusion, at McLean, VA, June 6-8, 2006.

5. Richard Antony and J. A. Karakowski, “Fusion of HUMINT and Conventional Multi-Source Data”, MSS National Symposium on Sensors and Data Fusion, July 2007.

6. Chee-Yee Chong, D. Hall, M. Liggins and J. Llinas (editors), Distributed Data Fusion for Network-Centric Operations, CRC Press, Nov 13, 2012.

KEYWORDS: Cloud architecture, distributed processing, data fusion, map reduce, co referencing, predictive analysis

N132-136 TITLE: Mine Drift Prediction Tactical Decision Aid (TDA)

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: PMS-495; SHD-12-04 Detection and Neutralization of Surface Drifting Mines

OBJECTIVE: To develop a Mine Drift Prediction Tactical Decision Aid (TDA) to enable Mine Counter Measure (MCM) planning and operations in areas threatened by surface and near-surface drifting mines.

DESCRIPTION: Drifting mines have been used intentionally by adversaries and there is evidence that drifting mines are an important part of access denial strategies, especially in deep water environments. The Mine Drift Prediction TDA will predict drift trajectories using real-time observations, oceanographic model data (if available) and other sources to provide intelligent preparation of the environment before operations commence, and situational awareness during operations. The TDA will comprise software tools to 1) allow optimal deployment of Mine Counter Measure (MCM) assets for search and/or environmental information gathering and to 2) generate a ship maneuver plan which minimizes risk of engaging drifting threats. The deliverable is a stand-alone software service compatible with Mine Warfare (MIW) Command and Control (C2) (e.g., the Mine Warfare and Environmental Decision Aids Library – Enterprise Architecture (MEDAL-EA), Environmental Post Mission Analysis (EPMA) and Net-centric Sensor Analysis for MIW (NSAM)) and an operator training package. The Mine Drift Prediction TDA must provide support for MCM planning and maneuver across a spectrum of connectivity conditions ranging from ideal (high bandwidth) to austere (no connectivity).

PHASE I: Based on current state-of-the-art knowledge of oceanographic phenomena, develop concepts and investigate methods to build and validate a model to predict the drift of surface and near-surface drifting objects in the ocean. Develop concepts and investigate methods to build tools to 1) allow optimal deployment of MCM assets for search and/or neutralization, and to 2) generate a ship maneuver plan which minimizes risk of engaging drifting threats. The concept design should at a minimum address the plan for software modularity, modeling of the relevant oceanographic phenomena, development of algorithms, implementation of computer code, and methodology for estimation of prediction uncertainties. The contractor shall conduct a kickoff meeting and a final review at ONR.

Develop an algorithmic strategy and software modules addressing topic objectives that are compatible with Navy Mine Warfare (MIW) Command and Control (C2) software systems (e.g., MEDAL-EA, EPMA and NSAM). Develop system architecture for the several components of a Mine Drift Prediction TDA compatible with existing MIW C2. Describe and formulate the mathematical models for drift prediction and necessary oceanographic models and/or observations required to initialize and run the model; describe and formulate mathematical models for optimal deployment of MCM assets for search and environmental observations; and, describe and formulate models for ship maneuver plans to minimize risk of engaging detected or simulated drifting threats.

PHASE II: Construct and demonstrate the operation of a prototype TDA. Develop a complete set of TDA algorithms and implement in computer code modules addressing each of the components of the problem described in Phase I. Develop plans for and implement in computer code the ability to visualize the results. Test simulation predictions using available data from the literature or other existing data. Develop interface control documentation for MIW C2 MEDAL-EA, EPMA and NSAM and control software and demonstrate compatibility with those systems. The contractor shall conduct a kickoff meeting, two interim project reviews and a final review at ONR.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Models for prediction of the drift trajectories of objects floating at or near the ocean surface have application to both DoD and civilian search and rescue, and for reconstruction of maritime accidents and related situations.

REFERENCES:
1. Zhijin Li, Yi Chao, John D. Farrara, James C. McWilliams, Impacts of distinct observations during the 2009 Prince William Sound field experiment: A data assimilation study, Continental Shelf Research, Available online 8 July 2012, ISSN 0278-4343, 10.1016/j.csr.2012.06.018.

2. Stone, L.D., Keller, C.M., Kratzke, T.M., Strumpfer, J.P., Search analysis for the underwater wreckage of Air France Flight 447, Information Fusion (FUSION), 2011 Proceedings of the 14th International Conference, 5-8 July 2011.

KEYWORDS: Mine Countermeasures; Ocean Surface Currents; Drifting Mines; Ocean Waves; Ocean Circulation Models; Optimal Search

N132-137 TITLE: <u>Low-loss Optical Polymer Materials in Multi-kilogram Quantities for Optical Lens Development</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors, Weapons

OBJECTIVE: We seek a source of thermoplastic polymer materials (e.g. Polymethyl methacrylate (PMMA), Styrene Acrylonitrile (SAN), et al) with internal scattering losses <0.5 dB/m in quantities (kilograms) suitable for the fabrication of extrusion processed and/or molded near diffraction-limited optical devices.

DESCRIPTION: Polymers have been used as optical materials for over 50 years, mostly in applications where low cost and light weight are a critical issue. The light weight and impact resistance of polymer lenses could provide a significant advantage in more demanding DoD applications. However, the use of polymers in optics with demanding specifications has been limited primarily by scattering losses. The haze and transmission specifications for commercial polymers are described in ASTM D1003 and/or the International Organization for Standardization (ISO) 14782 procedure. In the American Society for Testing and Materials (ASTM) D1003 measurement, only light scattered outside of a cone of ~8 degrees is reported as haze. In commercial polymers there is usually a specification for haze rather than one for scattering. Forward scattered light remaining within an 8 degree cone is included in the transmission. The light scattered within a small angle in the forward direction will have a deleterious effect on the imaging properties, Modulation Transfer Function of, for example, the night vision goggle. The level of scattering is not due to the intrinsic optical properties of the polymer, but rather to losses introduced into the polymer source materials during their manufacturing processes. For example, PMMA and perflourinated polymers have been synthesized with scattering levels more than three orders of magnitude lower than those usually specified by bulk manufacturers. More acceptable scattering levels are found in polymers produced under more careful conditions albeit in quantities smaller than that needed for the production of optical devices.

Low-loss polymers are produced by insuring extrinsic defects and impurities are excluded and by insuring the production conditions preclude the formation of localized inhomogeneities. A program to develop the science and manufacturing capability to produce polymer materials with specifications for higher end optical applications could have a substantial impact on the use of polymer materials in demanding optical applications and would have an excellent chance of transitioning into high end optical devices.

PHASE I: Define and if possible develop a concept for a cost effective method to scale up the synthesis and optimize the quality/volume/cost tradeoffs of polymer materials suitable for the fabrication of diffraction limited optics. Demonstrate the feasibility of producing one high optical quality thermoplastic polymer material with losses <0.5dB/m. This effort will define and if capable demonstrate the production to >1kg of thermoplastic polymer(s) suitable for the fabrication of extrusion processed and/or molded diffraction-limited optics.

PHASE II: Based on Phase I approach, demonstrate production on a scale up to >5kg or larger batch(s) of thermoplastic polymers that have losses <0.5dB/m with coextrusion rheology which is compatible with PMMA or SAN17. Provide test measurements suitable for specifying materials for high quality optics. Tests used by optical glass manufacturers and/or in ASTM E1653 - 94 (1999) could provide a starting point. Internal losses and on-axis stray light of <0.5dB/m (~ 0.5% in a 1 cm thick lens) over the 350-1650nm spectral range (2) will be demonstrated.

These materials will have index of refraction within the range 1.35 to 1.72 and Abbe numbers within the range of 20-80. The materials will be thermoplastic and coextrudable with PMMA and/or SAN17.

PHASE III: Demonstrate the development of 10Kg batches of a set of optical polymers that have indexes of refraction across the range 1.35 to 1.72 and Abbe numbers across the range 20-80. The materials will be thermoplastic and coextrudable with PMMA and/or SAN17 and a centimeter thick sample will have an internal optical transmission >99.5 % and on-axis stray light of <0.5% for the 350-1650nm spectral range2 which is sufficient to permit a demonstration of the feasibility of near diffraction-limited polymer optical systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High quality polymer optics will improve the performance, reduce the size and weight, and increase the durability of household and commercial optical devices, such as telephones, surveillance and web cameras and binoculars.

REFERENCES:
1. Y. Koike, T. Tanio, and Y. Ohtsuka; Macromolecules 22, 1367 (1989)

2. J. Stevens, Proc. of SPIE Vol. 5442 Helmet- and Head-Mounted Displays IX: Technologies and Applications,73-82.

3. N. Tanio and Y. Koike; Jpn J. Appl. Phys, 36, 743 (1997)

4. Y. Koike and K. Koike; J. Polym. Sci. Part B: Polym. Phys. 49, 2 (2011)

5. N. Tanio and Y. Koike; Polymer J. 32, 43 (2000)

KEYWORDS: Thermoplastic Polymers; Optical Fibers, Lens systems, optical design, optical scatter, coextrusion

N132-138 TITLE: <u>High Data Rate Acoustic Communication</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: Advanced Undersea Warfare System - ONR POM-14 FNC EC

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 an acoustic modem for sending information through ocean acoustic channels at extremely high bit rates (~ 500 Kbps) over ranges from 10 to 100 meters.

DESCRIPTION: The key to many off board sensing designs is communication at high data rates with Low Probability of Detection and Low Probability of Interception (LPD/LPI) at relevant ranges. At longer ranges this is very challenging, but as the range requirements are reduced below 100 meters, much higher frequencies and much wider bandwidths are made available. Imaging sonars take advantage of this bandwidth to capture high quality images at ranges up to 80 meters. An Ultra high frequency (.5-1 MHz) modem has only to deal with a one way transmission and will be expected to meet if not exceed the range and information rate of the imaging sonars at similar frequencies. The proposed effort will require the development of sampling and processing hardware and systems that operate at more than order of magnitude higher rates than are found in common commercial practice. Innovative concepts will be required to meet the challenges, particularly in the areas of size, weight and power requirements. System performance will mirror optics in some aspects; mainly that high attenuation limits the useful range, but also the ultimate detectable range.

PHASE I: Develop initial concept design and perform an analysis of the expected performance of a modem including the details of the carrier, modulation, and information coding strategy that will support bit rates in excess of 500 Kbps over ranges from 10 to 100 meters. Analysis should include a Low Probability of Detection and Low Probability of Interception (LPD/LPI) performance characterization with estimates of detection probability as a function of range and other considerations.

PHASE II: Develop a prototype acoustic modem system and demonstrate capacity and other performance metrics using actual transmissions of acoustic data. Analysis should include both communication capacity and LPD/LPI performance characterization as a function of range and other considerations. Develop a production design, including size, weight, power, and costs estimates, as well as complete system performance predictions and evaluations to include capacity estimates under a variety of environmental conditions and ranges.

PHASE III: Transition a successfully tested and functioning point to point communication system on components of the ONR Advanced Undersea Warfare System FNC and demonstrate sharing of both raw and processed information at short ranges. Determine the capabilities and limitations, and obtain end user feedback which can be used to improve the system under a spiral development strategy. SECRET clearance may be required for Phase III.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Direct system application of the modems will likely include users of UUVs in marine construction and oil/gas production, but the concepts developed may be leveraged to enhance other technologies that rely on sound propagation in the ocean for sensing and navigation.

REFERENCES:
1. “Unmanned Undersea Vehicles Master Plan,” 2004. www.navy.mil/navy data/technology/uuvmp.pdf

2. D. B. Kilfoyle and A. B. Baggeroer, “The state of the art in underwater acoustic telemetry,” IEEE J. Oceanic Eng., vol. 25, pp. 4-27, 2000.

3. M. Stojanovic, Josko A. Catipovic, and John G. Proakis, “Phase-coherent digital communications for underwater acoustic channels,” IEEE Journal of Oceanic Engineering, vol. 19, pp. 100-111, 1994.

KEYWORDS: Acoustic Communication, Modem, Underwater Networks, UUV

N132-139 TITLE: Tripwires for PEO C4I Systems

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: Distributed Common Ground System-Navy (DCGS-N) ACAT IAM

OBJECTIVE: Develop a software solution for monitoring and determining the operational condition and effectiveness of PMW 120 fielded systems afloat.

DESCRIPTION: PMW 120 desires the capability to monitor and determine the operational condition and effectiveness of PMW 120 fielded systems afloat. Some of the knowledge desired includes whether PMW-120 systems that are installed on Navy ships are operating correctly as designed and tested, have network connectivity and sufficient bandwidth, system hardware is functioning properly, operators are suitably trained and data is being delivered and utilized effectively and correctly. The developed software solution should be capable of being monitored from a shore location and able to determine the above knowledge without additional instrumentation being installed, and would function as a tripwire to alert the program office before the system degrades to the point of a Casualty Report (CASREP) or significant warfighter dissatisfaction. The solution should also encompass a maintenance analytics solution that will provide real time visibility into system and network component status, predicted downtime/failure rates, as well as recommended actions. Appropriate metrics for system effectiveness, training, network connectivity and other areas will have to be established and methods for remotely determining their values will have to be developed.

The solution will provide PMW 120 with a state of the art measurable and predictive risk based asset management solution that will enable the program office to drive down lifecycle and maintenance costs and improve system operational availability and effectiveness. Ideally, the solution will leverage predictive maintenance tools already being developed by the Navy. In addition, the solution will provide the capability to model system/equipment/LRU failure modes, which would allow continuous estimation of current and predicted equipment/electronics reliability. Based on projected reliability impacts to mission readiness, it would ensure achieving maximum mission reliability with minimum down time. Analysis and work-flow automation would reduce the manning required at the In-Service Engineering Activity shore node. The solution should provide the capability to store maintenance and parts failure history, which allows periodic computation of MTBF, MTTR, at the LRU failure mode level. This includes external factors, such as operator error or ambient conditions. A "one size fits all" solution is not required, but the level of tailoring for any system should be kept to a minimum.

PHASE I: Phase I will result in a design concept for providing a tripwire to predict DCGS-N and JTT system failures and performance issues without instrumenting the systems currently deployed.

Required Phase I deliverables will include:
- Design concept
- Block diagram of proposed solution
- Proposed metrics and measurement methodologies identified
- Proposed schedule for Phase II
- Cost estimate for Phase II
- Phase I Final Report

PHASE II: Based on Phase I efforts and any redirection from the program office, Phase II will develop, demonstrate and validate the solution. A working solution linked to a limited number of fielded systems will be delivered.

Required Phase II deliverables will include:
- Design architecture, algorithms and data analytics
- Test plan
- Software executables and source code
- Demonstration of solution effectiveness and relevance
- Phase II Final report

Phase II will probably require access to classified data for modeling and testing of developed algorithms.

PHASE III: Phase III will consist of transitioning the solution to one of the three programs of record by expanding the type of systems monitored as well as the number of systems concurrently scrutinized. Source code, will be provided in a format compatible with current Navy repositories such as forge.mil.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The solution developed under this topic has potential application to commercial entities seeking to reduce their equipment downtime without instrumentation costs.

REFERENCES:
1. OPNAV INSTRUCTION 3000.12A OPERATIONAL AVAILABILITY OF EQUIPMENTS AND WEAPONS SYSTEMS
http://doni.daps.dla.mil/directives/03000%20naval%20operations%20and%20readiness/03-00%20general%20operations%20and%20readiness%20support/3000.12a.pdf

2. Reliability Information Analysis Center: http://theriac.org/

3. MACSEA Improving Navy Ship Reliability
http://www.automation.com/resources-tools/application-stories/machine-monitoring-control/macsea-improving-navy-ship-reliability

KEYWORDS: Availability; reliability; afloat systems; tripwires; analysis; DCGS-N; SSEE Inc F; NITES Next

N132-140 TITLE: Utilization Of Inference Engine Technology For Navy Cyber Situational Awareness

TECHNOLOGY AREAS: Information 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 means of employing inference engine technology to improve accuracy and speed to response for Navy Cyber Situational Awareness (NCSA) application.

DESCRIPTION: Fleet Cyber Command/U.S. Tenth Fleet (FCC/C10F) is the operational entity responsible for assuring timely, trusted, and comprehensive situational awareness of the cyberspace domain. FCC/C10F currently relies on a variety of disparate tools many of which are based on unique display and database technologies. The current solution fails to meet the objective of providing an integrated, tailorable Cyber Situational Awareness (SA) capability that can incorporate dynamic data feeds synchronized with the maritime operating environment. FCC/C10F desires a Cyber SA system that can utilize data obtained from disparate tools by dynamically consolidating the most relevant information in an amalgamated display. Support of this objective necessitates a means to provide: (1) a well-coordinated picture of Cyber SA, (2) the ability to perform deep analysis of input data from a single source, (3) a solution that is adaptable to new threats and data feeds, (4) agile software development cycles, and (5) a long-term sustainment strategy.

The research question is to explore the extent to which inference engine technology can improve accuracy and speed to response by making inferences from multiple Cyber SA data sources. WolframAlpha is one such example of an inference engine technology.

Of particular interest is the determination of how quickly and directly the technologies can select desired output formats (i.e. visualization, text) appropriate for a particular scenario. As an example an NCSA analyst may receive information from a data source indicating that a particular device has been compromised within a Navy protected enclave. The analyst would likely want to know the location of the device along with any other information related to why the device may be compromised. Inference engine technology has the potential to make associations that may indicate causal or contributing factors to the device compromise. Inference engine technology can also serve to display any such associations in ways that are more meaningful to an analyst such that they are able to more readily determine a response and mitigation.

Data sources in support of NCSA include NetOps (Enterprise Networks Systems Management [ENMS]) and Computer Network Defense [CND] (for example, Host Based System Security [HBSS] and Assured Compliance Assessment Solution [ACAS]); SPACE; Signal Intelligence (SIGINT); and Information Operations (IO). Candidate data sources will include any form of output produced from any system or device within those primary groups (e.g., processed alerts, audit logs, raw data).

In the above example, the indication of a device compromise might result from an ENMS source. The ACAS and HBSS sources could contain information related to the device in question. In such a case the additional ACAS and HBSS data sources would likely contain information identifying causal or contributing events resulting in the device compromise. In addition the data sources could indicate a potential escalation of further device compromise. The accuracy of the correlation of events from such data sources is a key component to Cyber SA. The speed to response is key to contain and correct the situation. Inference engine technology has the potential to make associations related to device query and present the results in a manner that enables an analyst to respond rapidly.

PHASE I: Determine the applicability and relative benefits of inference engine technology to NCSA (candidate inference engine technologies to be discussed at kickoff). Establish control and baseline metrics from which to quantify potential improvements to NCSA accuracy and speed to response. Determine the extent to which the benefit of inference engine technology can be improved through tailoring. Identify other aspects of inference engine technology that may provide additional NCSA utility or new capability.

The phase 1 deliverable will address at least these factors:
• Baseline control metrics of existing NCSA solution accuracy and speed to response
• Initial improvements to NCSA accuracy and speed to response resulting from the use of inference engine technology
• Further improvements to NCSA accuracy and speed to response resulting from tailoring of inference engine technology
• Aspects of inference engine technology that may provide additional NCSA utility or new capability

PHASE II: Provide a practical implementation of the solution researched and designed in Phase I, whether it is an extension of existing inference engine technology or a completely new inference engine technology. Testing and evaluation should be accompanied to illustrate both feasibility and practicality. The solution should also show how the solution can be aligned with NCSA agile development methodologies. Disclosures to the operational environment may be made, making work under Phase II potentially classified.

PHASE III: Transition the proposed solution to current Navy systems that support NCSA.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The big data analytics component realized from this topic also affects industry. Scoping the research and development to improve accuracy and speed would also benefit industry components that already use current solutions.

REFERENCES:
(1) "Analytics in a Big Data Environment" - http://www.redbooks.ibm.com/redpapers/pdfs/redp4877.pdf

(2) "Fact Sheet: Big Data Across the Federal Government" (pg. 1) -
http://www.whitehouse.gov/sites/default/files/microsites/ostp/big_data_fact_sheet_final.pdf

KEYWORDS: cyber situational awareness; inference engine; big data; analytics;

N132-141 TITLE: Determining Evaporative Duct Afloat

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: Naval Integrated Tactical Environmental System Next Generation , ACAT III

OBJECTIVE: Deliver a capability for ship's force to rapidly and continuously measure the evaporative duct height in the vicinity of the ship.

DESCRIPTION: Historically, sea surface temperature, lower atmospheric temperature, relative humidity or wet bulb temperature, (either one), atmospheric pressure, and wind speed are used as inputs for determining evaporative duct height. Additionally, altitude range (height above sea level) measured at intervals of every 10 meters, from the sea surface -- i.e., at 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 meters altitude -- is also a key parameter. Reductions in ship's force manning have eliminated manpower assets that might take some or all of these required measurements. In addition, rapid changes in the evaporative duct height (due to natural changes only, ship movements only, or a combination of both natural environmental changes and ship movements) require a rapid and continuous measuring shipboard capability. An innovative means to determine the evaporative duct height automatically is desired. New ways of determining the height, such as sounders, refractivity or backscatter, that do not increase manpower or work load, or innovative ways to take conventional measurements and then compute the duct height are desired.

PHASE I: A design concept for providing an automated method of determining the evaporative duct height by ship's force.

Required Phase I deliverables will include:
- Design concept
- Block diagram of proposed solution
- Proposed metrics and measurement methodologies identified
- Proposed schedule for Phase II
- Cost estimate for Phase II
- Phase I Final Report

PHASE II: Based on Phase I efforts, and any redirection from the program office, Phase II will develop, demonstrate and validate the solution. A working solution suitable for shipboard use will be delivered.

Required Phase II deliverables will include:
- Design architecture, algorithms and data analytics
- Test plan
- Software executables and source code
- Demonstration of solution effectiveness and relevance
- Phase II Final report

Integration and testing may require access to classified systems, spaces and data.

PHASE III: Phase III will consist of transitioning the solution to the NITES Next program. Source code, will be provided in a format compatible with current Navy repositories such as forge.mil.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a potential for commercial use of the technologies developed. Commercial vessels would benefit from automated measurements of environment factors and the derived determination of the evaporative duct height.

REFERENCES:
1. COMPARISON OF EVAPORATION DUCT HEIGHT MEASUREMENT METHODS AND THEIR IMPACT ON RADAR PROPAGATION ESTIMATES (http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA345694)

2. Evaporation Duct Height (http://www.nrlmry.navy.mil/refract/evapductht.htm)

KEYWORDS: Evaporation ducts; propagation; refractivity; NITES Next; radar clutter

N132-142 TITLE: <u>REUSABLE FORWARD CLOSURE SYSTEM</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Strategic Systems Programs (SSP), 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: Demonstrate the feasibility of a reusable forward closure that allows payload egress without producing debris or environmentally hazardous materials. Additionally, the new concepts must satisfy the requirements of the current closure system such as protecting the payload from the underwater environment and imparting minimal loads on the payload front end during launch.

DESCRIPTION: Before a payload is ejected from a submarine it must typically be protected from the pressure of the ocean environment. The structure that protects the payload while it is in the launch tube is called the forward closure. During launch, the closure must not impede the payload as it exits the launch tube. Current forward closure systems use rigid structures that are separated pyrotechnically or flexible, fly-through structures to allow payload egress. In both cases the closures are destroyed and cannot be reused. In the case of rigid closures, the use of pyrotechnics increase handling costs. Also, the pyrotechnics expel environmentally hazardous material when rupturing the closure. Both rigid and fly-through closures come into contact with the payload front end during egress resulting in a load force. The goal of this project is to develop an innovative closure system that will support a variety of payloads and minimize or eliminate contact loads on the payload nose without producing debris. A challenging constraint for this type of closure system is the need to protect against external forces but also allow payload egress even if the closure fails to respond. In other words, the proposed technology must have an inherent backup capability to limit payload front end loads even in the event of power loss or command loss to the closure. Typically, closures made from stronger materials impart larger forces on the payload during egress. For past and current submarine launched weapons, a non-destructive, reusable closure has not been realized in part because of the technical challenges involved. Past closure technologies, such as frangible structures, flexible membranes, or hard pyrotechnically separated shells are all necessarily destroyed when the payload egresses. A new technology is needed to allow payload egress without destruction of the closure itself.

A reusable closure system needs to perform the same functions as a traditional closure in a demanding environment. These functions include protection of flight payloads from hydrostatic pressures of up to 150 psi and ability to allow the payload to egress during launch without interference. The closure should offer fast response and reaction times on the order of milliseconds. The target payload size will be between 30 to 40 inches full scale; however, the functionality of the proposed technology could be demonstrated at a subscale level. This topic is looking for new innovative technologies or concepts that provide equivalent performance as current systems with additional capabilities that minimize impacts to the payload and support reusability.

PHASE I: Determine the technical feasibility of a reusable closure. Use analysis, modeling and simulation, or subscale bench testing to prove the feasibility of the proposed concept. Complete the concept study of the closure system key components. Perform a study to examine potential scaling issues

PHASE II: Complete the design of the proposed system. Produce a subscale prototype reusable closure and demonstrate its predicted performance through testing.

PHASE III: Technology would be transitioned to the Ohio Replacement Program (OR Program) technology portfolio for inclusion in the OR Program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A cost effective, reusable closure that allows launch of payloads and provides protection against high pressures will have a variety of commercial and military applications. Applications in the private sector include rapid, low cost deployment of sensors and sono-buoys from ships and underwater vehicles for oceanographic data collection, pollution monitoring, and offshore exploration. A closure that allows reset to its original state would support the undersea recovery of sensors by the deployment vehicle.

REFERENCES:
1) Mussey, Richard A., “Launch Tube Closure.” US Patent 4301708. 24 Nov. 1981.

2) Callahan, Jeffrey C., “Submarine Horizontal Launch TACTOM Capsule.” US Patent 6427574 B1. 6 Aug. 2002.

3) Paul, Buddy R., “Article Comprising a Canister Closure with Pressure-Pulse Release.” US Patent 7685920 B2. 30 Mar. 2010.

4) Stephen J. Plunkett, Richard E. Dooley, “Launch tube system having inflatable bladder shock isolation.” US Patent 7128013. Issued 31 Oct 2006.

5) Sketch, Closure Envelope Space Calculation, uploaded in SITIS 5/23/13.

KEYWORDS: Seal; launch; closure; underwater deployment; reusable; launch tube

N132-143 TITLE: FLEXIBLE LATERAL MISSILE SUPPORT SYSTEM

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Strategic Systems Programs (SSP), 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 lateral support system that is remotely operable, maintains launcher alignment, protects a launcher and payload from shock and vibration inputs while it is stowed within a missile tube environment, and is able to actively adjust to and react to a dynamic shock and vibration setting.

DESCRIPTION: Currently, lateral support between the launch canister and the missile tube is provided by twelve hydraulic-actuated jacking foot assemblies that sit on studs mounted in the launch canister. Each jacking foot is approximately 8 inches high by 12 inches wide and contoured to generally match missile tube curvature. A neoprene pad is bonded to each jacking foot to prevent metal-to-metal contact and provide flexibility between the shoe and missile tube wall. The purpose of the jacking feet is to provide lateral support to the launch canister within the missile tube for depth changes and shock. The design and location of the lateral support system are a function of the missile geometry and weight distribution and provide no ability to accommodate changes in payload configuration.

The current lateral support system is also a static system that cannot be accessed or adjusted with the launch canister in place. A significant effort is required to remove and repair current components and potentially destroys launcher components during removal. The large mechanical components also use up valuable tube space that could be otherwise mission-utilized.

The deployment of a new or upgraded missile will require changes to the current fixed lateral support systems. The jacking feet and pads could be replaced with advanced materials or components that can be tuned and adapted by a control system that would allow varying payloads in a configured tube without labor intensive and consumptive removal and install operations.

PHASE I:
• Develop operational scenarios and define parameters for payload flexibility and missile tube reconfiguration
• Develop concepts and perform trade studies and conduct analysis (e.g., Modeling & Simulation)
• Identify possible materials, components, and system design
• Perform full scale analysis of lateral support concept against defined shock and vibration scenarios.

PHASE II:
• Perform component and subscale testing (i.e., shock, vibration, age-life testing) with scaled payload
• Perform full scale testing with representative payload
• Develop control system for integration with ship/fire control

PHASE III: Transition concepts and technologies developed in Phase II to applicable launcher program(s) / area(s). Following the transition to launcher programs, work with the Launcher Branch to demonstrate a near tactical lateral support system’s functionality in conjunction with a representative payload shape in a simulated or relevant payload environment. The near tactical eject system needs to demonstrate the ability to protect the payload during a shock or vibration event and to adapt to alternate payloads.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The lateral support technology is applicable for multiple commercial applications requiring shock and vibration protection. For example, a support system using magneto-rheological materials has been applied in the automotive industry such that the technology reduces shock and vibration inputs into the car resulting from rough road conditions.

REFERENCES:

1. Regelbrugge, Marc E.; Carrier, Alain C.; Dickson, William D.; (1995) Canceling vibrations with smart materials: a case study. Proceedings of SPIE - The International Society for Optical Engineering, v 2447, p 80-90, 1995

2. Song, G., Sethi, V., Li, H.-N.; (2004). Vibration control of civil structures using piezoceramic smart materials: A review; Department of Mechanical Engineering, University of Houston.

3. http://www.frost.com/prod/servlet/report-brochure.pag?id=D193-01-00-00-00, Smart Materials: Emerging Markets for Intelligent Gels; Ceramics; Alloys and Polymers (Technical Insights)

4. Sketches of current lateral support system (uploaded in SITIS 5/1/13).

5. Sketch, Lateral Support Space Envelope, uploaded in SITIS 5/23/13.

KEYWORDS: Radial Support; Advanced Materials, lateral support; magneto-rheological; piezoelectric; Shape memory

N132-144 TITLE: Development of Novel and Emerging Technology for the Enhancement of Fault Diagnostics

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

ACQUISITION PROGRAM: Strategic Weapons Systems: Trident II D5 (ACAT I)

OBJECTIVE: The overall objective is to develop innovative methods and tools to optimize maintenance by determining the most effective maintenance path considering history, likelihood of success for corrective actions, time constraints, and likelihood of future failures and then provide corrective action data.

DESCRIPTION: The current submarines are using aging Inertial Navigation Systems (INS), and maintenance for the INS is increasing. As a result of the increasing need for maintenance of the INS, and the reduction of maintenance support, a need for maintenance to be optimized is increasing. However, only traditional means for troubleshooting exists.

To reduce the Mean Time To Repair (MTTR), an innovative tool is desired to optimize maintenance. This tool should be capable of determining the most likely corrective action to take when maintenance is required. The tool should at a minimum take into account past failures and their corrective actions, likelihood of success for corrective actions, time constraints to determine the optimal corrective action. The tool should also factor into account potential future failures. It is desired for this tool to be able to predict future failures which may or may not have occured in the past.

PHASE I: 1) Develop enhanced diagnostics tool approach containing the above-mentioned attributes. Development of a minimal proof of concept to evaluate feasibility would be beneficial, but is not required provided sufficient documentation is made available. 2) Develop metrics and a strategy for measuring the effectiveness of the proposed approach. 3) Produce a detailed research report outlining the concept of the tool, as well as the advantages and disadvantages of the proposed approach.

PHASE II: 1) Based on the results from Phase I, develop a fully functioning proof of concept solution. 2) Provide experiment results that evaluates effectiveness of the overall system. 3) Develop a final report completely describing the concept

PHASE III: Develop and evaluate a fully packaged enhanced diagnostic tool that is suitable for use in a multitude of military and commercial applications. If successful, this device would transition into a future SP24 Shipboard Systems Integration Development Program and/or the ESGN Sustainment Program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would be able to be used in any advanced system that requires maintenance, such as a commerical Autonomous Underwater Vehicle's (AUV).

REFERENCES: None

KEYWORDS: Maintenance; Inertial; Navigation; Diagnostics; Faults; Submarine

N132-145 TITLE: Advanced Radiation Hardened Data Converter Architecture

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Electronics, Weapons

ACQUISITION PROGRAM: Trident II (D5), 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 an advanced radiation hardened data converter architecture which enables high speed (>25MHz) data conversion while reducing the need for multi-cycle latency and extensive active circuitry.

DESCRIPTION: Current high speed radiation hardened and commercial analog-to-digital (ADC) and digital-to-analog (DAC) converter topologies provide 1MHz to 20MHz conversion via multi-stage pipelining and error correction circuitry. This approach to data conversion results in large silicon footprints, 3 to 4 clk cycle latency, increased susceptibility to radiation effects, and increased radiation event recovery times.
This research effort seeks to develop a data conversion architecture with the following capabilities:
1. >25MHz 14 Bit data conversion
2. 1 clock cycle conversion (no latency)
3. Applicable to ADC & DAC converters
4. Reduced silicon footprint, enabling System-on-Chip (SOC) integration of multiple converters
5. Incorporation of Rad-Hard by Design (RHBD) techniques/topologies
6. Portable to existing commercial Integrated Circuit (IC) processes

PHASE I: The contractor shall deliver a detailed circuit topology with complete electrical modeling & simulation results demonstrating the capabilities of the developed architecture. Space and Strategic rad hard capabilities should be targeted. The design should target existing readily accessible IC processes. Ready to ship GDSII file should be delivered at phase end.
The contractor will propose a plan for the manufacturing and testing of prototype hardware performance in electrical and radiation environments to be conducted in Phase II.

PHASE II: The contractor shall produce prototype hardware defined in Phase I and demonstrate electrical and radiation environment performance through laboratory testing. An assessment of performance shall be delivered in formal report, along with finding and discoveries to be exploited for further advancement of the technology. The contractor will deliver updated modeling and simulation results and an updated ready to ship GDSII file at phase end.

PHASE III: Given successful completion of Phase II, a larger quantity of the integrated product shall be manufactured for larger scale testing and demonstration in candidate systems, for example Advanced IFOG or other sensor/instrument based systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Developed circuitry could be utilized by the space industry for satellite applications. The architecture can be applied to "traditional" pipeline data converter topologies to achieve faster sampling rates and increased resolution.

REFERENCES:

1. R. Ladbury, "Radiation Hardening at the System Level," Presented at the 2007 Nuclear Science and Radiation Effects Conference Short Course, Waikiki, HI, July 2007.

2. B. D. Olson, "Single-Event Effect Mitigation in Pipelined Analog-to-Digital Converters," Ph.D. dissertation, EECS, Vanderbilt University, Nashville, TN 2010.

KEYWORDS: analog to digital converters; digital to analog converter; microelectronics; radiation-hardened-by-design; integrated circuit design; rad hard electronics

N132-146 TITLE: <u>High Temperature Material Coatings</u>

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: Trident II (D5), 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: For future solid propulsion applications, develop and evaluate refractory coatings for carbon-based substrates that will survive an oxidizing environment of 1) greater than 3200 deg F for 10 minutes and 2) greater than 5,000 deg F for 1 minute. Evaluate the mechanical properties of the coating-substrate technologies and establish proof of concept in a laboratory environment and then subscale solid rocket motor firings.

DESCRIPTION: The current state-of-the-art for strategic solid rocket motor and gas generator components is to use expensive, monolithic refractory metals, such as tantalum tin tungsten, or ablative carbon materials that require long-lead procurement times. A less expensive, less time consuming, and non-eroding material-design solution is desired. The technical challenge is to develop a coating that bonds well to a carbon-based substrate while having the necessary high-temperature mechanical and chemical properties to survive a solid rocket motor firing. Potential applications include solid rocket motor nozzle flame-side liners, and manifolds and valve components for hot-gas control systems.

PHASE I: The contractor shall deliver a report that provides 1) details on the fabrication approach for high-temperature coating technologies for carbon-carbon and/or carbon phenolic, 2) microscopy/metallographic evaluation of the fabricated coating-substrate bond line, and 3) mechanical property evaluation of the coating-substrate bondline. Multiple candidates for high-temperature coating technologies shall be investigated for further evaluation and down selection in Phase 2 and Phase 3.

PHASE II: The contractor shall deliver a report on the evaluation of multiple candidates for coating technologies in laboratory evaluations of high-temperature compatibility. The laboratory evaluations shall be conducted at temperatures greater than 3,000 deg F using a gaseous environment that mimics the oxidizing potential of solid rocket motor propellant and gas-generator propellant combustion products to investigate gas-solid interactions. The report shall include pre- and post-test microscopy/metallographic evaluation of the fabricated coating-substrate bond line. The report shall include performance evaluations and down-selection to two coating candidate technologies.

PHASE III: The contractor shall deliver a report on the evaluation of coating-substrate samples that have been subjected to subscale solid rocket motor firings having a burn duration of greater than 30 seconds. The report shall include pre- and post-test microscopy/metallographic evaluation of the fabricated coating-substrate bond line. The report shall include performance evaluations and down-selection to one coating technology candidate for future evaluation and demonstration in an RDT&E Strategic Propulsion Applications Programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High temperature coatings are applicable throughout aerospace including commercial launch vehicles and air-breathing propulsion.

REFERENCES:
1. NASA SP-8115, Solid Rocket Motor Nozzles (June 1975)

2. AIAA-2000-3559, Economical Erosion-Resistant Rhenium Coating on Carbon Substrates

KEYWORDS: refractory coatings; high-temperature coatings; non-eroding coatings; solid rocket motor nozzle liners; pintle valves; hot gas manifolds; carbon-carbon substrates; carbon-phenolic substrates