NAVY
12.1 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, e-mail: 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 **9 November 2011 through 11 December 2011.** Beginning **12 December 2011**, the SITIS system: http://www.dodsbir.net/Sitis/Default.asp listed in Section 1.5, c of the DoD Program Solicitation must be used for any technical inquiry.

TABLE 1: NAVY SYSCOM SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	Activity	E-mail
N121-001 thru N121-003	Mr. Paul Lambert	MARCOR	sbir.admin@usmc.mil
N121-004 thru N121-045	Ms. Donna Moore	NAVAIR	navair.sbir@navy.mil
N121-046 thru N121-077	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N121-078	Mr. Chris Coleman	NSMA	chris.coleman@navy.mil
N121-079 thru N121-102	Ms. Tracy Frost	ONR	tracy.frost1@navy.mil
N121-103 thru N121-106	Ms. Summer Jones	SPAWAR	summer.m.jones@navy.mil

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

PHASE I GUIDELINES

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

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

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

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

PHASE I SUMMARY REPORT

All awardees must submit a non-proprietary summary of their final report (without any proprietary or data rights markings) through the Navy SBIR website. Submit the summary at: **http://www.onr.navy.mil/sbir**, click on "Submission", and then click on "Submit a Phase I or II Summary Report". A template is provided for you to complete. This summary, once approved, may be publicly accessible via the Navy's Search Database.

PHASE II GUIDELINES

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

The Navy will invite, evaluate, and select Phase II proposals using the evaluation criteria in Section 4.3 of the DoD Program Solicitation in descending order of importance with technical merit being most important, followed by qualifications and commercialization potential of equal importance. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy does NOT participate in the FAST Track program.

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

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

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

PHASE II ENHANCEMENT

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

PHASE III

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

ADDITIONAL NOTES

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

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

PHASE I PROPOSAL SUBMISSION CHECKLIST:

The following criteria must be met or your proposal will be REJECTED.

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

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

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

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

____5. Upload your technical proposal and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and Cost Proposal electronically through the DoD submission site by 6:00 am ET, 11 January 2012.

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

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N121-035	NANOMATERIALS FOR THERMAL BATTERY
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N121-082	A Cognitive Architecture for Naval Mine Countermeasures (MCM)
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NAVY SBIR 12.1 Topic Descriptions

N121-001 TITLE: Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits

TECHNOLOGY AREAS: Materials/Processes, Electronics

ACQUISITION PROGRAM: Ground/Air Task Oriented Radar (G/ATOR)

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 Atomic Layer Deposition (ALD) Silicon Nitride (SiN) thin-film process that is conformal, uniform, void and pin hole-free, dense, no embedded traps, and is deposited at a process temperature not exceeding 300 degrees C. The ALD SiN process to be developed must be both cost and processing time competitive with present PECVD SiN in use.

DESCRIPTION: DOD systems under development such as Active Phased Array Radars and Communication Systems utilize Gallium Arsenide (GaAs) and Gallium Nitride (GaN) MMICs, that use Plasma Enhanced Chemical Vapor Deposition (PECVD) Silicon Nitride thin film technology as both a passivation and as a dielectric for capacitors. PECVD deposited SiN dielectric film's embedded traps, pin-holes, overall lack of density, and voltage breakdown limitations, cause transistor gate leakage and capacitor failures on the MMIC, limiting MMIC wafer yield; however, an Atomic Layer Deposition Silicon Nitride Process would be dense, pin-hole and trap free uniform, and improved voltage breakdown, reducing the transistor gate leakage and capacitor failures, and improving the overall MMIC wafer yields.

PHASE I: Identify potential new and innovative research and development approaches that lead to an Atomic Layer Deposition (ALD) Silicon Nitride thin-film process. Explore expansion of the proposed process to other popular Silicon based thin film processes. Demonstration of the proposed prototype ALD SiN process is a plus at this stage, but not required. Collaboration with a GaN MMIC foundry is highly recommended.

PHASE II: Develop the proposed ALD thin-film SiN dielectric process, and other processes that are based upon the Phase I effort that will transition into a Gallium Nitride MMIC Foundry. Collaboration with a GaN MMIC foundry in Phase II is necessary in order to transition the process in phase III. Demonstrate the ALD SiN thin-film process, and measure the qualities and characteristics of the dielectric film.

PHASE III: Develop pre-production MMICs/ICs utilizing the processes developed under Phase I and II, in a GaN MMIC Foundry.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Cell Phone industry, WiMAX, Commercial Radars and Communication Systems, and Power Applications such as DC-to-DC Converters.

REFERENCES:
1. S.M Sze, Physics of Semiconductor Devices, John Wiley & Sons, 1981.

2. Jacob Millman, Micro-Electronics: Digital and Analog Circuits and Systems, McGraw-Hill, 1979.

KEYWORDS: Atomic Layer Deposition (ALD); Silicon Nitride (SiN); Gallium Nitride (GaN); Microwave Monolithic Integrated Circuit (MMIC); Transistor; Thin-Film Technology

N121-002 TITLE: HMMWV Variable Vehicle Cone Index (VCI)

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Program Manager Motor Transportation, HMMWV, ACAT 1C

OBJECTIVE: The HMMWV ORD clarification, dated 22 July 2010, requires the HMMWV to have a not-to-exceed Vehicle Cone Index (VCI) of 25 (Threshold). The VCI of the HMMWV in its current configuration is approximately 31 at 15,500 lbs. The objective of this SBIR is to develop a system that will enable the HMMWV to achieve the Threshold VCI of 25 at the GVW of 15,500 lbs. Additionally, it is desired to be able to vary the VCI "on-the go" to provide for rapid transitions between different surfaces, such as soft soils and hard surfaces.

DESCRIPTION: Soil strengths are described in terms of Rating Cone Index (RCI), as soils get softer (mud, snow, sand, silts, etc) the RCI gets lower. A vehicle's VCI describes the capability of a vehicle, as determined by test methods, to traverse a given soil a in single or multiple passes. To traverse a soil with an RCI of 20, a vehicle must have a VCI of 20 (or less). Since VCI is largely dependent on the contact patch of the tire and vehicle axle weight, varying the tire contact patch will also vary the VCI.

PHASE I: The contractor will investigate concepts for varying the HMMWV VCI on the fly based on soil and road conditions. The contractor will develop an analytical model to compare different concepts to include projected performance, reliability, maintainability. The contractor shall estimate hardware, installation and maintenance costs. The contractor will present the alternatives at the end of Phase I and make a recommendation for a Phase II demonstration.

PHASE II: The contractor will develop a prototype of the variable VCI system and evaluate it on a Government Furnish HMMWV. The modified HMMWV will be tested to validate the performance, reliability and maintainability of the variable VCI system.

PHASE III: A successful variable VCI system will follow a dual transition path. Some systems will be integrated onto HMMWVs that are deployed in mission areas that require variable VCI, while the overall system design will transition into the HMMWV RECAP program to facilitate that vehicle's need to traverse multiple soils.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The need to rapidly and safely traverse multiple soil types exists in many industries including agricultural, mining, oil exploration and forestry. Additionally, commercial recreation endeavors such as off-road vehicle competition and winter sports activities could benefit from a system that varies vehicle VCI.

REFERENCES:
(1) AGRICULTURAL ENGINEERING: AGRICULTURAL MECHANIZATION, Vincent A. Dodd, Patrick M.Grace

(2) CORRELATION OF MOBILITY CONE INDEX WITH FUNDAMENTAL ENGINEERING O PROPERTIES OF SOIL, Bohzad Rohani and George Y. Baladi, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS

(3) CENTRAL TIRE INFLATION SYSTEMS MANAGING THE VEHICLE TO SURFACE, Society of Automotive Engineers

KEYWORDS: Tire Contact Patch; Vertical Cone Index; Soil Rating Cone Index; Central Tire Inflation System; Soil Stability; Vehicle Mobility

N121-003 TITLE: Distributed storage in wireless mesh networks

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Marine Air Ground Task Force Command and Control 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: MAGTF C2 Systems is interested in indentifying a sound technical solution to facilitate distributed storage in wireless mesh networks. The developed protocol should provide an alternative solution for solving the data-at-rest problem. Ultimately, the desired goal is to alleviate sole dependency on encryption.

DESCRIPTION: Distributed storage is an important paradigm that has been embraced in many computing contexts, but faces unique challenges in the military austere wireless domain. For instance, the operational domain may dictate that a single data object should be spread across multiple devices for: i) performance; ii) security; and iii) resilience. Meeting the required objectives may require understanding of the physical space in which devices are operating (as opposed to fixed infrastructure), using distribution strategies that prevent insecure reconstitution of objects, etc.

There are a couple distributed storage technologies available today, however, each lacks at least one specific property of interest. For example, distributed storage properties include: 1) encryption, 2) erasure coding, 3) complete replication, 4) pre-shared key, 5) relies on external authentication, 6) scales to large sizes, or 7) external infrastructure dependencies. The current solutions include Mobile Distributed File System (MDFS) – containing the properties 1, 2 & 5; Tahoe-LAFS – containing the properties 1, 2, 4, & 7; Unisys Stealth – containing the properties 1, 2, 4, & 7; and GFS & Bigtable – containing the properties 3, 5, 6, & 7. This topic is interested in properties that facilitate distributing the storage without being vulnerable to single points of failure. For example, if one node is lost or compromised, the data is not recoverable without other nodes. Additionally this topic is interested in scaling the protocol, not relying on external infrastructure, not relying on pre-shared keys, or complete replication.

An innovative approach of interest is to integrate advanced concepts include erasure coding, Shamir’s threshold based secret sharing algorithm, and symmetric AES cryptography. The resulting system supports two important properties: (1) data can be recovered only if some minimum number of devices are accessible, and (2) sensitive data remains protected even after a small number of devices are compromised.

This topic is interested in optimizing mesh networks by leveraging the shared storage capacity and limiting the vulnerability associated with one node inherently hosting the data.

PHASE I: This would consist of a feasibility assessment using the proposed distributed storage protocol to meet MC2S program requirements. This phase may be extended beyond developing the proposed solution to prototype in follow-on phases.

PHASE II: This phase would consist of prototyping a design meant to meet the requirements of MC2S program, ensuring manufacturability, producibility and reproducibility. This phase would also look at the integrity and maintainability of design, as compared to conventional methods.

PHASE III: This phase would consist of perfecting the design, and acquisition of the final solution utilizing government funds (NON-SBIR) under the MC2S program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Ultimately the solution could provide a mechanism to increase storage capacity and reduce security vulnerabilities inherent to mobile devices.

REFERENCES:
1. F. Chang, J. Dean et al., “Bigtable: a distributed storage system for structured data,” in Proceedings of the 7th USENIX Symposium on Operating Systems Design and Implementation - Volume 7, Berkeley, CA, 2006, pp. 205–218.

2. Z. O’Whielacronx. (2011) zfec 1.4.22 erasure codec. [Online]. Available: http://pypi.python.org/pypi/zfec

3. Tahoe-LAFS. (2010) Tahoe least authority file system. [Online]. Available: http://tahoe-lafs.org/trac/tahoe-lafs

4. A. Dimakis, P. Godfrey, Y. Wu, M. Wainwright, and K. Ramchandran, “Network coding for distributed storage systems,” IEEE Transactions on Information Theory, vol. 56, pp. 4539 – 4551, Sep. 2010.

5. Huchton, Scott. “Secure Mobile Distributed File System (MDFS). Naval Postgraduate School. March 2011

KEYWORDS: Distributed File System; Distributed Storage; Bigtable; Unisys Stealth; Google File Storage; Tahoe-LAFS

N121-004 TITLE: Detection and Tracking of Moving Vehicles and Dismounts Across the Land–Sea Boundary

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

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: Develop a comprehensive suite of algorithms that can be used to detect and track moving vehicles (small boats and land vehicles) and dismounts when coverage extends across the open water, surf zone, and beach; perform accurate long-term tracking of detected targets; and reduce computational complexity, resulting in a high probability of detection with minimal false alarms.

DESCRIPTION: The ability to detect and track moving vehicles, small boats, and dismounts in the vicinity of the shoreline is a mission-critical function in littoral warfare. Traditional radar-based overland moving target indication algorithms suffer from poor performance in open water environments and at the land–sea boundary. Clutter characteristics and associated internal clutter motion differ dramatically as the radar beam shifts from an overland field of view to one that includes the beach and surf zone and then to one that is exclusively open ocean. In order to address these dramatically different clutter environments, adaptive algorithms are needed that will recognize and adapt to the varying clutter conditions. These algorithms must then be mated with appropriate transmit waveforms, antenna design, and platform characteristics to maximize performance.

A fully automated solution is desired. However, solutions may involve varying levels of human-in-the-loop involvement in the detection and tracking problem to help mitigate false alarms, but this level of involvement should be as minimal as viable and needs to be explicitly and quantifiably defined by the system. Metadata and contextual inputs to the algorithms are also permitted—with the same restrictions as for human-in-the-loop involvement. An innovative solution should avail itself of a combination of existing techniques while adding to these its own improvements and should also attempt (and justify) new methodologies.

PHASE I: Show proof of concept for algorithms that detect and track moving vehicles (small boats and land vehicles) and dismounts when coverage extends across the open water, surf zone, and beach; algorithms that perform accurate long-term tracking of detected targets; and algorithms that reduce computational complexity. Integrate the algorithms into a comprehensive algorithm suite and test them using government-controlled data.

PHASE II: Complete primary algorithmic development and primary software system implementation of algorithms. Test the completed algorithms using government-controlled data. Software implementation is required for testing and demonstration. However, principle deliverables are the algorithms. Documented algorithms (along with system software) should be fully deliverable to the government in order to demonstrate and further test system capability. Successful testing at the end of Phase II must show level of algorithmic achievement such that potential Phase III algorithmic development demands no major breakthroughs but would be a natural continuation and development of Phase II activity.

PHASE III: Complete final algorithmic development and final software system implementation of the algorithms. Test the completed algorithms using government-controlled data. Documented algorithms (along with system software) should be fully deliverable to the government in order to demonstrate and further test system capability.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This suite of algorithms can be used by the Department of Homeland Security for border protection. In private industry, the algorithms can be used for aspects of combined urban and maritime surveillance.

REFERENCES:
1. Guerci, J. R. (2010). Cognitive radar: The knowledge-aided fully adaptive approach. Boston, MA: Artech House.

2. Gini, F., & Rangaswamy, M. (Eds.). (2008). Knowledge based radar detection, tracking and classification. Hoboken, NJ: Wiley & Sons.

KEYWORDS: Aided Target Detection, Dismount Target Tracking, Human Activity Classification, Threat Determination

N121-005 TITLE: <u>Small Projector Array Display System</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Human Systems

ACQUISITION PROGRAM: JSF-AL

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OBJECTIVE: Develop innovative technology leveraging the large numbers of small commercial off the shelf (COTS) Light Emitting Diods (LED) based projectors to create a cost effective, high performance, immersive, rear-projection display system with small footprint.

DESCRIPTION: Currently, projectors used to create immersive high resolution display systems have cost, performance, size, and reliability issues. Arrays of LED based pico projectors can be harnessed to solve these problems but the technology does not yet exist to integrate them into arrays suitable for the unique requirements for real time simulation. Pico projectors are a recent product development and are rapidly improving in brightness and resolution, as high as 1280 by 800. This makes them a viable solution for rear projection displays by replacing one high performance projector with an array of pico projectors. The missing component of such a system is a video processor capable of importing one or more Image Generator video inputs, processing the video as required for immersive displays, and exporting to multiple pico projectors. Research and development is needed to create a rear projection system solution. Inherent advantages include low maintenance, high system reliability and stability, lower power, low cost, higher resolution, smaller display system footprint, and video black levels suitable for stimulating Night Vision Goggles (NVGs). Current training simulators typically have less than 20/20 visual resolution. In order to achieve 20/20 resolution, an array of small solid state projectors is required to replace each current projector. Also for rear projection systems, the display footprint and height is large, resulting in significant construction cost for facilities large enough. The large size also limits where they can be used. This system design approach includes any features uniquely beneficial to or necessary for real time training simulation.

PHASE I: Research and develop a system design approach to incorporate LED projector arrays into a display system suitable for training simulators. Evaluate benefits, risks, and feasibility of the proposed concept design. Demonstrate the technical feasibility of new techniques.

PHASE II: Complete/enhance the design proposed in Phase I. Build a prototype capable of meeting typical simulator display system requirements including alignment, synchronization, latency, compatibility. The prototype should also demonstrate any innovative features uniquely beneficial to real time training simulation. The prototype may be a subsystem of an immersive display or a fully immersive display. The specific implementation of the prototype shall be determined at a later date by mutual agreement between the government and contractor

PHASE III: Refine and transition the Phase II prototype effort into a solution that supports military and commercial real time simulation for pilot training.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial training flight simulators, improved immersive display systems for research such as the cave immersive display that is low resolution, extremely high resolution (20/20) with a large Field of View (FOV) display is the ideal solution for human visual interface with many applications including remote surveillance. The new display technology would be an ideal match for collimated wide displays required by Federal Aviation Administration (FAA) for commercial pilot training.

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1. Colin, D. (2009). The Pico Projectors Have Arrived! http://www.projectorcentral.com/pico_projectors.htm

2. Ephanov A. & Coleman C., Virtual Texture: A Large Area Raster Resource for the GPU, I/ITSEC 2006.

3. Patrick, E., Cosgrove, D., Slavkovic, A., Rode, J.A., Verratti, T., & Chiselko, (2000). Using a large projection screen as an alternative to head-mounted displays for virtual environments. In Proc. of the SIGCHI Conference on Human Factors in Computing Systems (CHI ’00), ACM Press, 478-485.

KEYWORDS: training; simulation; projectors; virtual reality; visual; display

N121-006 TITLE: Magnetic Noise Reduction in a Small Unmanned Aerial Vehicle

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA 264

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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 magnetic noise reduction system that will reduce platform magnetic noise in a small Tier 1 and/or Tier 2 unmanned aerial vehicle (UAV).

DESCRIPTION: The next Navy antisubmarine warfare (ASW) airborne platform is the P-8A. During the ASW mission, the P-8A is flown at high altitudes. Currently, a magnetic anomaly detection (MAD) system is used on ASW aircraft to contact, confirm, localize, and track submarines. However, magnetometers have a short intrinsic range and therefore will work only at low altitudes. To enable the P-8A to complete its mission successfully, a UAV with a magnetometer on board can be launched from the P-8A that will then fly down to a workable altitude to detect, localize, and track the submerged submarine.

Two types of UAV systems have been considered for this activity: small, modest-endurance, disposable platforms (Tier 1) and medium, long-endurance retrievable platforms (Tier 2). However, both platforms produce magnetic noise that can reduce their ability to detect the magnetic field produced by the submarine. Classic sources of magnetic noise include noise produced by the UAV's permanent, induced, and eddy current magnetic moments. Electronic sources of noise include noise produced by the UAV's avionics, wiring, and power generation/supply. The combination of classic magnetic noise and electronic noise is termed the platform noise. Additionally, there are environmental noises such as geomagnetic (sunspot and solar activity), geologic, and ocean swell that affect the detection range. This topic primarily addresses platform noise issues, but environmental noise cancellation techniques may also be included.

Current magnetometers have a sub-pico Tesla (pT) noise level, and it would be ideal to reach that noise level in the air, but previous work has shown that platform and environmental noise compensation have effective limits. The realistic goal of this project is to reduce the platform noise contribution to <10 pT/rt Hz in the 0.05 to 0.5 Hz band and <1 pT/rt Hz in the .05 to 5 Hz band, and <10 pT/rt Hz in the power line frequency and harmonic band.

The company selected for this project should be expert in airborne magnetometry and noise reduction tailored to a typical small Tier 1 and/or Tier 2 UAV.

PHASE I: Propose effective methods for reducing the platform noise of a Tier 1 or 2 UAV using hardware and/or software tools in order to maintain the noise level specified in the description.

The magnetometer, any other sensors, and the UAV will need to be provided by the contractor. The Navy will not furnish a UAV nor coordinate the use of a UAV for testing in the Phase I or Phase II effort.

Environmental noise cancellation techniques and automatic target detection may be addressed in this phase but are not required.

PHASE II: Develop a prototype magnetic noise reduction system that implements the hardware and software tools proposed in Phase I and validate the system in ground and flight tests. Also verify that the noise reduction techniques do not reduce the target signal. Typical target magnetic moments will be specified in the Phase II testing.

PHASE III: Integrate the magnetic noise reduction system in a Navy-selected UAV and demonstrate its effectiveness.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Geophysical exploration companies use magnetometery for locating oils and minerals. A small, sensitive magnetometer aboard a UAV would permit more extensive and less costly exploration. Additionally, MAD-equipped UAVs can be launched from surface ships for ASW missions. Also, the Army is investigating the use of magnetometer and E-field-equipped UAVs for power line monitoring and detection.

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KEYWORDS: MAD; magnetometer; UAV; ASW

N121-007 TITLE: LOW-TEMPERATURE/HIGH-VOLTAGE THERMAL BATTERY

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

ACQUISITION PROGRAM: PMA 264

OBJECTIVE: Develop a high-voltage thermal battery with a low operating temperature to increase battery operating life and safety.

DESCRIPTION: Standard thermal batteries operate at temperatures between 310 degrees Celsius and 500 degrees Celsius. These batteries are used in systems capable of handling such high temperatures without resulting in damaged electronic components, or possibly in ignition or degradation of sensitive materials located within the battery's vicinity. However, there is a need for batteries that do not operate at such high temperatures and have an operating life of over 20 years. Low operating temperature thermal batteries would have a longer life and would be safer; in addition, they would result in decreased overall material cost, battery case temperature, and battery size.

Miles et al. conducted work by using molten nitrate electrolytes as a viable low- temperature alternative to current electrolytes. They observed that the main problem of using molten nitrate electrolytes was contamination by chloride ions, sodium ions, and moisture. In particular, moisture contamination results in the evolution of hydrogen gas and, therefore, a very unstable battery.

General requirements for developing a high-voltage thermal battery with a low operating temperature include identifying suitable materials for the anode, cathode, electrolyte, and the material that will supply heat to melt the electrolyte. The electrolyte melting temperature should be between 100 degrees celcius and 230 degrees celcius. A single-cell battery must have the following performance characteristics that are equal to or better than current technology: voltage >2 V, current density >0.5 A/cm2, and current pulse >6 A/cm2. The batteries will be tested in operational and non-operational environments and undergo U.S. Navy safety testing.

PHASE I: Identify suitable materials for the anode, cathode, electrolyte, and the material that will supply heat to melt the electrolyte. Test a single-cell battery with the following design. Performance characteristics that are equal to or better than current technology: voltage >2 V, current density >0.5 A/cm2, and current pulse >6 A/cm2.

PHASE II: Develop a full-size prototype battery with at least 30 V, maintaining current density >0.5 A/cm2 and current pulse >6 A/cm2. Demonstrate battery performance by testing a sample of batteries meeting performance requirements of an actual missile system. Fully document all fabrication, test processes, test data, and results.

PHASE III: Transition technology to commercial and military applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Temperatures observed in boreholes for oil and gas drilling exploration are in the temperature range of this SBIR, and hence the battery developed can be used as power supply for measurement equipment.

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3. Miles, M. H. (June 12-15, 2000). Lithium thermal batteries using molten nitrate electrolytes. Proceedings of the 39th Power Sources Conference, pp. 560-563. Cherry Hill, NJ.

4. Miles, M. H., Grumet, A. A., & Solomon K. U.S. Patent 7629075, issued December 8, 2009.

KEYWORDS: Thermal Battery, Low Operating Temperature, Cathode, Anode, Electrolyte, Nitrate

N121-008 TITLE: High-Power Microwave (HPM) Weapons' Effects and Failure Analysis Tool

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

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OBJECTIVE: Develop a tool to model the vulnerability and susceptibility of electronic systems, subsystems, and components to directed-energy high-power microwave (HPM) weapons. The product of this SBIR will increase the Navy's ability to protect its own electronic systems from HPM attack, as well as to determine the level of damage incurred by the enemy on the battlefield.

DESCRIPTION: Advanced HPM devices are increasingly being deployed by U.S. adversaries for both defensive and offensive purposes. Unfortunately, the Navy has been slow to respond to the threats posed, partly as a consequence of a lack of awareness of how mature and effective this technology has become. However, because of the proliferation and success of these mechanisms, the vulnerability, susceptibility, and survivability of the Navy's current inventory and developmental defense systems, subsystems, and components to these devices need to be determined, as specified by MIL-STD-464C (Department of Defense Interface Standard: Electromagnetic Environmental Effects, Requirements for Systems). In addition, a way to ascertain the level of damage sustained by enemies in the field from U.S. military HPM weapons is also required. For example, the effectiveness of HPM devices is difficult to ascertain because, currently, there is no valid method to determine whether any disruption or damage has occurred.

Because HPM damage may not be readily apparent, a combination of internal signal monitoring and post-test disassembly, investigation, and analysis is necessary to determine specific failure modes. However, limited functional monitoring of the system during testing can make this process extremely problematic.

As such, a critical need exists for a viable and comprehensive simulation failure analysis tool that can establish the effects that HPM weapons have on targeted electronics such as communications systems, electro-optical/infrared sensors, Global Positioning Systems, inertial navigation systems, and processors. The objective of this SBIR effort is to develop a means to fill that critical gap.

Yet, finding a viable solution presents many challenges. For example, HPM devices nominally produce a pulse peak power of 100 megawatts or greater. Furthermore, some mechanisms generate a single pulse, while others produce multiple pulses. In addition, the means of delivery can vary dramatically, such as by an individual, via vehicles, or from large ground structures.

Moreover, unlike kinetic weapon effects, HPM weapon effects can result in signal interference and/or physical destruction. So, while a reasonable starting point is to adapt the processes and methodologies developed in kinetic weapon survivability testing, including electronic forensics and failure analysis, a novel approach must be taken to devise a tool that will provide the necessary functionality.

Another obstacle is that HPM coupling and interference/destruction mechanisms are stochastic in nature and thus have a high degree of variability. Therefore, coupling the internal signal monitoring with damage assessed by inspection will be essential to coupling the modeling with the actual HPM effects.

The aforementioned factors all contribute to the complexity of the problem presented. Thus, finding a functional concept will entail a high level of creativity, ingenuity, and technical acumen.

PHASE I: Develop a conceptual framework consisting of an analytical approach and process definition that meets the stated objective. Conduct modeling and simulation to demonstrate the feasibility of the proposed concept to successfully function in a relevant scenario provided by the government.

PHASE II: Refine the framework and develop and demonstrate the failure analysis process. Validate the simulation capability through detailed component testing and simulation.

PHASE III: Transition the tool to applicable engineering and operational communities, such as those in the areas of conceptual design, component selection, and mission planning.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The tool and processes developed under this effort will improve the hardening, shielding, and grounding of a myriad of electronic components and thus enable them to operate in high-radio-frequency environments. In addition, transition to multiple military sponsors is possible. For instance, there are various other applications for HPM devices, such as in radar or electronic warfare.

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KEYWORDS: Forensics; Failure Analysis; Directed Energy Weapons; High Power Microwave (HPM); Vulnerability; Survivability

N121-009 TITLE: Surface Flotation Device for Cold-Water Aviation Survivors

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA 299

OBJECTIVE: Develop a surface flotation device for aviation survivors that is more durable, lighter, and less bulky than existing devices and that provides protection from exposure to cold water.

DESCRIPTION: Global threats make flying over cold water a hazard that is increasingly faced by all military aviators. Ditching the aircraft is one of the most dangerous exigencies, as death can occur in mere minutes from immersion hypothermia. The best chance of surviving ditching is offered by surface flotation devices. Survival in cold water is dependent on not drowning, staying alive until rescued, and being found. These functions are currently performed by a combination of the life preserver, dry suit, and life raft. All three components are minimum-required survival equipment for all services, but the life raft is the most versatile and functional component of the cold water survival triad.

Less costly, lighter, less bulky, and more durable surface flotation devices are a chronic and documented need. A plethora of Naval messages, multiple Operations Advisory Group/Naval Air Requirements Group submissions, and deficiency reports indicate that current surface flotation devices have logistical shortcomings that overwhelm their survival benefit. The aviation life raft and life preserver have not changed significantly in more than fifty years. In routine use, inadvertent or failed inflation has been reported, and in cold temperatures, CO2 cannot expand rapidly, creating slow or partially filled conditions that jeopardize boarding, stability, and buoyancy.

Current life rafts are increasingly aircraft-specialized and logistically costly. Usually, a specific raft must be developed for the space that is grudgingly designated for the raft. With different raft types come different CO2 bottles; different manifolds with different inspection cycles and procedures; and different spares, repair parts, and consumables. This fracturing of demand across myriad rafts and spares often results in persistent supply deficits caused by sporadic contract awards that cannot keep up with demand.

Current life rafts are chronically heavy and bulky. Because inflatable life rafts are built to withstand improvised stowage, crash damage, and long sea exposures, they can weigh more than 100 lbs., and their packed dimensions can be very bulky and sometimes exceed the dimensions of the escape hatch. Logistically, the opportunity cost of carrying rafts equals the commensurate amount of fuel, ammunition, or other cargo that must be left behind in order to make room for the raft.

Current life rafts are also difficult to deploy and very hard to board. Swimming through an escape hatch with a man-mounted raft, or wrestling a multi-place out of the aircraft, is often possible through only one exit: the main door, which, to say the least, can be crowded in an emergency. Despite the addition of boarding aids, getting into the raft remains one of the most difficult survival tasks. A primary reason is that it is designed to be so; in order for a raft to keep water out, it must have high sidewalls. The inflated life preserver lobes act just like boat fenders, obstructing access and mobility to (as well as visibility of) the sidewalls. Deflating the jacket lobes is often necessary to allow boarding, an ironic burden and threat to the survivor.

The goal of this project is to develop a surface flotation device for aviation survivors that is less costly, lighter, less bulky, and more durable than existing devices and that provides protection from exposure to cold water. Innovative approaches involving the leveraging of the marine environment, use of novel buoyancy media, and consolidation of surface flotation components are sought.

The device should be able to maintain a user's body core temperature = 95 °F and hand skin temperature = 60 °F for 4 hours immersion in turbulent 32 °F water; provide the survivor with egress from the underwater aircraft (i.e., inherent system buoyancy not to exceed +175N) and mobility and flexibility to perform water survival procedures without impediment (i.e., minimum flotation buoyancy of +275N); achieve deployed form in < 60 sec (ideally, 15 sec); and maintain intact flotation in rough seas for 72 hours. A one-size-fits-most (small female to large male) device is desired, with the capacity and ability to include survival aids typically stowed in life raft packs now (e.g., water desalinators, signaling devices, bailing aids). The device should also enable survivor-capable repair while in water that lasts for 72 hours.

In regard to the mission, the device should be able to withstand an 11-hour flying time in routine ambient conditions (0 °F to 120 °F); provide resistance to environmental contaminants (e.g., sand, petroleum, oil, lubricants, solar radiation), prolonged exposures to temperature extremes of –20 °F to +140 °F, mold, mildew, flame, and salt fog; and ensure compatibility with current military gear and equipment required to be worn with military dry suits, such as armor, masks, gloves, helmets, and boots. The device should also be nontoxic to skin and have a low propensity to sudden static discharge or exposed surfaces.

PHASE I: Design a concept of a surface flotation device that provides protection from cold water exposure. Verify that the concept can meet the requirements provided in the description as well as in ISO-15027-3, MSC.81(70), and AIR STD 61/102/20 through analysis and limited laboratory demonstrations. Provide cost and reliability estimates.

PHASE II: Develop, demonstrate, and validate a prototype surface flotation device based on the design concept created in Phase I. Demonstrations should be performed on human subjects in controlled immersions in compliance with the requirements provided in Phase I. Provide engineering drawings, detail specifications, and benefit and cost/life-cycle cost analyses.

PHASE III: Develop mass production capability of the surface flotation device for sustainment by defense supply and commercialization for the private sector.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Novel alternative flotation devices can benefit other military, industrial, and recreational aviation operators and passengers, as well as industrial, merchant, and recreational marine operators and their crews or passengers. This flotation device also could possibly be adapted for cargo transport protection and/or salvage.

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KEYWORDS: survival; life raft; surface flotation/floatation; anti-exposure; immersion hypothermia; buoyancy

N121-011 TITLE: Improved Radio Frequency (RF) Modeling for Correlated Environment Communication System Simulators with Sensor Simulators

TECHNOLOGY AREAS: Air Platform, Information Systems, Human Systems

OBJECTIVE: Develop an innovative approach for on-the-fly (OTF), physics-based radio frequency (RF) propagation modeling that appropriately interacts with complex synthetic natural environments (terrain, cultural features, atmosphere/weather) for more realistic communication systems and radar sensor simulations.

DESCRIPTION: Current state of the art communications simulations use simplified Radio Frequency (RF) propagation modeling that lacks the more advanced phenomenological effects required for more realistic communications simulations in complex battlespace environments. Such missing effects include, but are not limited to, degradations due to weather and 3D atmospherics (attenuation, backscatter, absorption-noise, refraction and ducting), interference, line-of-sight obstruction attenuations from terrain topography, buildings, vegetation and other cultural features, surface reflection and scattering.

A new, physics-based approach to RF propagation modeling that provides for these coupling effects on-the-fly so that arbitrary transmitter-receiver pairs can be faithfully modeled as they move through the complex battlespace is sought. The approach must utilize a common, material/property-attributed synthetic natural environments (terrain, atmosphere and ocean) so that first-principles physics-based models may provide a consistent simultaneous representation of Command, Control, Communications, Computers, Intelligence, Surveillance Reconnaissance (C4ISR) systems, and correlated com-sims and vis-sims for out-the-window (OTW), Electro Optical (EO), Infrared (IR), and radar sensors (physics-based visible, night vision goggles (NVG), Medium Wavelength Infrared (MWIR), Long-Wave Infrared (LWIR), Synthetic Aperture Radar (SAR).

This approach should correlate with OTW, electro-optical/infrared (EO/IR) and Radar sensor simulations over realistic synthetic natural environments, and support improved interoperability between naval and ground forces, particularly in the area of communication.

PHASE I: Design a viable approach for advanced real-time, OTF RF propagation modeling for com-sims that are correlated with the SNE. Demonstrate the feasibility of how the design couples with the 3D atmosphere/weather, terrain and cultural features to model the desired effects, while maintaining physically consistent representations of EO, IR and SAR sensors. Proof-of-concept prototype illustrating EO, IR and RF correlation is desired.

PHASE II: Build a real-time prototype demonstrating the Phase I design on a complex SNE, maintaining correlation of RF communications with the terrain and atmospherics, and OTW and sensor vis-sims.

PHASE III: Implement capability at a larger scale for a major DOD simulation program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector applications include the gaming industry, and test routines for communications device manufacturers such as cell/wireless providers, etc

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KEYWORDS: communications; sensors; RF propagation; C4ISR; FLIR

N121-012 TITLE: Sensor Exploitation Management System

TECHNOLOGY AREAS: Air Platform, Sensors, Human Systems

ACQUISITION PROGRAM: PMA 290

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OBJECTIVE: Develop an innovative automated system that analyzes, and exploits radar sensor data in real time.

DESCRIPTION: Detection, tracking, and identification of targets in a complex environment is very difficult. The ability to prosecute agile maritime or overland threats amid rapidly changing conditions requires sensor operators to optimally use the capabilities of their airborne radar systems. This requires sensor operators to very quickly analyze and assess the situation based on the sensor returns, distill and convey the actionable information, and then modify the sensor tasking based on evolving conditions. The resulting workload can easily overwhelm the sensor operator as it is difficult to function effectively in such a situation.

The goal of this project is to develop innovative automated analysis and exploitation tools to support sensor information collection and resource management tools for existing naval airborne radar systems. The exploitation tools should provide an integrated human–machine processing approach to support sensor information analysis and exploitation methodologies along with data visualization, threat behavior analysis, and hypothesis testing. In order to maximize mission success, these tools should also identify and recommend sensor short-term (a few minutes) and long-term (tens of minutes) resourcing options based on general mission collection priorities and evolving conditions.

An innovative automated sensor exploitation management system can result in potential dramatic improvements in real-time sensor operator performance and mission planning.

PHASE I: Determine the technical feasibility of creating an automated system of sensor exploitation tools for existing naval airborne radar systems. Identify the specific nature of the analysis and exploitation algorithms and the human–machine interfaces to be used, establish interfaces with the sensor resource management framework and decision logic, and develop a detailed implementation plan.

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

PHASE III: Transition the developed sensor exploitation management system to appropriate platforms and interested commercial entities.

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

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KEYWORDS: Mission Planning; Information Exploitation; Human-Machine Interface; Resource Management; Operator Workload; optimization

N121-013 TITLE: <u>High-Efficiency, High-Temperature Laser Diodes for Naval High-Energy Laser Applications</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA 242

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 fabricate laser diodes that operate at high efficiencies and temperatures so that the solid-state fiber laser systems into which they are incorporated can meet the stringent size and weight constraints imposed for use on current state-of-the-art tactical air platforms.

DESCRIPTION: A vital need exists for a fieldable laser weapon system for use on advanced tactical air platforms. Recent developments in fiber lasers have made doing so feasible. However, stringent size and weight requirements preclude integrating current state-of-the-art high-energy lasers onto fast-moving aircraft. One means to meet those criteria is to reduce the size and weight of the prime power and thermal management systems (TMS) by improving the efficiency and increasing the operating temperature of the laser diode pumps.

For example, a current state-of-the-art 50-kW fiber laser system typically has an overall efficiency of approximately 33 percent when incorporating pump diodes having an electrical–optical efficiency of approximately 50 percent. Therefore, this notional system requires >150 kW of prime power, 100 kW of which must be dissipated via the thermal management system (TMS). However, if the diode efficiency can be improved to approximately 80 percent, the total power needed will be reduced by one-third, to only approximately 105 kW. As a direct result, the thermal load decreases almost by half, to approximately 55 kW. As such, the TMS would not have to dissipate as much heat and, thus, could be smaller and weigh less.

Furthermore, if the pump diodes could operate at significantly elevated temperatures (70 degrees Celcius to 80 degrees Celsius rather than 50 degrees Celsius), the level of cooling required by the TMS would be substantially reduced. Again, that system’s size and weight could be appreciably less than those utilized in laser weapon systems incorporating current pump diode technology.

The expectation for this SBIR is that the diode developed will afford a minimum electrical-to-fiber-coupled optical efficiency of 65 percent. However, the desired level is 70 percent. In addition, the diode must operate effectively at a temperature of at least 70 degrees Celsius (preferably 80 degrees Celsius). For compatibility with high-energy fiber laser systems under development, the diode output must be at a wavelength near 975 nanometers and must be coupled into an optical fiber suitable for standard fusion splicing with typical gain fibers. The device's life span must be in excess of 5,000 hours. In addition, the criterion for the minimum number of watts per diode package is 50.

The ability of the diode to successfully withstand the severe conditions to which it will be exposed when deployed is essential. Therefore, the device must pass pertinent shock, vibration, and temperature environmental testing. The diode must be designed in a way to be competitive with industry state-of-the-art high-volume manufacturing practices (on a dollar-to-watt basis). For instance, the goal for the end of the program is a cost of less than $5 per watt.

Successfully satisfying these challenging objectives will require an enormous degree of both innovation and creativity.

PHASE I: Develop a conceptual design for a laser diode that operates at the specified efficiencies and temperatures, and satisfies the other criteria presented herein. Include the methodology adopted, and prove feasibility of a prototype that will meet performance objectives.

PHASE II: Devise detailed designs for the concept developed in Phase I and fabricate a limited number of diodes suitable for proof-of-concept testing. Conduct preliminary assessments in a laboratory setting and in government-owned laser resonators and document the results.

PHASE III: Scale up for mass production of the advanced laser diodes. These devices, upon meeting Navy requirements, will be transitioned to various laser programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These devices have significant commercial potential in components for laser systems used in large-area displays, medical equipment, and semiconductor/lithography systems. In addition, these cutting-edge diodes have applications that are integral to the communication industry. The suggestion is to team with a fiber laser developer because these diodes will be a major component in their laser systems.

REFERENCES:
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2. Kamuz, A. M., Oleksenko, P. F., Ovsyannikov, E. Y., Sizov, F. F., & Dyachenko, T. A. (1996). Low-temperature photo-hydro-modification of II–VI and III–V semiconductors. Applied Surface Science, 103(2), 141-148. doi: 10.1016/0169-4332(96)00111-0

3. Krivoshlykov, S. G. (1999). U.S. Patent No. 5,909,614. Washington, DC: U.S. Patent and Trademark Office.

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KEYWORDS: Laser Radar, Laser Diodes, High-Efficiency Diodes, High-Temperature Diodes, High-Energy Laser, Electrical–Optical Efficiency, Laser Weapon Systems

N121-014 TITLE: Low-Erosion and Affordable Nozzles for Advanced Air-to-Air Missiles

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMA 259

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 low-erosion nozzle technologies that yield an affordable, thermally and structurally robust nozzle in a multi-pulse tactical solid rocket motor environment.

DESCRIPTION: Current tactical air-launched solid rockets employ reduced-smoke propellants with gas temperatures of approximately 5,000 degrees Fahrenheit and a relatively high percentage of oxidative species. Additionally, air-launched rocket motors employ fairly low-cost nozzles, which utilize phenolic inlet and exit cone materials for ablative control and thermal protection, as well as graphite throat materials for Mach 1 flow orifice erosion control. This combination of materials has proven to be suitable and cost effective for current generations of single-pulse air-to-air rocket motors. However, it is anticipated that implementing existing nozzle technologies in multi-pulse motors will cause nozzle survivability to decrease and heat soak to adjacent structures to increase because multi-pulse rocket motors have a higher total impulse and are exposed to longer operating times than single-pulse motors.

This topic is soliciting proposals for innovative nozzle technologies and architectures that can sustain exposure to hot gas with temperatures of as high as 5,000 degrees Fahrenheit for up to 10 seconds of total exposure that is supplied either continuously or split into two pulses distributed over a 30-second operating time. Target attributes are 1) nozzle throat erosions of <5 mil/s (threshold)/<3 mil/s (objective), 2) zero erosion after two full pulse operations and an inter-pulse delay, and 3) nozzle outer envelope temperatures of <200 degrees Fahrenheit at the end of a 30 second two-pulse operating sequence. Thermal shock robustness is also required, meaning that nozzle components should not crack upon cool-down after the first pulse or upon thermal shock at initiation of the second pulse.

Technologies of interest include advanced oxidative and erosion-resistant high-temperature materials, advanced structural insulator materials, advanced nozzle blast tube/inlet/entrance/throat/exit cone architectures, integral assembly technologies, and other technologies that might meet the goals identified above.

PHASE I: Design and develop material and architecture metrics. Demonstrate feasibility that candidate technologies can support the high-temperature, oxidative, long-duration, multi-thermal shock environment and meet thermal insulation goals. Perform supporting analysis anchored on feasibility demonstration and a credible material property basis to verify that candidate technology can meet project goals.

PHASE II: Develop/tailor analytical models to predict proposed technology performance and compliance to project goals. Develop component-level design and demonstrate proposed technology in the following representative environments: high temperature, oxidative gas, long-duration exposure, and multiple thermal shock events.

PHASE III: Transition technologies demonstrated under this effort to an advanced air-to-air missile propulsion system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Materials and propulsion industry entities will benefit through advanced material and material engineering technologies that pertain to a number of high-temperature and high-speed aerospace applications. These applications include multiple next-generation air-launched propulsion systems and leading-edge hypersonic and nose tip components.

REFERENCES:
1. MIL-STD-855C. (4 May 1984). Missiles, guided, design and construction, general specification for.

2. Opeka, M. (2004). Thermodynamics based material selection for corrosion resistant performance in high temperature missile propulsion systems. Proceedings Electrochemical Society Conference on Ultra-High Temperature Materials.

3. Sutton, G. P., & Biblarz, O. (2001). Rocket propulsion elements (7th ed). New York: John Wiley & Sons, Inc.

4. Technical Guidelines for Phase I Low Erosion Nozzles, uploaded in SITIS 12/6/11.

KEYWORDS: Nozzle Materials, Low-Erosion Nozzles, High-Temperature Materials, Structural Insulators, Multi-Pulse Rocket Motors, Air-Launched Missiles

N121-015 TITLE: Minimum-time optimization of in-situ antenna performance

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PMA 234

OBJECTIVE: Develop an optimization design tool that will work in conjunction with the Method of Moments (MoM) to restore on-platform antenna properties in minimum time.

DESCRIPTION: The performance of antennas can be improved substantially through the use of optimization methods [1], [2]. This is especially true when an antenna is initially designed either in free space or over a ground plane and eventually mounted on a geometrically and materially complex platform. The in-situ performance of an antenna may not only be inferior to that intended, but also interfere with the performance of other, nearby antennas. Optimization can also be used in designing antennas in situ as, for example, structurally embedded antennas.

Antenna characteristics can be restored and even reconfigured (in case of interference) using optimization methods that perturb the geometry and materials of an antenna under given constraints. These methods require the use of a computational electromagnetics (CEM) code. We are interested in the method of moments (MoM) [3], one of the principal CEM methods for analyzing and designing antennas in the frequency domain. As is well known, MoM involves the solution of a dense system of linear algebraic equations. The solution of the system can be very time consuming. For this reason, we are seeking methods that engage the MoM code as few times as possible and minimize its execution time. We also assume that we are near enough an optimum so as to be able to use deterministic optimization methods, to the exclusion of stochastic and, in general, metaheuristic ones [2].

Innovative optimization techniques that minimize the time penalty inherent in solving the MoM system of equations are sought. The final product should be a software package that can communicate with CEM MoM solvers (to be specified by NAVAIR), run on a single CPU and on CPU clusters, and take advantage of all cores and GPUs present. Emphasis should be placed on the total time required to reach an optimization level rather than the time it takes to perform a single iteration. An intelligent graphical user interface (GUI) should guide the user through the optimization process. Proposal should exhibit solid evidence of the team’s expertise in optimization and contain only one optimization approach.

PHASE I: Prototype in Matlab (or any other computing environment) the proposed optimization approach. Apply the method to one or more antenna problems, mutually agreed upon with NAVAIR. Prepare detailed plan for its implementation. Consult with NAVAIR as to the MoM codes of interest and GUI requirements and incorporate the results of the discussions in the plan.

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

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Antenna in-situ performance and cosite interference are problems common to both military and commercial aircraft. This package will find equal use in commercial avionics as in military ones.

REFERENCES:
1. Bonnans, J.F., Gilbert, J.C., Lemaréchal, C., Sagastizábal, C.A. (2006). Numerical optimization: Theoretical and practical aspects. Universitext (Second revised ed. of translation of 1997 French ed.). Berlin: Springer-Verlag.

2. Horst, R., Pardalos, P.M., and Thoai, N.V. (2000) Introduction to Global Optimization, Second Edition. Kluwer Academic Publishers.

3. Kolundzija, B. M., & Djordjevic, A. R. (2002). Electromagnetic Modeling of Composite Metallic and Dielectric Structures. Artech House.

KEYWORDS: GUI; optimization; Computational electromagnetics; antennas; method of moments; CPU/GPU clusters

N121-016 TITLE: Wear Indicating Lined Spherical Bearings

TECHNOLOGY AREAS: Air Platform, Materials/Processes

OBJECTIVE: Develop and demonstrate a lined, spherical bearing or rod end bearing assembly with a built in wear limit measurement feature that will provide indication when the minimum allowable liner thickness has been reached.

DESCRIPTION: Lined, spherical bearings are used in a variety of aerospace applications to provide a connection between two structures experiencing rotating and/or misaligning motions. An issue often arises in the ability to measure the wear within a lined bearing especially when the bearing is in a hard to reach/see location or under load. Wear in a lined bearing is inherit and is acceptable to a limit, but beyond that, the bearing becomes more susceptible to failure. The ability to effectively provide indication, once wear in the bearing has reached an allowable limit, can help mitigate the chance of bearing failure and the associated hazards.

A lined spherical stand alone bearing or part of a rod end bearing assembly is desired. The orientation of the bearing within the housing/fixture should not affect the capability of the wear indication (i.e. wear indication should be capable circumferentially). Trial bearing configurations should be comparable to some existing configurations on US Navy or Marine Corp fixed or rotating wing aircraft, where on continuous rotation dynamic components or intermittent rotation applications, such as landing gear, control surface attachments or other control actuators. Bearing and wear indicators must be capable of operating within a rotating environment if applicable. The bearing must also wear in a manner that allows sufficient time from the point of indication that the flight may end prior to reaching an unacceptable liner thickness. The bearing must also wear in a predictable, consistent manner and have a life of at least that currently used in a similar deployed application. The bearing must meet the complete requirements of the associated AS standard. This SBIR would find a solution to prevent bearing failure in multiple aerospace applications by providing indication once the maximum acceptable wear limit has been reached.

PHASE I: Design and develop an innovative approach for a bearing with built in wear indicating features. Identify and define the most effective method to indicate that the minimum liner thickness has been reached and the bearing should thus be replaced. Develop a detailed analysis of the predicted performance of the bearing and indicator in the presence of various environments and contaminates (both fluid and solid). Demonstrate the feasibility of producing the demonstration bearing and outline the success criteria for the demonstration.

PHASE II: Finalize the design and demonstrate practical implementation of a production-scalable prototype bearing. Establish performance parameters through experimentation and prototype fabrication. Evaluate the prototype bearing through demonstration testing.

PHASE III: Transition the approach to the fleet and other candidate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A bearing capable of wear limit indication has the potential for transition to the commercial aircraft market for production and maintenance cost reductions and reduced risk of unexpected bearing failure enhancing both safety and reliability.

REFERENCES:
1. ARP 5448/7 Plain Bearing Wear Measurement.

2. ARP 5488/8A Plain Spherical Bearing Radial and Axial Clearance Measurement.

3. SAE ARP5448A Plain Bearing Test Methods.

4. SAE AS81819 Bearings, Plain, Self-Aligning, Self-Lubricating, High Speed Oscillation -65 to +160°F General Specification For.

5. SAE AS81820 Bearings, Plain, Self-Aligning, Self-Lubricating, Low Speed Oscillation.

6. SAE AS81935 Bearings, Plain, Rod End, Self-Aligning, Self-Lubricating, General Specification for.

KEYWORDS: Wear; Indicator; Maintainability; bearing; safety; rod end bearing assembly

N121-017 TITLE: Adaptive, Automated Real-time Event/Target Detection using Supervised Learning

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: PMA 281

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 automatic, adaptive event detection tool that allows supervised learning to minimize operator involvement and achieve near real-time performance.

DESCRIPTION: Current Digital Camera Recording System (DCRS) and Unmanned Air Vehicle (UAV) control systems ingest and display imagery data from various sources that include 8mm tape, other magnetic media, solid state devices, and Full Motion Video (FMV) via data link. Some of the events and targets are identified during the initial image acquisition, but when transferring, analysts must watch the transfer to the DCRS to mark the events on the DCRS, which is a time consuming activity. UAV operators often watch live imagery feeds from a data link, a time and bandwidth consuming activity which can result in large inefficiencies and missed events.

Previous efforts focused on Automatic Target Recognition (ATR) to identify specific entities. Other efforts used basic change detection algorithms over long time periods to identify events. ATR efforts along these lines have produced some successes, but have not captured a capability useful across multiple environments with varying situations. Proposers are encouraged to review unclassified technical reports highlighting development and progress which can be gleaned from Proceedings of SPIE (International Society for Optics and Photonics) conferences, symposia reports and other relevant IEEE (Institute of Electrical and Electronics Engineers) conference proceedings. (see References)

For this topic we define an event as the interaction of one or more objects in an environment (e.g. a small truck departing a parking lot, a person dismounting a vehicle). Each object has basic properties such as size, color, speed, location, and direction of movement. Events can also have properties (e.g. action, time, and location). In order to minimize the topic complexity, this effort will be constrained to identifying the activity of the object in relation to other objects and their locations. Object recognition through formal ATR processes is not expected.

The development of this effort will focus on a specific high priority event set identified by current sensor operators. To constrain the overall research and development, the effort will be limited initially to an event of critical importance (e.g. person exiting vehicle), with specific object and event properties. The goal of the effort is to recognize and alert the user of 90 percent of the instances of a specified event. These detections should be encoded as imagery and video metadata.

Based on these technical advancements this topic concentrates and will direct the innovative development of a novel software tool capable of performing automatic event recognitions as outlined above. The tool should have the capability to accept instruction (i.e. real-time supervised learning) regarding automated recognition of these particular and/or similar events in future occurrences.

This software tool should be trainable with an a priori defined event database similar to the biological process or other advanced algorithmic techniques (as defined by proposer(s)) as a baseline for automatic real-time detection. In future phases, the software tool should allow real time sharing of the event database between analyst stations. A Service Oriented Architecture software environment is preferred.

PHASE I: Design and prove the feasibility of a software tool that is not only able to automatically detect time critical events but must be 'trainable' by analysts so as to add previously unidentified ad hoc events when indicated. Detections should be encoded as imagery and video metadata and highlighted to users.

PHASE II: Develop and demonstrate a prototype based upon the design and innovations developed in Phase I.

PHASE III: Transition the tool developed to the DCRS and/or Unmanned Vehicle Common Control Station and adapt to and implement in, commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The system developed could readily be transitioned to many persistent surveillance applications such as border, coastal and harbor security monitoring. Additionally, private sector security monitoring systems can greatly benefit from this technology.

REFERENCES:
1. Ke, Y., Sukthankar, R. & Hebert, M. (2007). Event Detection in Crowded Videos. IEEE International Conference on Computer Vision. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.64.4575

2. Dikmen, M., Ning, H., Lin, D., Cao, L., Le, V., Tsai, S., Lin, K., Li, Z., Yang, J., Huang, T. (2009). Surveillance Event Detection. http://www-nlpir.nist.gov/projects/tvpubs/tv8.papers/ifp-uiuc-nec.pdf

3. Seo, H.J. & Milanfar, P. (2010). Visual Saliency for Automatic Target Detection, Boundary Detection and Image Quality Assessment. http://users.soe.ucsc.edu/~milanfar/publications/conf/Saliency_ICASSP_Final.pdf

KEYWORDS: Automatic Target Recognition; supervised learning; service oriented architecture; software; UAV control station; Autonomous event detection

N121-018 TITLE: <u>Self-Healing Corrosion-Protection Coating</u>

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

ACQUISITION PROGRAM: JSF-AV

OBJECTIVE: Develop an innovative, polymer-based corrosion-protection coating that is capable of self-healing scratches and cuts in the coating when it is used in the naval aviation environment.

DESCRIPTION: The corrosion of aircraft is a big problem for the U.S. Navy and Marine Corps. The costs to inspect and repair damage caused by corrosion and the operational inefficiency of aircraft downtime and required maintainer inspection time are enormous. Protective coatings have been shown to control corrosion. However, the coatings themselves are susceptible to scratches, cuts, and other damage that, if extensive, can negate their protection abilities. Consequently, ground crews spend considerable time inspecting the protective coatings of naval aircraft, identifying damaged areas in the coating, assessing the extent of damage to the coating, and repairing the coating. The Navy would save money and gain operational efficiency if the coating could heal itself with no involvement of aircraft maintainer required.

The goal of this SBIR is to develop an innovative self-healing coating system. The coating must retain its self-healing and corrosion-protection capabilities after long, continuous exposures to the thermal, climatic, and chemical environments commonly encountered in naval aviation operations. Typical thermal conditions range from –65 °F for flight at altitude to 400 °F for proximity to engines or exhausts. Climatic conditions include arctic/antarctic cold, desert heat and intense sunlight, hot and humid climates, rain/snow/hail precipitation, and blowing dust and sand. Chemical environments include atmospheric salt fog from sea-borne operations; aviation fuels, lubricants, and oils; and aviation and industrial de-icers, cleaners, wash fluids, and solvents.

The developed coating should be able to retain its self-healing and corrosion-protection abilities after exposure to and in the face of various operational conditions; be cost effective relative to frequent aircraft maintainer inspection and repair; and have minimal weight penalties relative to existing, non self–healing coatings. The coating should be functional when applied to a broad range of typical naval aviation metallic substrates and should demonstrate corrosion protection at least equivalent to the Navy's top-performing primers, both chromate and nonchromate. The coating should also be capable of being manufactured in sufficient quantities to support naval aviation requirements. Manufacturing processes for producing the coating formulation should either be standard chemical industry processes or should be developed in this project to at least a pilot-plant level of operation. The coating materials and manufacturing processes developed in this effort must avoid, to the greatest extent possible, the use of environmentally restricted substances.

While the references associated with this topic refer in large part to formulating micro-encapsulated self-healing agents into the coating matrix, the topic is not limited to solutions using only this technology.

PHASE I: Develop an innovative approach for polymer-based self-healing coatings for naval aviation corrosion protection. Demonstrate feasibility of the approach by formulating and evaluating candidate coatings with a chemical bench-scale process or higher, giving consideration to specific thermal, climatic, and chemical exposure conditions. Consider a broad range of typical substrates.

PHASE II: Fully develop the coating concept into an optimized self-healing coating system and obtain sufficient data for certification on navy platforms, giving consideration to typical naval aviation conditions. Scale up the coating formulation process to at least pilot-scale operations.

PHASE III: Produce sufficient quantities of the coating system for aircraft demonstration and evaluation. Transition the coating system to military and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Corrosion is a pervasive problem in infrastructure (e.g., bridges, buildings, and similar structures), automotive, commercial aviation, and commercial marine industries. A polymer-based self-healing corrosion-protection coating would be of great benefit in any and all of these applications and would have widespread use in commercial settings.

REFERENCES:
1. Michael W. Keller (2010). Self-healing epoxy composites. In J-P. Pascault & R. J. J. Williams (Eds.), Epoxy polymers: New materials and innovations (pp. 325-344). Weinheim, Germany: Wiley-VCH.

2. Cho, S. H., Andersson, H. M., White, S. R., Sottos, N. R., & Braun, P. V. (2006). Polydimethylsiloxane-based self-healing materials. Advanced Materials, 18, 997-1000.

3. Bergman, S. D., & Wudl, F. (2008). Mendable polymers. Journal of Material Chemistry, 18, 41-62.

KEYWORDS: Materials; Coatings; corrosion; mendable polymers; chemical processing

N121-019 TITLE: In-Situ Crack Characterization

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

ACQUISITION PROGRAM: PMA 265

OBJECTIVE: Develop a method and associated instruments for on-aircraft, on the ground failure analysis of cracks found in metallic aircraft structure.

DESCRIPTION: In traditional Engineering Investigations, cracks are cut out of the part and opened up so that failure analysts can look at the crack faces and determine whether the crack propagated as a result of cyclic (fatigue) loading or a one-time (static) overload. This determination is nearly essential to finding the source of the load, and thus the cause of the cracking. However, in many situations where cracks are detected in aircraft structure, the most desirable in-service structural repair does not allow for excising the crack for traditional failure analysis. In these cases, engineers are not able to determine the cause of the cracking which inhibits development of corrective actions to prevent similar cracks in the rest of the fleet.

The initial goal is to have the ability to determine if the crack propagated by fatigue or static loading. Beyond that, identification of crack initiation site, and the presence of corrosion products would be desirable

PHASE I: Conceptualize, design and determine the feasibility of an innovative method for on-aircraft, on the ground failure analysis of cracks found in aluminum, steel, and/or titanium materials commonly used in aircraft structures.

PHASE II: Mature, verify and demonstrate the method developed in Phase I using lab-generated cracks in test coupons and/or cracks of known origins in real flight hardware.

PHASE III: Finalize the process and instrumentation for transition to aircraft in limited access areas.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: All industries maintaining metallic structures could use this technology, e.g. airliners, heavy equipment, bridges, buildings, ships.

REFERENCES:
1. Brooks, C. & Choudhury, A. (2001). Failure Analysis of Engineering Materials. McGraw-Hill Professional.

2. Hull, D. (1999). Fractography: Observing, Measuring and Interpreting Fracture Surface Topography Cambridge University Press.

3. Photos provided by TPOC, uploaded in SITIS 12/6/11.

KEYWORDS: crack; load; failure; structure; Fatigue; Material

N121-020 TITLE: Improved Resin Injection Repairs for Polymer Composite Materials

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA 261

OBJECTIVE: Develop an innovative injection repair process that has improved rheological properties, chemical reactivity and mechanical properties for use in structural resin repairs.

DESCRIPTION: Injection of resin to repair voids, delaminations and disbonds present in composite laminates either from manufacturing flaws or operational damage is a common practice for naval aircraft. These repairs are only cosmetic for the most part, providing inadequate performance to restore the flawed laminate to full structural capability. Consequently, their permissible use within NAVAIR is limited.

Previous investigations have identified shortcomings in resin injection that limit their suitability for structural applications. First, the resin's rheological properties are such that it is difficult or impossible for the resin to fill the flaw completely, especially narrow and convoluted constrictions. Second, the reactivity between the injected resin and the internal surfaces of the flaw may be low, preventing an adequate bond from being established. This is particularly true on flaws created in manufacturing. Finally, the mechanical properties of the injection resin itself may not be sufficient for structural applications.

A solution through materials and processes suitable for structural resin injection repairs of manufacturing and operational flaws in naval aviation graphite/epoxy laminates is sought.

Innovative resins capable of restoring the structural integrity of flawed graphite/epoxy laminates, along with the development of the appropriate injection processes for these resins will be considered. Because it is generally considered in the technical literature to be the more challenging situation, the focus of the project should be on developing materials and processes for resin injection of manufacturing flaws. Consequently, the appropriate injection processes developed in this project should be targeted for use on a typical factory floor.

The injection repair resin and associated processes must be capable of restoring the repaired laminate for use in the conditions typically encountered by Navy and Marine Corps aircraft. These conditions include thermal exposures ranging from -65 to 200 F, global climate extremes, and chemical exposures encountered while operating aircraft aboard ships.

Although it is anticipated that the successful resin materials and processes will require improvements to rheological properties, chemical reactivity and mechanical properties, the topic is not limited to improvements in these characteristics only. The successful resin must be capable of being manufactured in sufficient quantities to support naval aviation requirements. Manufacturing processes for these resins must either be standard chemical industry processes or must be developed in this SBIR to at least a pilot-plant level of operation. The resins, injection repair processes and resin manufacturing processes must avoid, to the greatest extent possible, the use of environmentally restricted substances.

PHASE I: Develop a concept for an innovative resin injection repair process. Demonstrate feasibility of the approach by performing simple repairs and demonstrating improved performance.

PHASE II: Optimize the technology into a fully developed repair process that provides restoration of structural performance. Perform validation and verification testing, and demonstrate the repair technique through restoration and testing of structural components.

PHASE III: Transition the developed technology to military and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful innovative solutions for structural resin injection repair materials and processes would have potential commercial use in commercial aircraft, marine, automotive and wind turbine blade applications.

REFERENCES:
1. Baker, A., Dutton, S. & Kelly, D. (Eds.). (2004). Composite Materials for Aircraft Structures (2nd edition). pp 375 -376. Reston, VA: AIAA

2. Austrailian Government Department of Defence (2006). Progress Report on Activities in Support of Composite Repair Engineering Development Program Tasks AF, AH and AI. (Defence Science & Technology Organisation No. DSTD-TR-1932). Victoria, Austrailia: Rider, A. & Parslow, D. Retrieved from: http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA465919

3. Evaluation of bisphenol E cyanate ester for the resin-injection repair of advanced composites; Wilber Y. Lio; Iowa State University, 2009; http://www.osti.gov/bridge/servlets/purl/969023-WTBBj0/969023.pdf.

KEYWORDS: composites; composite repair; resin injection repair; structural repair; resin viscosity; resin reactivity

N121-021 TITLE: Improved Diagnostic Capabilities of Avionic Systems Containing Boundary Scan Technology

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA 273

OBJECTIVE: Enable and modify Boundary Scan utilities to improve fault isolation of complex avionics Weapons Replaceable Assemblies (WRAs) at the Organizational Maintenance Level.

DESCRIPTION: Supporting avionic systems in a field environment is a daunting task. Organizational Level maintainers are tasked to quickly and accurately diagnose which Weapons Replaceable Assembly (WRA) has failed in a complex avionics system. This tasking would be acceptable if the maintainer had the proper tools to accurately reduce WRA ambiguity groups to one WRA. Unfortunately, for many of these complex systems, these tools are not available. Existing built -in-test (BIT)/support equipment solutions are often unable to assist the maintainer in identifying which specific WRA has failed in the avionics system. Without accurate methods of reducing WRA ambiguity groups to one WRA, the Organizational Level maintainer often has no choice but to remove and replace multiple WRAs until the system is repaired. As a result of these Organizational Level maintenance practices, Intermediate Level maintenance finds a large number of good or no fault found WRAs are being submitted to them. Unfortunately this best guess method of maintenance has greatly increased maintenance/logistic costs.

Boundary Scan is an IEEE standard that is typically used by the manufacture for board level manufacturing test applications. Boundary Scan enables the manufacturer of chip sets/Circuit Card Assemblies (CCAs) to perform functional acceptance testing at the original equipment manufacturer (OEM) production site. While the Boundary Scan process was designed and developed primarily for the production phase of the system/sub-systems, it should be possible to modify the Boundary Scan manufacturing test hardware and software tools for field level testing. This SBIR program initiative will identify the tools and techniques required to test not only the WRA (e.g. the circuit assemblies in a VHF/UHF receiver) but also the tools and techniques required to test systems that interface with the test system of interest (e.g. the VHF/UHF receiver, the mission computer (controller), the power supplies, etc.).

Because IC chips are the heart of electronic circuits and they literally touch every point of the system, it may be possible to use Boundary Scan and the IC’s connectivity to fault isolate to the failed component. In many cases, Boundary Scan has the potential to find faulty components that BIT and support equipment solutions fail to identify. Additionally, this test process can be accomplished externally without the need of manual probing. Boundary Scan has never been used beyond the circuit card level. This effort is to develop tools to access single/multiple WRAs (outside of the box) at the Organization level of maintenance, with the intent on extracting vital diagnostic data, that can be used by the maintainer, to fault isolate to the point of failure.

Resulting information will significantly augment the weapons system's Built-in-Test (BIT) test data. With this additional Boundary Scan information, the Organizational level maintainer will have available the tool sets required to reduce false WRA removals to near zero percent. This ability to reduce false removals of WRAs will save millions of dollars a year in repair costs and significantly increase aircraft availability. This type of complete system testing using boundary scan has not been applied to Navy and Marine Corps avionics systems. To perform these innovative test routines, new software and Automated Test Equipment (ATE) will need to be designed and developed. This SBIR will address the requirement to develop these test systems. Special emphasis will be placed on the use of existing Common Support Equipment (CSE) and Peculiar Support Equipment (PSE) to augment Boundary Scan applications.

PHASE I: Investigate electronic systems used by the military that contain boundary scan and document issues that are relevant to their utilization in the framework of field support, diagnoses and repair. Develop the methodology and architectural concepts to support the use of algorithmic software that can utilize boundary scan for improved diagnostics of electronic systems. Document the feasibility of these methods and concepts using analysis and/or simulation results. Government Furnished information GFI (interface control documents, WRA specifications) will be provided to the selected offerors for use in their study phase.

PHASE II: Further explore the methods identified in Phase I. Design and develop algorithms, techniques and software/firmware prototypes that can be demonstrated and evaluated via simulation or benchtop testing. Document system supportability improvements (efficiency, accuracy, cost reduction) using Boundary Scan.

PHASE III: Create robust software, firmware, and/or hardware products to be used independently or in concert with CSE/PSE to achieve definitive fault isolation. Demonstrate the use of these products on a military electronic system. Provide cost benefit analysis for improved supportability and logistics.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: If Boundary Scan proves to be an effective field deployable tool for diagnosing complex electronic systems, its use could be expanded to include commercial avionic/electronic systems.

REFERENCES:

1. 1149.1A&B-1990 IEEE Standard Test Access Port and Boundary-Scan Architecture, IEEE, Piscataway, NJ, Jan 1990. http://standards.ieee.org/findstds/standard/1149.1-1990.html

2. Bennetts, Dr. R G. “Boundary Scan Tutorial.” 25 September, 2002. http://www.asset-intertech.com/pdfs/boundaryscan_tutorial.pdf

3. Frenzel, Louis E. “The Embedded Plan For JTAG Boundary Scan.” September 11, 2008. http://electronicdesign.com/article/test-and-measurement/the-embedded-plan-for-jtag-boundary-scan19626.aspx >

KEYWORDS: Diagnostics; support; boundary scan; built-in-test; integrated circuits; access points

N121-022 TITLE: Development of Advanced Stainless Steel for Aircraft Engine and Lift Fan Gearbox Bearings

TECHNOLOGY AREAS: Air Platform, 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: Design and develop an advanced stainless bearing steel for application to aircraft engine and lift-fan gearbox and bearings with a combination of fatigue and corrosion resistance needed to achieve improved component durability.

DESCRIPTION: Ball and roller bearings are integral components of jet turbine engines and the lift-system for fighter engines. To achieve vertical take-off and landing, the lift-fan is continuously injecting moist air that drives corrosion in key transmission components. Typical bearing steels used in industry are inadequate to meet the combination of rolling contact fatigue performance, core fracture toughness, and dimensional stability with good corrosion resistance. New alloy developments by leading steel and bearing manufacturers all lack some degree of bearing performance or corrosion resistance sought by the military. Pyrowear® 675 is an advanced high temperature corrosion resistance case carburized bearing and gear steel that has been shown to offer significant improvements in bearing performance, providing increased benefits to turbine machinery operating in a marine environment [1]. Conventional carburizing techniques have had limited success in meeting all required properties necessary for bearing and gear performance. Typically, these basic mechanical properties and microstructures can be achieved, but corrosion resistance is not substantially better than conventional bearing steels like M50, 52100, or 440C. Recent advances in computational alloy design [2] and new surface processing capabilities like carbo-nitriding [3] and low-pressure carburizing capabilities provide the opportunity to rapidly design advanced, corrosion-resistant bearing steel. Innovations are sought for custom alloy design to optimize material thermal, bearing, corrosion, and core mechanical properties, providing engines and lift-fan components increased corrosion resistance, load bearing capacity, durability, and ease of processing. Working in collaboration with OEM is suggested but not required.

PHASE I: Define key material performance and identify manufacturing requirements for a new alloy in collaboration with government engineers. Generate proof-of-concept designs that demonstrate the feasibility of achieving the desired combination of properties.

PHASE II: Develop alloy and processing techniques. Finalize material specifications and manufacturing. Evaluate performance in bench-scale tests relevant to aircraft engine operating environments.

PHASE III: Manufacture and qualify components fabricated from the newly invented alloy. Develop a commercial supply and aerospace procurement specifications for robust domestic supply of the alloy. Demonstrate corrosion and fatigue reliability improvements leading to cost savings in military platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The new alloy will be applicable to commercial aerospace propulsion systems and other high-performance transmission components requiring improved corrosion resistance.

REFERENCES:
1. Trivedi, H.K., Forster, N.H. & Rosado, L. (2010). Roling Contact Fatigue Evaluation of Advanced Bearing Steels with and Without the Oil Anti-Wear Additive Tricresyl Phosphate. Tribology Letters, 18 December 2010

2. Wright, J.A., Sebastian, J.T., Kern, C.P., & Kooy, R.J. (2010). Design, Development and Application of New High-Performance Gear Steels. Gear Technology.

3. Chin, H.A., Ogden, W.P. & Haluck, D.A. (2007). Carbo-nitrided Case Hardened Martensitic Stainless Steels. U.S. Patent No. 7,156,304 B2, March 6, 2007

4. Grant, D. H., Chin,H. A., Klenke, C., Galbato, A. T., Ragen, M. A., & Spitzer, R. F. (1998). High Temperature Aircraft Turbine Engine Bearing and Lubrication System Development. Bearing Steels: Into the 21st Century, ASTM STP 1327, J. J. Hoo and W. B. Green, eds., American Society for Testing and Materials.

KEYWORDS: Advanced bearing, stainless steel; corrosion resistance; fatigue resistance; alloy; durability; lift-fan gearbox

N121-023 TITLE: Innovative Lift Fan Clutch Plate Concepts

TECHNOLOGY AREAS: Air Platform, 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 innovative concepts for more efficient and reliable clutch plates for a clutch that transfers the high-speeds and torque generated by jet engines to power a lift fan.

DESCRIPTION: Carbon-carbon composite clutch plates can meet a1,500 engagement life requirement for a lift fan clutch, but this is at least two times less than the desired lifetime. The carbon-carbon composite also does not consistently provide the desired range of friction coefficients. A new, innovative clutch plate concept that reduces wear rate and higher overall friction coefficient is required to increase the service life of the clutch.

The F-35 lift fan for vertical take-off and landing is powered by a rotational moment transferred from the engine through a clutch. The lift fan clutch is a 5 disk dry clutch. The clutch design constrains the size of the clutch plates to roughly one foot in diameter with a stack length of approximately 5 inches. The clutch engages at up to ~8500 rpm and the clutch plates must survive rotational speeds in excess of 10,000 rpm. The clutch plates are required to withstand a high shear load in transferring ~70,000 in-lb of torque. The required instantaneous dynamic friction coefficient is >0.1 with a desired mean static coefficient of ~0.2. The clutch plates need high thermal capacity and thermal conductivity to dissipate large amounts of frictional energy introduced at a very high rate during engagement and to avoid hot spot formation. The design must ensure minimum plate warpage. The heat sink must be able to absorb over 11,000 BTUs at an average temperature of 1500 F. In addition, because of the high speed operational environment, the clutch plates must meet a balance requirement of no greater than 5 gram-inches for each plate.

In addition to wear and friction coefficient requirements, issues that should be explored include oxidation, friction coefficient variability (e.g. low coefficient associated with a cold, damp clutch), heat capacity, thermal conductivity, and dust generation. Reliable service in a marine environment is required. The cost and weight of the proposed solution should be comparable to or better than the current system. Teaming with the lift fan clutch manufacturer is highly recommended to ensure that the range of requirements are understood and addressed and to facilitate transition.

PHASE I: Demonstrate the feasibility of innovative clutch material(s) to provide long wear life and a high, stable friction coefficient. Preliminarily evaluate weight and cost impacts. Forecast expected improvements.

PHASE II: Fabricate and test at least two full scale clutch stack prototypes. Evaluate wear, static & dynamic friction coefficients, friction coefficient variation, mechanical properties, thermal conductivity, heat capacity, oxidation, weight, and cost of the new clutch plate material.

PHASE III: Perform full-scale endurance testing of the optimized clutch material and transition the technology onto an F-35.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed for this clutch could be advantageous in any dry clutch design, benefiting by extending the service life. Brake systems (aircraft and automotive) could also benefit from this technology.

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http://www.designnews.com/article/1558-The_man_with_the_fan.php

2. Ludema, K.C. (1996) Friction, Wear, Lubrication: A Textbook in Tribology. CRC Press. http://books.google.com/books?id=YTi6CUI9Wa0C&dq=K.C.Ludema,+Sliding+and+Adhesive+Wear&source=gbs_navlinks_s

3. Tatarzycki, E.M., and Webb, R.T. (1992). Friction and Wear of Aircraft Brakes. Friction Lubrication and Wear Technology, ASM Handbook.18, p 582. http://www.asminternational.org/portal/site/www/AsmStore/ProductDetails/?vgnextoid=8ede7e0e64e18110VgnVCM100000701e010aRCRD

KEYWORDS: Turbine Engine; Clutch; Reduced Wear; Friction Coefficient; Shear Strength; High Temperature

N121-024 TITLE: Complex Field Wavefront Sensing and Control for Mitigation of Deep Turbulence Effects

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: PMA 242

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, high-energy laser (HEL) sensor system that will simultaneously measure the phase and intensity distributions under the extreme atmospheric turbulence conditions that are common for Navy aircraft and ship-based offensive and defensive applications.

DESCRIPTION: The performance of the Navy’s future HEL directed-energy weapon systems depends on efficient mitigation of atmospheric effects over tactical- and middle-range propagation paths, which are characterized by strong-intensity scintillations. Compensation of turbulence- and thermal-blooming-induced laser beam distortions is commonly associated with the use of adaptive optics techniques originally developed for astronomical applications. Those types of activities are usually conducted at locations and under conditions in which the intensity of scintillations is relatively weak.

In stark contrast, in typical ship and aircraft defense operations, pre-compensation of the turbulence- and thermal-blooming-induced laser beam wavefront phase aberrations are performed under conditions in which the intensity of the scintillations of the target-returned light is strong. As a consequence, conventional adaptive optics techniques are not effective, mostly because of the absence of sensors that are capable of rapidly making simultaneous measurements of the wavefront phase and intensity distributions. In addition, these devices are frequently unable to differentiate between complex field measurement effects that are related to turbulence and those associated with laser beam scattering off the extended target surface (speckle effects).

As such, a novel complex field sensing system that can operate under strong-intensity scintillation conditions is required for the HEL to function optimally. The proposed concept should be capable of real-time retrieval of the target-return complex field characteristics in the presence of strong speckle modulations. In addition, the complex field reconstruction algorithms should be computationally efficient in order to achieve real-time adaptive system operation.

PHASE I: Develop a complex sensor system concept that meets the specified objectives and demonstrate, via analysis and numerical simulations, its ability to do so. Identify critical hardware components and perform a risk assessment.

PHASE II: Develop a prototype and demonstrate its functionality over tactical range distances in atmosphere via laboratory experiments. Conduct studies to establish the potential of making the sensor affordable.

PHASE III: Integrate hardware and software components into a fully functional system. Demonstrate system performance under selected maritime conditions and in civilian applications, e.g., laser communications and active imaging.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could vastly improve optical–video capabilities that have practical applications in the commercial sector.

REFERENCES:

1. Andrews, L. C., Phillips, R. L., Hopen, C. Y., & Al-Habash, M. A. (1999). Theory of optical scintillation. Journal of the Optical Society of America A, 16(6), 1417-1429. doi: 10.1364/JOSAA.16.001417

2. Majumdar, A. K., & Ricklin, J. C. (2010). Free-space laser communications: principles and advances. New York: Springer Publishing Company.

3. Vorontsov, M. A., Kolosov, V. V., & Polnau, E. (2009). Target-in-the-loop wavefront sensing and control with a Collett–Wolf beacon: speckle-average phase conjugation. Applied Optics, 48(1), A13-A29. doi: 10.1364/AO.48.000A13

KEYWORDS: High-Energy Laser (HEL), Direct Energy Weapon Systems, Strong-Intensity Scintillations, Complex-Field Sensor, Atmospheric Effects Mitigation, Wavefront Sensing

N121-025 TITLE: Detecting Submerged Targets Using Very Low-Frequency Signals

This topic has been removed from the solicitation.

N121-026 TITLE: Fiber Optic End Face Termination and Processing

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Sensors

OBJECTIVE: Develop fiber optic end face termination or processing method that minimizes insertion loss and return loss at the connector interface for use in aerospace platforms.

DESCRIPTION: Optical waveguide theory and application performance have revealed that power budgets and system operational integrity are sensitive and inhibited by poor termination and signal coupling attenuation. Great emphasis has been put on the component interface loss mechanisms to reduce these network impediments. Fiber end face polishing, coating and lens technologies have been developed to minimize end face degradation from contamination, signal reflections and coupling power loss. System data has shown the combination of these effects over time debilitate the overall throughput of the network. Back reflections not only represent power that is not reaching its intended destination, but can introduce potential complications to the optical system. Reflected light propagates in the opposite direction of the source signal, causing interference, fluctuations in source wavelength and power, and can permanently damage the transmitter. With multiple interfaces and components throughout the cable plant, a given path can easily exceed the 3.0 dB link budget margin designed into most optical links. Power loss can raise the bit error rate (BER) in digital systems and lower the signal-to-noise ratio (SNR) in analog systems, both causing a loss of information. Changes to source wavelength can be very detrimental to information accuracy, especially when implementing wavelength division multiplexing (WDM).

As existing fiber optic networks look to exercise unused bandwidth and evaluate co-deployment of digital and analog Millimeter Radio Frequency (RF) applications, loss budgets and component operational integrity becomes critical in maintain continuous spatial and temporal reliability of information exchanges. Future digital based fiber optic network designers looking to integrate analog signaling schemes have now realized focus on reducing connector end face effects for calculating link loss budgets and system reliability over the lifetime of the infrastructure.

Fiber termination processes employed by commercial harness and interconnect manufactures provide them with automated and manual capabilities that typical produce connector insertion losses range between 0.2 and 1.0 dB with a maximum allowable end-of-life loss of 1.5dB. In order to remove any obstacles to utilizing fiber networks for RF applications, target insertion loss will have to be 0.05 - 0.10 dB, while target return loss is less than – 60 dB. In addition, mechanical end face performance should also be durable enough to withstand 500 mate/de-mate operations, while keeping end-of-life insertion loss below 0.50 dB. It is envisioned that Electro-Optic (EO) based systems components, modules, backplanes and weapon replaceable assemblies would utilize this technology.

Design should work with multiple termini (MIL-PRF-29504) connectors (MIL-DTL 38999, MIL-PRF-64266, and Glenair NGCON).

PHASE I: Design, model, simulate and demonstrate intended termination/processing methods ability to meet design targets. Demonstrate feasibility of the design.

PHASE II: Design, construct and demonstrate the termination/processing method from Phase I in a laboratory environment and ensure results are repeatable and manufacturable to the design targets. Meet entry criteria for Technology Readiness Level (TRL) 6 accreditation. Construct plan for cost effective mass production of qualified fiber segments.

PHASE III: Transition technology for mass production of cable segments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Durable, low loss fiber optic endfaces can be used in the medical, automobile and telecommunication industries to provide reliable human to machine interfaces. These requirements can be found in surgical apparatus, test equipment, probe interfaces, etc. in all of the mentioned industries.

REFERENCES:

1. Audet, F. (2004). Optical Return Loss Testing—Ensuring High-Quality Transmission. EXFO Application Note 044. http://documents.exfo.com/appnotes/anote044-ang.pdf

2. MIL-STD-220B. (2004) METHOD OF INSERTION LOSS MEASUREMENT. http://www.everyspec.com/MIL-STD/MIL-STD+(0100+-+0299)/MIL-STD-220B_CHANGE-1_21983/

3. MIL-PRF-29504/18 - Termini, Fiber Optic Connector, Removable. http://www.dscc.dla.mil/Downloads/MilSpec/Docs/MIL-PRF-29504/prf29504ss18.pdf

4. MIL-PRF-64266 - CONNECTORS, FIBER OPTIC, CIRCULAR, PLUG AND RECEPTACLE. http://www.dscc.dla.mil/Downloads/MilSpec/Docs/MIL-PRF-64266/idprf64266ss21.pdf

KEYWORDS: Fiber Optic Interface; End Face Performance; low optical loss; Low Return Loss; MIL-PRF-29504; MIL-STD-220B

N121-027 TITLE: Automated Support System for the Development and Maintenance of TPSs

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PMA 275

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 set of test program set (TPS) related tools based on signal models to enable translation of test requirements from different sources (e.g., human, text fields, and test program code) into standard schemas, development and analysis of standard signal libraries, and semantic awareness of the test requirements and automatic test equipment (ATE) capabilities.

DESCRIPTION: Historically, TPSs were designed specifically for the ATE on which they were intended to be executed. This design was acceptable as long as the ATE remained unchanged or the unit under test (UUT) was not enhanced. However, if either the ATE or UUT was modified, it was very difficult to change the TPS because the data related to the UUT test requirements and ATE instrument capabilities were embedded in nonstandard test programming language software. This problem was intensified by events such as the eventual replacement of the ATE system due to obsolescence or by the need to re-host the TPS on an alternate ATE to achieve maintenance objectives. The use of nonstandard test data and programming languages is one of the difficulties that the Department of Defense's (DOD's) automatic test system (ATS) framework was designed to alleviate.

The DOD ATS framework was sponsored by the DOD ATS Management Board (AMB) to achieve an open systems approach in DOD ATS. The framework contains a set of elements that are to be satisfied by industry standards and that, when applied, would reduce ATS life cycle costs while improving interoperability among different ATSs. A key area of the framework, the definition of UUT test requirements and ATE instrument capabilities, is achieved by using models of electrical stimulus and measurement signals that conform to industry standards. These signal representations are collected into groups called signal model libraries. Building TPS-related tools based on signal models would allow for plug-and-play capabilities of reusable commercial off-the-shelf (COTS) tools. In addition, these signal libraries are necessary for the development of UUT model-based programming that is required to bridge the gaps between UUT requirements, the tester, and the instrumentation. However, the definition of these signal libraries has only just begun in industry, and more complex areas, such as advanced radio frequency (RF) and digital communications, have not been addressed at all. This topic will allow for advanced research into the development and utilization of complex signal models in both the UUT and the ATS arena.

The proposed tool must leverage ATS framework elements in order to ensure accurate and unambiguous mapping of UUT test strategies and test requirements to the identification, location, and configuration of resources required for the development and implementation of test programs. Historically, these types of analyses were performed manually. However, manual analyses present problems, including loss of information related to how the mapping was performed, lack of ability to reuse the mapping on other ATE, lack of an automated means to verify TPSs upon development, and possible human error.

The proposed tool set will need to perform the following functions. First, a tool must analyze legacy test programs (which were previously not based on industry standards) and place the programs in industry-standard Automated Test Markup Language (ATML) schemas. A second tool must interpret human text and test data files and translate the further requirements into the ATML format. A third tool must analyze the ATML test requirements against ATE capabilities via mathematical signal models. A critical aspect of the work performed under this topic is to define test requirements and capabilities by using mathematical signal libraries, which have yet to be defined by an industry-standard working group (especially RF and electro-optics [EO]). These signal modeling libraries should result in improved test and diagnostics quality due to more formal definitions, which are interoperable across ATS and can be used by COTS tools to manage test requirements across Navy and DOD UUTs. Since the signal modeling libraries will be based on industry standards, the developed tools will be able to work with other commercial tool sets created independently of this effort. The tools must also be able to support multiple phases of the TPS and ATS life cycle, especially development, operation, and maintenance. The tool(s) should be capable of reading text entered by humans or found in test data files to supplement the test strategy and requirement information. The tool(s) should be capable of being expanded to provide the functional information required to match capabilities of testers, instruments, and test requirements. Finally, the developed tool(s) should be able to analyze the ATML test requirements against ATE capabilities via signal models for both the requirements and capabilities.

The proposed tool will improve instrument interchange, provide faster technology insertion, improve TPS re-host and interoperability, and promote model-based programming techniques. In fact, the use of a standards-based approach will enable TPS information to be transferred across DOD organizations.

PHASE I: Investigate and analyze test methods, specifications, and capabilities used in testing on current Navy ATS. Develop a sample signal library by utilizing industry schemas and standards. Identify and analyze selected TPSs. Demonstrate the feasibility of the proposed tool set's ability to retrieve pertinent test data from legacy TPSs to support a TPS development and maintenance effort (i.e., test strategy, requirements, and test methods) and to convert the test data to ATML format. Present how ATML test requirements may be analyzed against ATE capabilities via signal models for both the requirements and the capabilities.

PHASE II: Complete the development of prototype automated tool(s) and demonstrate the ability to translate test data from legacy TPSs into ATML format.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The need to improve TPSs is common throughout the DOD and industry, as is the pressure of reduced budgets. The tools and test definition libraries will not only reduce the cost and efforts of re-hosting TPSs from legacy testers to new open system ATS, but will also provide the mechanism to develop class libraries that will address the needs of current and emerging technologies and their associated TPSs.

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2. IEEE AUTOTESTCON Proceedings (various papers on ATML, Standards, and ATS Framework topics). Retrieved from http://ieeexplore.ieee.org/Xplore/dynhome.jsp.

3. The Institute of Electrical and Electronics Engineers. (2005). Standard for signal and test definition. (IEEE STD1641). doi: 10.1109/IEEESTD.2005.95928

4. The Department of Defense. The DoD Automatic Test System Framework Roadmap. Retrieved from http://www.acq.osd.mil/ats.

KEYWORDS: Semantic Awareness, Signal Modeling, Automatic Test System (ATS), Test Signal Framework, Automatic Test Equipment (ATE), Digital Communication

N121-028 TITLE: <u>Highly Compact Supersonic Cruise Missile (SSCM) Engine Inlet</u>

TECHNOLOGY AREAS: Space Platforms, Weapons

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

OBJECTIVE: Develop a highly compact, low cost inlet that can efficiently interface with a small, supersonic turbofan/turbojet engine.

DESCRIPTION: As air vehicle speeds increase, air breathing engine and inlet technology follow through concurrent supersonic performance requirements. The recent ability to build smaller supersonic engines has established a void in small air vehicle inlet capability. A solution to decrease the overall footprint of supersonic inlets within next-generation Supersonic Cruise Missiles (SSCMs) is desired. SSCMs, like the Next Generation TOMAHAWK (NGT), are under consideration in response to Prompt Global Strike (PGS) requirements, which characterize engagement time with Time-Critical-Targets (TCTs). The main savings of decreased inlet volume within the air vehicle provides a direct correlation to the range capability of SSCMs through increased fuel storage. With increased standoff range and speed, the warfighter is better protected from the enemy as well as better prepared for tactical action. The highly compact inlet would provide a faster time to target with the SSCM, but maintain the current Tomahawk lethality and range capability.

The compact, supersonic inlet should capture and manipulate freestream air to desired speeds and pressures at the engine face. Air breathing engines require subsonic flow at the engine face, typically around Mach = 0.4. Due to the inlet design slowing the supersonic freestream air at the inlet down to subsonic speeds for engine operation while maintaining separation-free flow, supersonic inlets tend to be long and heavy.

The inlet development requires an optimization of inlet length and geometry. Inlet development should avoid mechanical shockwave manipulation as used in linearly actuating spikes by employing a fixed geometry. Mass flow capabilities will be refined when matched to a specific engine, but the preliminary inlet design should be scalable for a range of small, supersonic engine mass flow rates. Computer analytical tools like Computational Fluid Dynamics (CFD) utilizing 3D Navier-Stokes flow field calculations often can depict these inlet flow fields. The inlet should produce ample high total pressure airflow, or rather minimal pressure loss, at the engine face for optimum engine performance as seen by thrust output which correlates to fuel consumption and subsequently air vehicle range. The design should also account for minimizing inlet drag at off design speeds due to supersonic inlets having a higher drag than subsonic inlets at subsonic flow conditions. The inlet design effort is intended to provide an example of a feasible, compact, low cost, supersonic inlet geometry within the constraints of an SSCM, namely the NGT. The NGT and associated inlet should have a low development and unit cost and must fit within the existing surface ship and submarine launch systems. Nonetheless, the design should lay a developmental framework to easily adapt the inlet design to any compact application.

A compact inlet study proves challenging in that desirable flow characteristics break down in highly manipulated, tight spaces. An inlet study will aid the design of SSCM efforts by saving upfront costs, reducing schedule, and decreasing the complexity of inlet and engine integration.

PHASE I: Demonstrate feasibility of designing a supersonic inlet suitable for small (approximately 12-14 inch diameter) SSCM turbofan/turbojet engines operable up to Mach 2.5 and meeting constraints of being compact, lightweight, fixed geometry, and low cost.

PHASE II: Develop and demonstrate a computer simulation prototype of the supersonic inlet to allow integration into the NGT. Materials development is not a concern.

PHASE III: Deliver computer model and, if possible, physical models of supersonic engine inlets.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The availability of a compact, supersonic inlet could prove very useful when paired with small, supersonic engines in the commercial sector as it would provide for a preliminary design point for high-speed, small transportation. The technology would be critical for new air vehicle design attempting to minimize volume, weight, and drag while maximizing fuel efficiency.

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KEYWORDS: Inlet; Supersonic Cruise Missile (SSCM); Next Generation TOMAHAWK (NGT); Computational Fluid Dynamics (CFD); Pressure Recovery; engine

N121-029 TITLE: High Reliability Electro-Hydraulic Servo Valve (EHSV)

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

ACQUISITION PROGRAM: JSF-Prop

OBJECTIVE: Develop an innovative electro-hydraulic servo valve (EHSV) to increase the reliability of fueldraulic systems on aircraft gas turbine engines.

DESCRIPTION: Aircraft engine hydraulic systems which utilize fuel as the working fluid are called fueldraulics. Fueldraulics provide some clear benefits for aircraft engines over traditional hydraulics and over many other actuation technologies. A fueldraulic system can be lighter than a closed loop hydraulic system because the fueldraulic system does not require a dedicated pump and fluid reservoir. Instead, it utilizes the engine's fuel pump to provide motive power. A dedicated reservoir is eliminated because the working fluid is necessarily available whenever the engine is operating. EHSVs are electromechanical devices which are frequently used in fueldraulic systems to control actuator positioning. They are often utilized in gas turbine engine control systems for various control functions. For example, an EHSV may be utilized to precisely position a fuel metering valve to control engine power output. An EHSV may also be utilized to operate a piston actuator to position the variable guide vanes in an axial compressor or to set the nozzle area of an afterburning engine.

EHSVs are a leading cause of fueldraulic system failures on aircraft gas turbine engines. A drawback of fueldraulics is that contaminants are continuously introduced into the system as thousands of gallons of fuel may be processed through the system during each flight. Though all fuel is filtered before it passes through a fueldraulic system, small contaminants pass through the filter yet may be large enough to affect the operation of fueldraulics, and of EHSVs in particular. The secondary stage of an EHSV includes a valve spool which moves within a sleeve. The clearance between these parts is on the order of the particle size which may pass through the upstream fuel filter, so the EHSV secondary stage is prone to stiction and seizure by these contaminants. EHSV stiction leads to increased positioning errors for the engine actuators and to erratic fuel flow control. These in turn can reduce aircraft controllability and may place the gas turbine at risk of compression system stalls and surges. Reducing the filter mesh size significantly to avoid this problem is not a viable solution because it would lead to unacceptably rapid filter clogging.

Another common EHSV failure symptom is null bias shift. For failsafe purposes, the EHSV design incorporates a spring feature to drive the EHSV output flow in a safe direction if energizing current is lost. During normal operation, a specific level of electrical current is required to maintain the valve spool in the centered position. Null bias shift is a common EHSV failure symptom in which the actual null bias current requirement shifts away from the specified value. This failure mode can manifest itself as an actuator position error. Several features of popular EHSV designs contain failure modes which can cause null bias shift.

Prevalent EHSV designs also contain the following failure modes within the torque motor section: breakdown or short circuit in the coil, faulty wires to the driver current source, imbalance in the air gaps.

In the flapper nozzle section, failure modes include: nozzle hole blockage, flapper erosion, broken flapper.

An innovative EHSV design solution is sought to reduce or eliminate these failure modes in fueldraulic systems. A successful solution will also have key characteristics comparable to typical fueldraulic EHSV designs on metrics of accuracy, response, hysteresis, package size, and electrical interface. Key environmental concerns include temperature and vibration extremes.

Collaboration with an aircraft gas turbine manufacturer is strongly encouraged.

PHASE I: Prove feasibility of an EHSV design concept which will be insensitive to contaminant particles at least 64 microns in size and reduce or eliminate the failure modes which may lead to null bias shifts. Design shall reduce the number of other EHSV failure modes within the design concept.

PHASE II: Develop prototype EHSV hardware and characterize the transient response behavior, accuracy, and hysteresis through testing. Demonstrate performance relative to the Phase 1 objectives utilizing laboratory test equipment.

PHASE III: Mature EHSV design to production-grade compatible with a current fueldraulic control system and test using procedures defined by MIL-STD-810C. Transition to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: EHSVs are frequently utilized in hydraulics applications whenever electronic control systems interface with hydraulics to provide position and flow control. Therefore, improved EHSV technology can benefit multiple industries including industrial motion control, flow control, and ground vehicle applications including steering control and active suspension control.

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KEYWORDS: EHSV; Reliability; actuator; fueldraulics; hydraulics; mechatronics

N121-030 TITLE: <u>Global Positioning System Precision Encrypted (Y) Code Approach/Landing at</u>

Civil Airfields

TECHNOLOGY AREAS: Air Platform

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OBJECTIVE: Develop and incorporate the capability, on board military aircraft, to conduct an approach to near Category I minima utilizing Precision Encrypted Y Code (P(Y) available on both the L1 & L2 signals from the Global Positioning System (GPS) satellites. Desired solution would be independent of ground augmentation.

DESCRIPTION: Military aircraft require the ability to divert to airfields in cases of emergency without having to rely on a unique set of landing system infrastructure. The current civilian GPS based landing systems, Space Based Augmentation Systems (SBAS) and Ground Based Augmentation Systems (GBAS), have limited areas of coverage and utilize Coarse Acquisition (C/A) code. Military aircraft have been directed to utilize P(Y) Code and reduce reliance upon the civil available C/A code. Use of P(Y) code only would prevent them from being able to land at civilian airfields based upon current technology. Even if SBAS and GBAS were the solution set for military aircraft civil divert capability, the current GBAS and SBAS infrastructure and resulting areas of coverage do not provide for a true 'world-wide divert' capability to all airfields.

In order for US military aircraft to fly a precision approach to support all-weather operations, a vertical protection level [5] of 35 meters, and a horizontal protection level [5] of 40 meters are required. In addition, vertical accuracy required is 6 Meters, and horizontal accuracy required is 16 Meters. In practicality, this level of protection and accuracy affords aviators the ability to fly an approach in bad weather down near 200 ft above ground in 1/2 sm visibility (near Category I minima).

A solution which requires the least modification to existing aircraft, preferably software modifications only, are preferred, but all solutions will be considered.

The intent of the improvements made to the processing of the GPS signals is to improve the availability and integrity of the navigation solution. It is not anticipated that the accuracy of the P code GPS will be significantly affected by the improvements.

At present, the US military utilizes various different RADAR based systems to support landing at military airfields. GPS based approach technology is proliferating in aviation and replacing the aging legacy systems. For landings at military fields, the US military is developing and soon will begin to field JPALS. JPALS uses P(Y) code and local infrastructure to support precision approaches to precision minima. The ability to divert to civilian airfields improves the US military's ability to operate world-wide and gives combatant commanders greater flexibility in air operations.

PHASE I: Determine technical feasibility of utilizing only P(Y) Code to meet Category I requirements at any civil airfield world-wide.

PHASE II: Develop, demonstrate and validate use of only P(Y) Code to meet Category I requirements at any civil airfield world-wide.

PHASE III: Transition and implement the new capability on appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Utilization of dual frequency GPS to perform Category I approaches. P(Y) Code would utilize L1 and L2. However, for the civil aircraft, there is a potential to utilize L1 and the coming L2C or L5 frequency to provide Category I approach capability without ground augmentation.

This capability would allow/provide for the ability to:
- perform approaches below Tactical Air Navigation System (TACAN) minimums to 4,611 runways in US (TACAN supports 603 runways).
- perform diverts to 9,315 runways worldwide (345 TACAN approaches outside US).
- perform civilian approaches to 1,145 US military runways that are not supported by Ground Control Approach (GCA).
- increase safety margin during emergencies by providing vertical guidance to runway.

The private sector would have the entire DoD fleet of aircraft as potential customers. Dual frequency capability could be used with future C/A code frequencies to provide commercial use in a similar manner.

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KEYWORDS: Civil Interoperability; P(Y) Code; Precision Approach; World-wide Divert; Unaugmented; Category I

N121-031 TITLE: Low Maintenance Helicopter Tail Driveshaft Hanger Bearing

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA 299

OBJECTIVE: Develop a new and innovative design concept for a more-reliable helicopter tail rotor driveshaft hanger bearing to minimize the level of the man power and other resources required to replace and maintain the component.

DESCRIPTION: Helicopter tail rotor driveshaft hanger bearings support multiple segments of the helicopter tail rotor driveshaft and allow it to rotate. Therefore, typically, there are several on each H-60. Because of the extreme environmental conditions experienced by ship-based aircraft, as well as this component’s function, the bearing incurs a great deal of corrosion and surface wear. In addition, debris and lubrication become lodged within, thus exacerbating any damage. To ensure the helicopter’s flight worthiness, immediate steps must be taken to correct these issues.

The typical mitigation approach adopted is to conduct numerous visual inspections and to replace the bearings frequently. Unfortunately, the costs and level of man power involved in these efforts can be quite high. Furthermore, as a direct consequence, the amount of time that the helicopter is operational drastically decreases. Therefore, a need exists for a robust bearing that requires little to no maintenance and that has a service life of ~10,000 hours. In addition, the proposed component must successfully withstand the harsh conditions to which it will be exposed, as well as satisfy stringent maritime environmental regulations and rotary-wing mass property and safety specifications. Currently, there are no devices that can fill this technology gap.

Devising a viable alternative becomes even more complex because the following criteria must also be met. The new bearing must be independently mounted and require no external power source. The proposed concept must entail no other configuration changes to the helicopter, must weigh the same or less than the current bearing, and must fit within the same space. In addition, the driveshaft's balance must remain within existing parameters, and the radial runout must be the same or better than that of the bearing presently being used.

Also desirable is that the resultant bearing be a "drop-in" into Federal Logistics Information System (FLIS) National Stock Number (NSN) item 3110013298573 or 3110011771936 or both to preclude the need for any disassembly and replacement of any other aircraft components. Doing so will save untold hours of labor and substantially reduce the costs of hardware and other associated materials. (Note that the specifications for the two mentioned parts are provided at the end of this section.)

An enormous degree of creativity and innovation is required to develop a concept that will satisfy all of these challenging objectives.

NSN: 3110013298573
Criteria / Characteristic
Material: Steel Overall
Style Designator: 40A 4 Point Ball Contact, Solid Inner and Outer Rings, Non-separable
Overall Width: 0.6249 Inch Minimum and 0.6301 Inch Maximum
Bore Diameter: 1.9680 Inches Minimum and 1.9685 Inches Maximum
Overall Outside Diameter: 3.1492 Inches Minimum and 3.1498 Inches Maximum
Bore Shape: Straight
Load Direction: Radial

NSN: 3110011771936
Criteria / Characteristic
Material: Steel Comp 440C Ball, Steel Comp 440C Inner Ring Steel Retainer
Style Designator: 10A Non-loading Groove, Non-separable
Overall Width: 0.6249 Inch Minimum and 0.6299 Inch Maximum
Bore Diameter: 1.9682 Inches Minimum and 1.9685 Inches Maximum
Overall Outside Diameter: 3.5427 Inches Minimum and 3.5433 Inches Maximum
Bore Shape: Straight
Load Direction: Radial

PHASE I: Determine the feasibility of developing a helicopter tail rotor driveshaft hanger bearing that meets the stated objectives. Devise a viable concept and perform computer modeling and analysis to validate the proposed design.

PHASE II: Based on the results from Phase I, complete the component design. Fabricate a prototype and conduct characterization assessments to establish that it meets the performance specifications. If required, further refine the design and perform bench testing to demonstrate that the new bearing meets the targeted platform environmental, maintenance, and reliability requirements.

PHASE III: Fully transition the new bearing to PMA-299 (H-60) and possibly to PMA-274 (VH-60).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology is applicable to aerospace and non-aerospace production assembly and repair supply sources.

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KEYWORDS: Bearing, Driveshaft, Rotation, Lubrication, Debris, Surface Wear

N121-032 TITLE: <u>Low-Cost, Robust, Monolithic Semiconductor Mid-Infrared Laser With Very Wide Tunability</u>

TECHNOLOGY AREAS: Air Platform, Chemical/Bio Defense, Sensors, Battlespace

ACQUISITION PROGRAM: PMA 272

OBJECTIVE: Develop a low-cost, robust, compact, monolithic chip-based solution for a quantum cascade laser (QCL) with no mechanical moving parts of any kind, high continuous wave (CW) output power, excellent beam quality, and very wide tunability in the mid-wave infrared (MWIR) spectral range.

DESCRIPTION: High-power, monolithic, cost-effective, and reliable semiconductor MWIR laser sources, such as QCLs operating in the CW regime on thermoelectric coolers (TECs) [Lyakh et al. (2009) see reference section], are highly desirable and critical for current and future Navy applications. These applications include directional infrared countermeasure (DIRCM) and other surveillance and mine- and improvised explosive device- (IED)-sensing applications. In particular, DIRCM performance can be substantially improved by using high-power widely tunable MWIR QCLs with excellent beam quality, which can defeat future-generation missile IR seeker head with a laser-jamming wavelength-blocking countermeasure. This is a unique topic that seeks the best-in-class, game-changing, scientifically and technologically innovative, widely tunable mid-infrared (IR) laser solutions for Future Naval Capability (FNC) Sea Shield Missile Defense and Joint Strike Fighter (JSF) programs.

Commercially available external cavity-tuned (ECT) QCLs with relatively reasonable output power levels and impressible tunable ranges as wide as ±14.5 percent tunability from the center wavelength [Hugi et al. (2009) and Caffey (2011)] have been recently demonstrated for sensing and instrumentation applications in laboratory settings and civilian operating environments [Pushkarsky et al. (2006) and Van Neste et al. (2009)]. However, there are serious performance and reliability gaps in ECT QCLs that can potentially prevent them from transitioning into military platforms. First, ECT QCL requires hybrid integration and mechanical movement of external optical elements for wavelength tuning. Hence, the optical alignments of all the elements are sensitive to shock, vibration, and extreme temperature variations, thereby resulting in ECT configurations that are not sufficiently robust for reliable operation in harsh military environments. Second, the entire hybrid assembly of external grating, optics, and mechanical parts adversely impacts the overall laser system’s size and weight and contributes to its high manufacturing cost. Third, wavelength tuning by mechanically moving the grating or mirror is inherently slow, thus prohibiting deployment in some applications that require very agile wavelength tuning over a very wide spectral range. Fourth, it is also difficult to achieve tuning over a broad spectral range free of mode hopping because ECT QCLs require very high-quality antireflection coatings with low reflectivity, and active and simultaneous adjustment of grating angle, EC length, and laser chip optical length. Finally, the ECT QCL's hybrid integration platform does not provide a viable path forward for more compact monolithic beam combining of the tunable lasers for future power scaling. It is therefore the goal of this program to seek a feasible solution for a low-cost monolithic tunable semiconductor-based MWIR laser source with very wide tunability that circumvents all the shortcomings of the existing ECT QCL platforms. It is also the intent of this call for proposals to seek a completely broadly tunable, monolithic semiconductor laser solution with high output power capability and excellent beam quality. Proposed tunable laser solutions must circumvent the previously mentioned shortcomings of existing ECT QCL platforms.

PHASE I: Design and develop a viable TEC-cooled, monolithic, widely tunable, single-mode QCL source with a room temperature (RT) CW output power of greater than 500 millawatt (mW) over the entire tunable range, at least ±10 percent from a center wavelength around ~4.6 microns with near diffraction-limited beam quality (M2 of less than 1.3). The design should enable tunable step size as small as 0.1 nanometer (nm). Propose a viable design path forward for further increasing the output power of the laser operating at RT CW mode via an integrated on-chip power amplifier and/or monolithic beam combining scheme.

PHASE II: Demonstrate and deliver a prototype of a monolithic, widely tunable, single-mode QCL source with an RT CW output power of greater than 500 mW over the entire tunable range, at least ±10 percent from a center wavelength around 4.6 microns with near diffraction-limited beam quality (M2 of less than 1.3) and tunable step size as small as 0.1 nm. Investigate and propose designs that would increase the tunable laser RT CW output to greater than 10 W.

PHASE III: Commercialize the monolithic, broad QCL wavelength tuning technology and leverage the advantages of wafer-level scalable manufacturing to develop a very cost-effective manufacturing process for technology transition to various system integrations for both DOD and civilian applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial sector can use advanced chemical sensors based on high-power, broadly tunable QCLs to detect toxic industrial gases and for environmental monitoring.

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KEYWORDS: Quantum Cascade Lasers, Monolithic, Tunable, High Continuous Wave Output Power, Mid-Wave Infrared, Beam Quality

N121-033 TITLE: Innovative Concepts for Low Cost, Light Weight, Highly Durable, Tooling for Composite Structural Component Fabrication

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: JSF-AV

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OBJECTIVE: Develop an innovative, low cost, light weight, highly durable approach to produce tooling that is used for the fabrication of composite airframe structural components, and capable of withstanding high temperature processing conditions.

DESCRIPTION: Mold tools for the lay-up and autoclave curing of precision composite parts for air vehicle application are primarily made from invar metal or polymer matrix composites. Metal tooling is generally expensive and subject to long lead times. Composite tooling is typically made by hand-layup and autoclave cure of prepreg materials. While prepreg tooling is generally less expensive than metal tooling, the need for autoclave equipment and freezer storage limits the industrial base and complicates the supply chain. Composite tooling durability is also an issue in the curing of bismaleimide (BMI) resins due to exposure to more extreme thermal profiles during part processing. Therefore both invar and composite tooling requiring prepreg and autoclave cure is of no interest.

The ideal tooling concepts should be capable of implementation by substantially cutting the lead time to build a tool and reduce cost. Eliminating the use of an autoclave to cure the tooling and freezers to store the prepreg materials prior to lay-up and cure would be ideal. The mold tools created must be suitable for subsequent lay-up and cure of current typical aerospace structural polymer matrix composite materials comprised of epoxy, BMI and out-of-autoclave polymers. The mold tools must be capable of sustaining autoclave pressures up to 100 pounds per square inch (psi) and temperatures up to 375 fahrenheit, with a strong desire to meet a 450 fahrenheit temperature requirement enabling post-cure of BMI components on the mold tool. The mold tools must be durable and repairable to facilitate the manufacture of hundreds or thousands of parts from the mold.

PHASE I: Develop an innovative approach for a tooling concept that would enable the fabrication of composite structural components.

PHASE II: Fully develop the concept conceived during Phase I into a prototype tooling system. Demonstrate the suitability of the developed approach by producing multiple tools and using those tools for the fabrication of multiple composite structural components constructed of various material systems, including high temperature resin systems. Demonstrate the durability of the tooling concept by producing a quantity of composite components.

PHASE III: Fully implement the tooling concept by transitioning the technology to aircraft component fabricators.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this effort has direct applicability to the commercial aircraft industry.

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KEYWORDS: Low Cost tooling, composite fabrication, moulding, tooling, RTM, VARTM, composites, carbon fibre.

N121-034 TITLE: High-Speed, High-Fidelity, Reprogrammable Kernel for Use in Digital Radio Frequency Memory (DRFM) Systems and High-Speed Signal Digitization and Processing Applications

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Evaluate, design, fabricate, and demonstrate the framework of a high-speed, high-fidelity, reprogrammable kernel for use in digital radio frequency memory (DRFM) systems and high-speed signal digitization and processing applications.

DESCRIPTION: The advent of modern electronics is enhancing our ability to save warfighters' lives. However, the enemy's capabilities are also improving significantly. Therefore, it is imperative that our fighting men and women are equipped with only the best and most up-to-date equipment possible. Doing so is facilitated by the decreasing cost of electronics over the last decade, a fact that will enable us to deliver more cost-effective solutions.

With modern electronics, items such as a DRFM, which is an electronic method for digitally capturing and retransmitting a radio frequency (RF) signal in radar jamming, can be rendered more difficult to detect. Two reasons are the higher number of bits and higher sampling speeds of state-of-the-art analog-to-digital converters (ADCs) and digital-to-analog converters (DACs). For example, the higher number of bits in ADCs and DACs allows for a higher spurious-free dynamic range (SFDR), thus making it more difficult for a radar system to detect when a DRFM is being used. Higher sampling speed affords a higher intermediate frequency (IF) bandwidth, thereby making it possible to use much simpler and less expensive RF front ends, as well as allowing for lower latency and increased resolution.

The kernel, which is the core part of the DFRM's operating system, takes an analog IF input and digitizes it with an ADC, processes the data in one of several ways within a field-programmable gate array (FPGA) chip, and outputs the altered digital data through a DAC. Having a high-speed, high-fidelity, reprogrammable kernel will result in significant improvements in the Navy's ability to defeat cutting-edge radar systems.

While the focus of this SBIR effort is on DRFM systems, the product developed should be a modular kernel design that can be used for many applications, not solely for a DRFM. Therein, the FPGA chip should allow the hardware to be reconfigured in numerous ways for air, land, and sea applications. Furthermore, the firmware should have the basic functions needed to implement a DRFM, as well as allow additional features to be added by the end user. In fact, the hope is that the hardware incorporating the proposed kernel can be used for any project requiring high-speed data conversion and signal processing.

To defeat modern radar systems, the design must meet the following minimum specifications. The system must have a total SFDR of greater than 60 decibels (dB), the kernel section's total latency must be less than 60 nanoseconds, and the system must have four digital channels and be able to generate delays in excess of 64 microseconds. Other goals include the ability to send portions of the data stream to a PC for analysis, to control the device via PC, and to easily reconfigure the firmware. The system must be clocked at a minimum of 1 gigahertz (GHz). Finally, the system should be able to provide frequency modulation with 0.1-hertz (Hz) or smaller steps on time-delayed signals.

PHASE I: Determine the feasibility of designing a system meeting the specifications stated in the "Description" section for both hardware and firmware solutions. Develop an approach for executing all aspects of the design, including frequency modulation, time shift, and hardware. Conduct modeling of the firmware solutions for the targeted device to prove the concept's ability to satisfy the stated requirements.

PHASE II: Develop a hardware, firmware, and user interface as a prototype. Demonstrate and validate that the prototype meets the required specifications and is manufacturable.

PHASE III: Test the system and integrate it into military applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The kernel portion devised under this SBIR project can be used for any weapon system that requires high-speed analog data capture, processing, and transmission. Because of the reconfigurable firmware, the device can be repurposed for many applications, including, but not limited to, hardware-in-the-loop systems requiring high bandwidth and high signal fidelity, radar test and evaluation, and analog control systems.

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KEYWORDS: Digital Radio Frequency Memory (DRFM), Reconfigurable, High Speed, Kernel, Digital-to-Analog Converter (DAC), Analog-to-Digital Converter (ADC)

N121-035 TITLE: NANOMATERIALS FOR THERMAL BATTERY

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

ACQUISITION PROGRAM: PMA 263

OBJECTIVE: Develop a thermal battery by using nano-sized anode, cathode, separator, and heat pellet materials to improve battery power capabilities and compactness.

DESCRIPTION: As missiles are required to travel greater distances, the thermal battery will need to supply a significantly higher level of power to the missile's electronics, fuze, and actuation components. Yet, the battery will have to fit into a more compact volume, as the space inside a missile continues to decrease.

Although current thermal batteries are made from materials in the micron-size range, no new net increase in performance has been achieved since their initial development during World War II. Nanomaterials potentially offer an opportunity to produce batteries similar to current technology, but with much improved performance characteristics, such as higher voltages and increased current densities. Applying nano-sized materials to as many of the battery components as possible would be a significant step in reducing battery size and increasing operating life and power density. For example, nanostructured cathodes used in thermal batteries have resulted in improved electrochemical performance. With the same weight as that of current pellets, these nanostructured cathode pellets are over 20 percent thinner than conventional pellets, react more rapidly and completely, and are more mechanically robust. Additionally, the U.S. Army Research Laboratory (ARL) tested a new heat source for thermal batteries called NanoFoil that was developed by Reactive NanoTechnologies. This material showed significant promise; however, further work is necessary to improve material properties. In addition, using carbon-nanotube and silicon nanowires results in high-performance lithium batteries that may find application in thermal batteries.

Battery with performance characteristics that are equal to or better than those available in current technology: current density >0.5 A/cm2 and current pulse >6 A/cm2 should be considered. The batteries will be tested in nonoperational and operational environments and undergo U.S. Navy safety testing.

PHASE I: Determine the feasibility of using nano-sized materials for a thermal battery's anode, cathode, electrolyte, and heat pellet. Test a single-cell battery with performance characteristics that are equal to or better than those available in current technology: current density >0.5 A/cm2 and current pulse >6 A/cm2

PHASE II: Develop full-size prototype battery with at least 30 V. Maintain performance characteristics of each cell. Fully document all fabrication, test processes, test data, and results. Demonstrate improvements in battery performance by testing a sample of batteries that meet performance requirements of an actual missile application.

PHASE III: Transition developed technology to appropriate users and platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology would benefit any Thermal Battery users.

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KEYWORDS: Thermal Battery, Nanomaterial, Cathode, Anode, Electrolyte, Pellet

N121-036 TITLE: ADVANCED PROCESSING ELECTRONIC ATTACK (EA) Digital Radio Frequency Memory (DRFM)

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

ACQUISITION PROGRAM: PMA 208

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 advanced processing methods to lead to state-of-the-art advancements in real-time threat-representative electronic attack (EA) Digital Radio Frequency Memory (DRFM) test emulators.

DESCRIPTION: A new EA DRFM capability that uses advanced computing technologies that significantly extend the instantaneous bandwidth and spectral purity of the transmitted waveform beyond what is possible using conventional RF technology; efforts to anticipate and emulate next generation EA capabilities, are sought.

Current DRFM technology utilize an RF translation to baseband, RF sampling, storing digitized samples into memory and then reversing the process to reconstruct the RF signal prior to transmission to the victim radar. This allows for both time domain and frequency domain manipulation of the radar signal. In contrast, implementing advanced high-speed digital signal processing technologies, perhaps using optical computing for DRFM applications, may eliminate the characteristic RF sampling byproducts (spectral impurities) as well as provide extremely wide instantaneous frequency bandwidth response with an unlimited number of simultaneous (time coincident) false target outputs.

New technology should provide instantaneous ultra-wide bandwidth EA DRFM responses which are currently not possible. Improved Electronic Protection (EP) system performance of Fiber Optic Tow Decoys and significant improvement in signal spectral purity over that of conventional RF DRFM systems are needed. RF spectrum characteristics unlike traditional DRFMs which may compound the identification process would be considered. The use of COTS technology for affordability, and significant cost savings as a result of reduction in delicate RF electronics that are subject to frequent damage during mission operations are all areas of interest.

PHASE I: Determine the feasibility for implementing advanced processing technologies to EA DRFM systems. Develop a system design approach and establish the associated requirements for implementing a lab bench prototype for testing in Phase II.

PHASE II: Develop and build a lab bench prototype advanced processing EA DRFM. Perform bench tests in order to validate the basic technology.

PHASE III: Finalize and build a flight qualifiable production prototype advanced processing EA DRFM and perform airborne tests in order to validate the technology on actual fighter aircraft on outdoor Test and Evaluation ranges.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential Dual Use in support of both DoD and Homeland Security. This project will provide a self-protect jamming capability for use in airborne platforms.

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1. Nguyen, L. (2003). Photonic Radio Frequency Memory - Design Issues and Possible Solutions. DSTO Research Report DSTO-TR-1491, Australian Defense Science Technology Organization.
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KEYWORDS: Optically-based digital signal processing (DSP); Fourier Optics; Digital Radio Frequency Memory (DRFM), Real-Time DRFM DSP; Electronic Attack (EA); Optical Computing

N121-037 TITLE: Cosite Interference Prediction and Mitigation Tool

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA 263

OBJECTIVE: Develop an automated simulation tool that will predict and mitigate intrasystem (cosite) interference while integrating with existing databases of radio frequency (RF) component and equipment characteristics.

DESCRIPTION: Successful missions require compatibility between the numerous RF systems operating on a platform. The ability to predict and mitigate intrasystem, or cosite, interference before it becomes a problem is currently limited by the lack of suitable performance data for all of the systems on the platform (which is necessary to predict interference accurately). An integrated solution to model creation and simulation is needed in order to streamline the process of cosite interference prediction and mitigation. This in turn will improve the probability of successful fielding and deployment of new and upgraded aircraft.

Simulation tools exist today that predict cosite interference in complex RF environments such as those encountered on aircraft, ships, ground vehicles, and fixed installations. Sophisticated analysis engines have been implemented in these tools to enable them to predict many types of important electromagnetic interference (EMI) effects, including nonlinear phenomenon such as intermodulation products that can lead to interference when multiple RF systems operate simultaneously, even at different frequencies. The use of these simulation tools during initial system design and integration, as well as during upgrades and modifications to a platform, allows the electromagnetic environmental effects (E3) engineer to predict potential interference issues prior to installation and to put appropriate mitigation strategies in place. Further, the simulation models created for the analysis form a valuable baseline for evaluating future modifications and tracking changes over the course of the platform's life cycle.

The ability of these simulation tools to predict important interference effects is well established, but their successful application relies on the availability of appropriate models and databases for all of the RF equipment used on the platform. This includes all transmitters and receivers as well as other components such as cables, filters, amplifiers, diplexers, isolators, and so on. These models are based on the broadband performance characteristics of each subsystem, and the data needed to create the models can be difficult to obtain and assimilate into the simulation tool, often requiring a high level of expertise and investment of time on the part of the analyst. This creates a roadblock to realizing the significant benefit of these tools in identifying and mitigating interference problems early in the system design and integration phase, where their impact on ensuring interference-free deployment and mission success is at a maximum.

In order to leverage these simulation tools to their full potential, they must be capable of working with existing databases of equipment characteristics by extracting the necessary data and creating the required simulation models in an automated fashion. The models created should then be saved in a model library that is accessible within the simulation tool for re-use across multiple projects. The Joint Spectrum Center (JSC) maintains and continually updates a comprehensive database of equipment characteristics that contains "detailed technical information about communications, radar, and electronic warfare equipment." The information contained in the JSC Equipment, Tactical and Space (JETS) database contains, among other things, the data needed to create the simulation models necessary for cosite interference prediction. However, manual extraction of the parameters required for cosite models is time consuming and error prone due to the voluminous nature of the data available for each subsystem and the particular nomenclature employed in JETS.

The integration of simulation tools with the JETS database requires the automated extraction and filtering of the necessary subsystem performance parameters at both the equipment and platform levels. The data so obtained should be used within the tool to create a library of models for use in cosite predictions. The simulation tool itself should incorporate the model library and allow the sharing of libraries between users and organizations. It is also desirable to develop new RF component models as needed and improve existing ones for which data are available in JETS but no models exist, or for which existing data are incompatible with current models. The model library should be updatable as new information is added to the JETS database by the JSC. This will lead to comprehensive, reusable, and extensible libraries that can be used for maintaining a cosite compatibiity model of a platform over its entire life cycle. Science and technology advances are needed in the area of automated data mining. Automating methods to accurately extract information from multiple different large data sets is required. A tool is needed that combines advanced computer science, artificial intelligence, and database management approaches.

PHASE I: Demonstrate the compatibility of a suitable simulation tool with the JETS database for extracting relevant data to create accurate simulation models for cosite analysis. Develop detailed requirements for interfacing with the JETS database, including the filtering and extraction of the necessary RF subsystem data, and demonstrate the validity of the approach. Develop a Phase II implementation plan that includes database integration as well as any additional subsystem and component models that will be developed as part of the work.

PHASE II: Execute the plan developed in Phase I using the selected simulation tool, including the automated extraction of RF subsystem data from the JETS database, the creation of portable and maintainable model libraries within the simulation tool, and the development of any new subsystem and component models as identified. Explore the potential for integration with other RF equipment databases such as those available from the Federal Communications Commission (FCC). Deliver the analysis tool with JETS integration and thorough documentation to the Navy and provide on-site training on its use.

PHASE III: Refine the methodology and tool developed in Phase II, including extending integration to other commercial databases (e.g., FCC), either alone or in partnership with another company. Make the necessary arrangements to commercialize the tool either alone or in partnership with another company and seek potential sponsors.

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

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KEYWORDS: Cosite Interference; Electromagnetic Vulnerability; Electronic Survivability; Electromagnetic Interference; RF System Performance; Modeling

N121-038 TITLE: Radar Signature Tools for Small Boats in Dynamic Sea Environments

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA 205

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 set of software tools that simulate high-frequency radar signatures for small boats in dynamic littoral and deep water environments.

DESCRIPTION: Small boats at sea cause unique challenges due to their relative size, mobility, and often nonthreatening outward appearance. Detection and identification of potentially threatening small boats in and among other small boats and in proximity to U.S. naval assets is of high interest and importance for the safety of the Fleet. The ability to simulate the radar signatures of small boats in these challenging and dynamic environments aids in developing detection and identification methodologies, algorithms, and systems.

Complicating the problem is the dynamic sea state, which comprises multiple wave phenomena and the dynamic motion of the small boat relative to the sea state, including the position/orientation of the boat and its associated wake as a function of time. Modeling and simulation tools exist for generating a 6-degrees-of-freedom (6-DOF) ship state as a function of time given a sea state and the mass distribution and hull shape of the ship, but these tools typically are not coupled to radar signature modeling and simulation tools. Conversely, a number of high-frequency radar simulation codes are capable of generating radar signatures for objects like small boats, but these typically are not coupled to dynamic models for generating the changing sea state and ship position/orientation as a function of time. Many of these codes also are not suitable for computing the complex scattering mechanisms resulting from the sea state—including gravitational waves, capillary waves, and wake phenomena—and the interaction of this changing sea state with the small boat. Further, the large physical scale of the wake relative to the small boat presents computational problems for both full-wave and high-frequency codes that require a mesh of the entire scene at each time step, which may span hundreds of thousands of wavelengths or more in size and thousands of coherent processing intervals (CPI) in time.

Understanding and exploiting radar signature characteristics of small maritime threats is a key component of maritime surveillance missions. A set of robust tools is required that can accurately model and efficiently predict high-frequency radar signatures for small boat(s) in the changing sea environment over many CPIs. The tools should use high-fidelity physics-based modeling to (1) account for interactions involving motion of the boat and the nearby sea state, (2) include the return of waves and the ship wake, and (3) predict radar returns for one or many CPIs to allow computation of coherent radar cross-section (RCS), synthetic aperture (SAR), and/or inverse SAR (ISAR) images. Approaches should also address how to interface between new or existing sea state modeling tool(s) and how to represent the sea state geometry as a function of time for use in the signature simulation tool.

PHASE I: Develop and demonstrate proof-of-concept prototype algorithms or tools for computing the combined radar return from small boats in a dynamic sea state environment over many seconds of simulated time. Develop a detailed implementation plan including the tool requirements and a graphical user interface (GUI) development to be carried out in Phase II.

PHASE II: Further develop the methods proposed in Phase I and address the computational challenges identified. Develop a GUI to visualize modeling inputs and signature outputs. Integrate the software tools for sea-state generation and signature computation. Demonstrate signature computations for small boats, wakes, and wave phenomena through use cases and tutorials. Demonstrate accuracy and robustness of the computational electromagnetics model for selected evaluation scenarios.

PHASE III: Develop a commercial-grade software tool that solves the end-to-end modeling and simulation problem, including development of necessary interfaces to existing government or commercial software tools for modeling the dynamic sea state and ship motion, as well as a robust GUI and user documentation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are numerous commercial/dual-use applications for this capability, including port security, commercial shipping safety and security, and civilian watercraft protection.

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KEYWORDS: Radar Signatures; Small Craft; Hydrodynamics; Electromagnetic Modeling; Sea Scattering; simulation

N121-039 TITLE: Durable Solution for Compressor Airfoil Leading Edges in Gas Turbine Engines

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA 275

OBJECTIVE: Develop an advanced, robust solution that improves the durability of the leading edges (LEs) of a compressor's airfoils while incurring minimal to no impact on the original performance and structural integrity of the airfoils in gas turbine engines operating in austere environments.

DESCRIPTION: Operations in austere environments introduce performance, reliability, durability, and safety concerns for military aircraft. Corrosive maritime environments and engine ingestion of foreign media (e.g., sand, volcanic ash, foreign object damage) result in reduced engine performance and reliability. Current state of the art erosion/corrosion coatings developed over the last decade for compressor airfoils have provided an increased capability in erosion degradation modes but have provided minimal protection to airfoil LEs due to high-energy particle impacts.

LE deformation leads to adverse effects on aerodynamics and significantly reduces the compressor's flow capacity and efficiency. In addition, LE deformation has the potential to introduce safety impacts due to shifts in airfoil aeromechanical response during normal engine operation, thereby resulting in vibratory failure modes.

A robust solution with enhanced durability is necessary to protect the LEs of the compressor's airfoils from particle impact deformation. The goal is to protect the airfoil LEs of engines operating in austere conditions while maintaining original airfoil properties and introducing no adverse failure modes. This technology is vital in maintaining engine performance and reliability for current and future applications as the number of austere missions continues to increase.

PHASE I: Develop laboratory test coupons that simulate actual aircraft engine hardware and demonstrate the feasibility of the solution in protecting LE characteristics following high-energy impacts.

PHASE II: Develop, demonstrate, and validate a robust solution to be applied to the LEs of compressor airfoils in order to protect them from high-energy impacts. Assess the performance of the solution using a series of standard verification tests and in a field-representative environment.

PHASE III: Team with an original equipment manufacturer of Navy and Marine Corps gas turbine engines to develop, validate, and deliver a robust solution with enhanced protection properties for compressor airfoils in a current in-service application. Apply this technology to future programs coming online that will operate in austere environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of this technology for military aircraft engines can be translated easily into applications for commercial engines, land-based turbine systems, and other power plant parts. Results and understanding gained from applying this technology to particular compressor blades would significantly help decrease life-cycle cost through reduced scrap-rate and increased time on wing while mitigating safety concerns.

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KEYWORDS: compressor airfoil leading edge; erosion corrosion coating; compressor coating; compressor airfoil durability; gas turbine engine compressor

N121-040 TITLE: Distributed Physics Based Electronic Warfare Object Models

TECHNOLOGY AREAS: Information Systems

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: Develop a consistent physics based approach to replicating the effects of Radio Frequency (RF) Jammers and Emitters across the Information Operations Range (IOR) to support the Joint Live, Virtual and Constructive (JLVC) Modeling and Simulation Federation.

DESCRIPTION: The parametric data and algorithms essential to accurately replicate jamming and radar emitting effects in a simulated, distributed environment are at a very rudimentary level, if defined at all. Especially for newer systems, the parameters of the jamming systems and their effects on targets are not very well known. Furthermore, the algorithms which do exist are largely physics constructs and do a poor job of replicating the real world with all the environmental factors.

Currently, manual operator intervention is required for consistent representation of jamming effects across the federates. If a desired jamming effect is clearly defined by the Navy's Jammer Techniques Optimization (JATO) group, then there is likely a manual method which could be devised to generate the desired effect. The success in our ability to manually depict jamming effects is highly dependent on the ability of the model to replicate the desired jammer characteristics, replicate the effects on the targeted receiver system(s), as well as how long and how wide spread the effects are. Since execution depends on manual control to achieve a desired jamming effect, the success of replicating the effect diminishes the more complex, wide scale and long term the jamming event is.

RF effects will need to include those induced by the atmosphere and surrounding terrain across the entire electro-magnetic spectrum with each model having complete geometric freedom dictated by the operator. Each model must support many on many at the waveform level with a variety of user defined antenna patterns. Jammer models will need to replicate the effects of EA-6B and EA-18G Tactical Jamming Systems, including Digital Radio Frequency Memory (DRFM) coherent jamming systems, on Integrated Air Defense System (IADS) Radars and RF communication devices. The technical risks for these models should include (1) overcoming the inherent latencies and (2) instantiating real-world RF effects across a distributed, networked test and training environment such as the Information Operations Range (IOR).

In addition, the models should be integrated with High Level Architecture (HLA) devices to replicate jamming effects on IADS and to replicate the effects of IADS on Tactical Jammer Receiver Systems (TJRS) such as the ALQ-218. Model algorithm performance shall not be at risk to inherent latencies of distributed networked test and training environments such as the IOR.

Reusable event architectures, object models and protocols must be capable of supporting the Secure Defense Research and Engineering Network (SDREN) based IOR to integrate Electronic Attack, Electronic Protect and Electronic Surveillance hardware in the loop with threats from various agencies (such as the Missile and Space Intelligence Center) to replicate the interactions between blue jamming platforms and red targets as a Joint Mission Environment Test and training Capability. This will provide a persistent integrated capability that enables rapid formation of realistic, high fidelity combat and adversary operational environments from which to conduct joint EW testing, training and exercise events.

PHASE I: Develop innovative concept design, model key elements and perform detailed analysis to demonstrate feasibility of predicted performance for prototype, distributed physics based EW object models that replicate the effects of jammer and emitter systems on RF receiving systems across a distributed test environment. A validation methodology will need to be developed in support of this demonstration.

PHASE II: Use validated concept design to investigate, analyze and develop prototype high fidelity jammer, radar and communication emitter models and RF receiver models for integration and demonstration with both the Test and Training Enabling Architecture (TENA) and Joint Integrated Mission Model (JIMM). Prototype demonstrations will make use of the validation methodology developed during Phase I.

PHASE III: Engineer the models to support Capability Test Methodologies for distributed testing in a LVC joint test environment to evaluate system performance and joint mission effectiveness across the acquisition life cycle in a realistic joint mission environment. Finalize and transition the technology to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Electromagnetic Interference testing of military and commercial devices and capabilities in a distributed test environment.

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KEYWORDS: Modeling; simulation; jammer; emitter; Electronic Warfare; electronic attack

N121-041 TITLE: Innovative Collimated Controller Displays

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

ACQUISITION PROGRAM: PMA 205

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

OBJECTIVE: Develop innovative visual displays to provide variable collimation and improved 3D depth perception for rotary wing chin windows and cargo hatch operation.

DESCRIPTION: Visual systems used for flight simulation have traditionally concentrated on training fixed-wing pilots. For fixed-wing training high-detail is primarily critical only for target models and for relatively distant airfields (viewed out the front windscreen).

Rotary wing platforms require a different set of flight regimes and a more complex set of close proximity visual cues during hovering, take-off and landing, search and rescue, confined area and emergency landing, and cargo loading/unloading operations. For example, current visual displays used for operation and training do not present stereo imagery to the viewer and as a result these non-variable collimation displays create only a distant background effect, resulting in ground appearances that are distorted and unrealistic when the controller/trainee needs to make critical judgments of distance to points of interest in the environment and the corresponding relative motion/closure rate. An innovative variable collimation display that can selectively present stereo scenes (with appropriate and continuously changing depth information) will correct for this lack of cuing and enable initial and refresher training for tasks.

A new visual display design that is light-weight and thin enough to be incorporated into existing rotary wing and VSTOL simulator housings is sought. Current collimated display designs provide fixed (rather than variable) depth perception and are too bulky and expensive to be used in these critical application settings. The resulting display should have a sufficiently large viewing angle to allow viewers to perform their tasks naturally. The display should be able to take advantage of many sources of depth information, such as stereo satellite imagery, synthetically computed stereo pairs, as well as time-stamped streaming video. The display should be capable of matching real-world depth perception without losing general spatial orientation, and include the following characteristics: a) Correct presentation of obstructions and flight hazards, cultural features, and vegetation, especially forested areas; b) nap-of-the-earth terrain and feature rendering based from new Intelligence, Surveillance, Reconnaissance, (ISR) stereo camera imagery; c) low-altitude weather effects; d) low-altitude Night Vision Goggle (NVG) presentation; e) chin window and cargo hatch viewing of low-altitude and landing zones with changes in depth perception that are correct with dynamic changes in own-aircraft altitude; and f) full correlation with the forward field-of-view (Out-the-Window/windshield) imagery.

PHASE I: Design an innovative visual display that meets the unique requirements of simulation based rotary wing and VSTOL training. Demonstrate conceptual design and the feasibility of the new visual display technology.

PHASE II: Develop, integrate, demonstrate and validate a prototype that addresses the elements listed above.

PHASE III: Commercialize the advanced technology and transition to appropriate training commands.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed technology can be applied in commercial rotary-wing flight simulators as well as military rotary-wing flight simulators.

REFERENCES:

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KEYWORDS: helicopter training; rotary wing training; VSTOL; Systems; Visual Simulation; chin Windows

N121-042 TITLE: High-Fidelity Residual Strength and Life Prediction Tool for Adhesively Bonded Composite Structures

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA 261

OBJECTIVE: Develop a multiphysics-based tool that assesses the residual strength and bondline-damage propagation of as-built and service-disbonded adhesively bonded composite joints subjected to significant thermal/mechanical/environmental loads.

DESCRIPTION: Adhesively bonded joints are an increasingly popular alternative to mechanical joints in aerospace engineering applications and provide many advantages over conventional mechanical fasteners, including increased strength-to-weight ratios, design flexibility, ease of fabrication, cost efficiency, integrity, and durability. These attributes make them attractive for use in military and aircraft structural components.

To ensure the integrity and durability of the bonded primary structure, adhesively bonded joints need to be evaluated to determine their strength and life expenditure. However, it is difficult to evaluate bond strength due to the process-driven bonding properties, service-driven failure modes, and damage initiation and propagation. Bonding processes involve critical steps such as surface preparation, adhesive mixing, adhesive application, and curing time, as well as critical parameters such as curing temperature and pressure. Service- and environment-induced damages include crack initiation and propagation along the interface, crackling within the adhesive, and failure of the adherend.

Currently, the bond strength of adhesively bonded joints is evaluated using a variety of methods—all of which entail problems of some sort. Coupon-level test data, for example, cannot ideally represent the bonding properties of a large-scale bonded structure at field due to the non-uniform applied temperature and different curing time experienced. Analysis simplification by smearing a finite adhesive layer with a cohesive model either through a cohesive element or a cohesive interface interaction is also problematic because the adhesive's physical properties and nonlinear material behavior, as well as the discrete damage in the adhesive layer, are lumped into a few parameters to describe the constitutive behavior of the cohesive model. The use of a conventional finite element discretization of the adhesive layer is burdensome because an extremely higher mesh density has to be introduced to maintain an adequate element aspect ratio for the adhesive layer of the thickness between 0.03 mm and 0.5 mm.

The goal of this project is to develop an innovative, high-fidelity multiphysics-based tool along with standardized material characterization to evaluate the residual strength and life expectancy of adhesively bonded composite structures.

PHASE I: Develop and demonstrate the technical feasibility of creating a tool that will evaluate processing-dependent bonding properties, mechanical performance, residual strength, and life expectancy of adhesively bonded composite structures. Conduct validation at the subcomponent level to illustrate the accuracy and modeling efficiency of the tool.

PHASE II: Based on the approach selected in Phase I, design, develop, and validate a prototype that integrates all of the algorithms developed. Validate that the prototype software provides appropriate results by correlating it to test data on a selected component.

PHASE III: Implement the validated algorithms in collaboration with a software house.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The use of adhesives for bonding structures is steadily growing and finding new applications in areas such as electronics, construction, and packaging. Bond integrity is critical to both commercial and military aerospace structures. This tool will be applicable to both sectors for optimizing design and maximizing performance. It is increasingly being used in automotive applications where there is a need to join sheets of dissimilar materials to produce lightweight car bodies.

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KEYWORDS: bonded structures; durability; damage tolerance; composite fatigue; disbond growth; model validation

N121-043 TITLE: Landing Gear Structural Health Prognostic/Diagnostic System

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

OBJECTIVE: Develop a low-cost, highly reliable, multifunction prognostic/diagnostic system to assess and monitor the structural health of airframe landing gear systems and improve on methods currently used for fatigue damage tracking of these systems.

DESCRIPTION: Current methods of tracking fatigue damage of airframe landing gear systems and fuselage support structures depend on data collection of aircraft parameters recorded onboard at various sampling rates by structural health monitoring (SHM) devices. These service usage data are processed postflight using applications such as Structural Appraisal of Fatigue Effects (SAFE) to identify flight conditions, recognize landing and ground maneuver events, and determine any overload or exceedance occurrences. The service data are used to determine the airframe's maintenance and inspection requirements and ensure the landing gear systems' flight-worthy condition/flight safety, which can help extend the life of the aircraft and reduce life-cycle costs.

However, the data collected to track fatigue damage has its limitations. Limited sets of parameters recorded and low sampling rates allow for gaps in data quality, requiring conservative assumptions to be made for the characterization of landing, ground, and braking events. Errors in aircraft gross weight and center of gravity (CG) estimations require additional conservatism to be applied to fatigue damage tracking values and fatigue life expended values of landing gear systems and their back-up structure. These assumptions and conservatisms quite often result in too many inspections, premature replacement of parts, and/or an inability to use aircraft to their full capacity (i.e., need to minimize cargo and crew).

New technologies for sensors, wireless communication devices, and miniaturized data acquisition systems have presented a significant opportunity to quickly obtain, via hardware and software modules, a multifunction SHM system that can directly measure landing gear and support structure loads for use in fatigue damage tracking, provide a method for capturing improved estimations of gross weight and CG, and at the same time provide prognostic/diagnostic methods for assessing the condition of landing gear components. Direct load monitoring provides an improved solution to accurately calculate fatigue damage on landing gear components, minimizing assumptions and conservatisms and significantly enhancing the ability to recognize landing and ground exceedances. With improved gross weight and CG estimations, cargo and crew capacities can be maximized to published limits in order to get full benefit out of the aircraft, leading to life-cycle cost reductions and optimized mission capabilities. By being able to assess and check the condition of landing gear components (e.g., tires, brakes, pistons, oleos) individually, maintenance requirements and inspections intervals can be adjusted to ensure that maintenance actions are performed only when appropriate and necessary.

PHASE I: Develop and demonstrate the technical feasibility of a multifunction SHM prognostic/diagnostic system that will capture and assess the structural data required to accomplish fatigue damage tracking of landing gear systems, improve on weight and CG estimations, and provide a method to evaluate the condition of individual landing gear components.

PHASE II: Fully develop, demonstrate, and validate a multifunction SHM prognostic/diagnostic system in a laboratory environment and on representative landing gear systems and associated back-up structures that it is low cost and highly reliable and improves on existing methods for fatigue damage tracking of these systems. Demonstrate direct load monitoring capabilities at key locations in the landing gear's load path, taking into account any hardware, software, environmental, and weight sensitivities at these key locations. Develop and provide an overall cost–benefit analysis for the multifunction system developed.

PHASE III: Transition the multifunction SHM system for implementation by original equipment manufacturers or onto an existing aircraft platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Similar to naval aircraft, commercial aircraft experience fatigue, which can culminate in cracks and lead to complete fracture after a sufficient number of load cycles. Structural deterioration in aging aircraft increases the maintenance workload, reduces aircraft readiness, and potentially increases safety risks. A multifunction structural health monitoring prognostic/diagnostic system that captures and assesses the structural data required to accomplish fatigue damage tracking of landing gear systems can ensure that maintenance requirements and inspection intervals can be adjusted so that maintenance actions are indeed appropriate and necessary.

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KEYWORDS: landing gear; prognostic; diagnostic; structural health; fatigue tracking

N121-044 TITLE: Making airborne radome structural members

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Electronics

ACQUISITION PROGRAM: PMA 231

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 fabricate one or more prototype structural members, for the Hawkeye Rotodome, which will minimize structural members’ effect on Radio Frequency (RF) propagation.

DESCRIPTION: Radio signals are propagated as planar waves. Different media have different propagation speeds; when optical and radio waves cross from one media to another, such as air to fiberglass, the electromagnetic waves will refract. In 1967 Victor Veselago theorized development of substances which exhibit unusual or unnatural properties at a given wavelength of interest. Hawkeye radar works in the UHF Band and the IFF works in the IEEE L Band. The Hawkeye rotodome is fabricated with fiberglass structural reinforcements that refract the RF energy increasing sidelobes and distorting their antenna patterns. Using substances which have negative refractive indices in the B Band and L Band, as part of the of the rotodome structural reinforcements, has the potential of reducing the sidelobes and antenna pattern distortion.

Structural members with a negative refractive index that can allow antenna to perform as in “free-space” for use in Hawkeye Rotodome should be developed. Materials that have low absorption will be needed to “steer” the beam around the structure with a combination of natural and negative refractive index materials. Materials with high absorption could be utilized to minimize the impacts of Sidelobe interference. The first phase should include a design for a structural member made with negative refractive index material for use in the Rotodome which will allow B and L band radio waves to propagate through them as if they were in free-space. Isolate a structural member in the Rotodome to redesign, and obtain it’s structural requirements, PHASE I: Design and determine the feasibility of fabricating prototype structural members, for the Hawkeye Rotodome, which will minimize structural members' effect on Radio Frequency (RF) propagation.

PHASE II: Develop a prototype(s) for ground electrical and structural testing. Demonstrate the prototype representative Hawkeye rotodome at an approved test facility. Construct a revised prototype and retest. Document test plans, instructions for use, and development artifacts. Fabricate, design and electrically test additional prototype structural members to be tested in a representative rotodome. Phase II completion goal is TRL-06.

PHASE III: Finalize and transition the structural members to appropriate platforms and/or backfit to fleet aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology could be applied to nearly any commercial-sector B or L-band Radar system that has similar power transmission/antenna/Rotodome constraints. Broadcast television equipment also shares many requirements with the E-2 Radar and could benefit from improved transmission efficiency.

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KEYWORDS: E-2; Radar; meta-materials; negative refractive index; wave propagation; Veselago

N121-045 TITLE: Maritime Airborne SOA Integration

TECHNOLOGY AREAS: Air Platform, Information Systems

ACQUISITION PROGRAM: PMA 290

OBJECTIVE: Develop an open-architecture integration system using service-oriented architecture (SOA) design principles and practices to integrate legacy airborne mission computing systems and sensors for near-real time dissemination of collected maritime airborne mission data, to include virtualization, open application programming interfaces (APIs), and service orientation.

DESCRIPTION: Current maritime airborne platforms are unable to exhibit rapidly changing net-centric requirements and traits due to limitations of traditional siloed software and systems development. These limitations are exuded through closed, proprietary systems and subsystems that require extensive engineering and re-engineering in order to gain access to systems and sensor data. These limitations usually incur large cost and schedule penalties and will not allow for the rapid agile technology development and integration that is required to stay in lock step with warfighter needs.

SOA design principles and practices dictate an architectural as well as design pattern that encourages openness through standardization. SOA enables reuse and rapid integration of information, taking what you have and structuring it to allow you not only to continue to use it, but to use it securely and make it adaptable for future change that will be simple, straightforward, safe, and fast. SOA is flexible, adaptable, and agile. It promotes standards and industry best practices and results in reduced redundancies, increased system efficiency, and improved collection and processing of data and distribution of information. Cost efficiencies, mainly as a result of savings in life-cycle information technology maintenance and reduced development costs, are also realized.

The goal of this project is to use SOA design principles and practices to develop an open-architecture system that will integrate legacy airborne mission-computing systems and sensors so as to provide near-real time dissemination of collected maritime airborne mission data. The foundation laid here will ultimately result in a common integration architecture and strategy for maritime airborne assets that can quickly establish and exude net-centric traits and allow for the rapid insertion and integration of emerging technologies at a far lower cost.

PHASE I: Assess and determine the feasibility of using a common open SOA to develop an integration system for mission-computing environments and subsystems. Determine and define the appropriate standards, integration criteria, and strategy for the exposure of data, subsystems, and sensors. Identify and describe potential maritime platform open service-oriented infrastructure (SOI) integration prototype concepts.

PHASE II: Based on the results from Phase I, develop, demonstrate, and validate an open SOA integration prototype that integrates with a current maritime air platform's mission-computing infrastructure and demonstrates SOA characteristics and design patterns for evaluating the exposure of data, subsystems, and sensors.

PHASE III: Refine and mature the architecture and software developed in Phase II in order to define an SOA reference implementation as applied to a maritime airborne platform's mission-computing environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: When complete and mature, this project can be used, and serve, as a model for integration and development across the aircraft manufacturing industry, both military and commercial, and can significantly reduce modification costs to existing inventories.

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KEYWORDS: SOA; SOI; software systems integration; open architecture (OA)

N121-046 TITLE: Spatially-Distributed Electron Beam Technology for Millimeter-Wave Amplifiers

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PEO IWS 2.0, Surface Electronic Warfare Improvement Program (SEWIP), ACATII

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 and evaluate a spatially-distributed electron beam gun and beam transport system suitable for use with a high power millimeter-wave vacuum electronics amplifier.

DESCRIPTION: Radio-frequency (RF) amplifiers are a key component in Navy/DoD transmitters used for electronic attack, high-data-rate communications, and radar. In the millimeter-wave frequency regime, higher RF output power is needed for improved platform self-protection against emerging threats, to extend the range of radar and communications systems, and to provide all-weather operational capabilities. This SBIR will develop the enabling technology for a new class of compact amplifiers to meet these needs, increasing millimeter-wave amplifier RF output power by more than a factor of two over the current state-of-the-art and decreasing the amplifier system cost per watt of output power.

Vacuum electronic (VE) devices have a demonstrated ability to deliver single-device power in excess of projected solid-state amplifier power, particularly at millimeter-wave (MMW) frequencies. For this reason, vacuum electronic slow-wave amplifiers are expected to be key elements in future MMW transmitters for electronic attack, high-data-rate communications, and radar systems. However, overall transmitter weight and size must be reduced, particularly for weight- and space-constrained platforms, while transmitter power, efficiency, and bandwidth must be improved. Although extremely high powers are available from gyro-amplifiers, these devices are not conducive to compact form factors. Slow-wave, linear beam radio-frequency (RF) power amplifiers have the potential to meet size and weight goals but require development to meet the needs of applications requiring kilowatts of continuous-wave (CW) power.

Current slow-wave, linear beam MMW VE amplifiers are driven by a single axisymmetric electron beam. At cathode voltages below 25 kV (necessary to minimize system weight and volume), space-charge effects place a limit on the maximum beam current that can be propagated without de-bunching, hence limiting the maximum beam power to ~7 kW and the RF output power to less than 1 kW CW. To address emerging threats and applications, higher RF output power and bandwidth are desired, necessitating higher beam power. Such power levels are not achievable with existing electron gun technology. The goal of this SBIR is to develop a new electron gun technology that is capable of >30 kW of total electron beam power - a more than four-fold increase in the state-of-the-art - that will in turn facilitate a more than two-fold increase in RF output power (>2 kW CW).

To facilitate the development of higher power MMW VE amplifiers, this topic is soliciting innovative electron gun approaches based on spatially-distributed electron beam technology such as multiple pencil beams or elliptical/rectangular cross-section electron beams. Spatially-distributed electron beam devices are an emerging technology that has been made possible by recent advances in three-dimensional computational modeling and in manufacturing and materials technology. The non-axisymmetric nature of the beam generation, propagation, and collection presents many technical challenges and requires the development of innovative solutions. Performance goals include >30 kW of total beam power with cathode voltages less than or equal to 25 kV (to meet compact system footprint goals and to minimize system cost); and a beam optics and beam transport system design with 100% transmission from the gun to the electron collector in the absence of RF drive. While the primary focus of the research is on spatially-distributed gun development, candidate gun designs must demonstrate that they can be integrated with a beam-wave interaction circuit capable of producing >2 kW of broadband MMW RF output power at frequencies up to 45 GHz. An expected by-product of the research and development of the hardware is the establishment of a design methodology, scalable in power and frequency, which makes use of and expands upon the potential of modern 3D design codes.

PHASE I: The company will develop concepts for a spatially-distributed electron beam gun, transport system, and beam-wave interaction circuit that meets 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 determination will include analytical and/or computational modeling of potential designs, including the effect of beam space-charge, emittance (thermal beam), and realistic magnetic field profiles. Concepts must be capable of meeting all requirements for the MMW amplifier. The company will provide a Phase II development plan with performance goals and key technical milestones.

PHASE II: Based on the Phase I research results and the Phase II development plan, the company will design and fabricate a prototype spatially-distributed electron beam gun and create an engineering design for the beam transport system and collector. The prototype and overall design will be evaluated to determine its capability in meeting the performance goals defined in Phase I. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will conduct a cost analysis of a pre-production prototype and will prepare a Phase III development plan to transition the technology for Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. The company will integrate the spatially-distributed electron beam gun, transport system, and collector together with an interaction circuit for evaluation and will assist in its incorporation into a Navy/DoD relevant prototype transmitter. The company will support the Navy in the certification and qualification of the system for further testing in operationally relevant environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications of spatially-distributed beam amplifier technology include broadband high-power amplifiers for commercial satellite up-links and point-to-multipoint wireless broadband “last mile” applications, where the low operating voltage is attractive due to reduced costs and increased reliability.

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KEYWORDS: Electron beam; multiple beam; spatially distributed beam; millimeter-wave; vacuum electronics.

N121-047 TITLE: <u>Deep Reach Wire Based Inner Diameter Laser Cladding Capability</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 392, Strategic and Attack Submarine Program Office

OBJECTIVE: Research and develop the components/process to create a Deep Reach Wire-Based Inner Diameter (ID) Laser Cladding Capability to improve material refurbishment characteristics and reduce repair time/costs for small bore shipboard components.

DESCRIPTION: There are many high-value fleet system components having corrosion and/or wear damage inside small cylindrical bore shapes that cannot be repaired ship-board with existing commercially available laser cladding repair systems due to geometric constraints. There are industrial laser cladding systems that can perform these types of repairs in a shop environment using “powder-based” filler material; but there are no commercially available systems that use “wire-based” fillers. The powder-based systems create a containment and contamination issue that presently restricts their use in the shop environment. There are unique challenges and unknowns associated with wire cladding inside a narrow bore that must be adequately researched to support a product solution. The melt pool characteristics, material addition/delivery, laser beam reflections, heat dissipation, laser power, heat affected zone (HAZ), gas coverage/type, clad deposit characteristics, and grain structure are just some of the elements that must be addressed. This topic is seeking research and development of an advanced repair capability to address current deficiency. Potential repair applications for a Deep Reach Wire-Based ID Laser Cladding capability are ship and submarine valve bodies, pump and motor housings, hydraulic components, hull penetrations, and dampening system components.

A typical architecture for laser cladding includes the following high-level subsystems, however the scope of this topic only pertains to the last element, “Laser Processing Work-Head.”

- Laser system: Includes the laser, chiller, and fiber optic beam delivery cable.
- Positioning System: Typically a robot or custom multi-axis servo driven unit for positioning the Laser Processing Work-Head.
- Control System: Provides the commands for system operation, process monitoring, and would include a user interface device for the Human/Machine Interface (HMI).
- Laser Barriers: A method for maintaining safe energy levels outside the controlled repair area using laser barriers or complete containment with an enclosure.
- Filler Material Delivery: The device that delivers the powder or wire to the repair area and may or may-not include the gas coverage flow control.

- Laser Processing Work-Head: An optics assembly that processes the laser beam to melt the substrate and filler material at the repair area creating a full metallurgical bond. The work-head shall have a method for mounting to the positioning system (i.e. robot), be able to connect to a fiber optic beam delivery cable, have real-time video feed for wire alignment and process monitoring, provide gas coverage routing, connect to a commercially available wire-feed system and have a robust mechanism for wire-alignment positioning. For the purposes of this topic, the Laser Processing Head will have a wire filler material and have the ability to repair inside cylindrical bores.

The scope of this topic is the necessary development of the Laser Processing Work-Head, as described above, with deep reach cladding capability. The Deep Reach Wire-Based [small] ID Laser Cladding Repair Capability shall be capable of depositing metal-based wire filler material on metal-based substrate inside cylindrical bores with targeted dimensions of 4 inches or less in diameter and 18 inches deep. Development of an innovative method for performing the wire alignment/setup to the melt pool and offset distance to the work piece shall also be included in the effort. The head must be portable, which permits removal, transport, and reconnection with the Laser Cladding Repair System, either in a shop environment or onboard a submarine. A successful effort will result in an industrial-hardened Laser Processing Work-Head with deep reach wire cladding capability ready for delivery to Navy maintenance organizations for use with existing laser processing equipment. In addition to the hardware development effort, experiments will be performed to optimize deposition parameters for a select group of commonly used materials.

PHASE I: Develop concepts for a Laser Processing Work-Head that will provide a Deep Reach Wire-Based [small] ID Laser Cladding Repair Capability and meet the requirements described above. Demonstrate the feasibility of the concepts to provide the capability and the feasibility of developing the technology to achieve the capability. Provide data on expected repairable geometrical shapes, material types, deposition rates, portability, and interface requirements. Document optimum parameters, approach, tradeoffs, benefits, and risks. Prepare a Phase II development plan with performance goals and key developmental milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, develop a working prototype of the selected concept. Evaluate the prototype using expected geometries (bores) constructed of Navy common materials, and develop a set of optimum repair parameters. Demonstrate that the prototype can interface with a typical laser cladding robotic system to repair mockups of representative Navy components in a simulated shipyard operating environment. Demonstrate the portability of the system by interfacing with a Navy Laser Cladding System and then performing mockup repairs in a simulated shipyard operating environment. Based on evaluation results, determine the refinements that would be needed to refine the prototype into an industrially hardened portable unit.

PHASE III: If Phase II is successful, the small business will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. The small business will finalize the deep reach solution, including any refinements and lessons learned in Phase II. The small business will conduct testing necessary to qualify the Laser Processing Work-Head for Navy use and applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology/components developed as part of this effort has the potential to benefit the commercial sector by expanding the capability of laser based repair technology. Business areas that could benefit from a Deep Reach Wire-Based ID Laser Cladding system would include the oil, mining, coal, power generation, and the automotive industries. These industries have similar needs as the Navy for improved repair metal deposition processes to recover high-value components. Other DoD agencies including the Air Force and Army, along with other federal agencies such as the Department of Energy (DOE) could also benefit from the advancement of this technology.

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KEYWORDS: Laser cladding deposition; Robotics; laser processing work-head; deep reach small bore repair; wire-based laser cladding; powder-based deposition systems

N121-048 TITLE: Embedded Sensors with Low Power Telemetry for Towed Arrays

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS 5.0, Thin Line Towed Array Program, ACAT III

OBJECTIVE: This research will develop innovative embedded sensors with low power telemetry for towed arrays.

DESCRIPTION: The performance of current towed arrays can be improved by employing more hydrophones and telemetry channels per unit length. This topic seeks the development of innovative concepts that can increase the number of hydrophones and telemetry channels per unit length while simultaneously achieving a very small form factor (i.e., the length/diameter requirement). For example, one methodology might involve embedding the telemetry and sensors such that the response of every sensor/hydrophone is transmitted to the processing system. This differs from the current approach of electrically summing a number of sensors/hydrophones and transmitting the summed response topside for processing. A new process could result in a greater number of channels and reduce power consumption per channel; however, embedding the sensor and telemetry in conjunction with the towed array application also imposes dimensional constraints. This means that the telemetry electronics need to be significantly smaller than current designs. As such, the degree of miniaturization of the diameter and length of the embedded sensor and telemetry should be a significant part of any innovative concept developed.

Increasing the sensor count will result in higher data rates for these oversampled arrays, requiring innovative approaches to accommodate the resulting increased data bandwidth. Additionally, a robust fault-tolerant approach is needed to improve array reliability. Having multiple sensors and telemetry channels where currently there is only one of each will result in inherent redundancy and graceful degradation in the event of a sensor failure. Innovative concepts, products, methods, or techniques are needed to develop embedded sensors and telemetry to increase the number of channels per unit length in sonar arrays to improve system performance while simultaneously reducing the power required and improving reliability.

PHASE I: One or more methods to embed sensors and telemetry will be developed. The results will include increased channel count per unit length within the towed sensor, reduction in telemetry power and associated acoustic sensor noise, and no degradation of detection performance metrics. An initial feasibility study of the concept(s) to embedding sensors, and telemetry using theoretical, empirical, or provided experimental data shall be conducted. A Phase II development plan with performance goals and key technical milestones will be provided.

PHASE II: Using the results of the Phase I study, a prototype low power acoustics sensor towed array with embedded sensors and telemetry will be developed, fabricated, and evaluated. A comparison study of the reduced effective noise levels with a similar baseline sensor or towed array system will be completed. The possible detection enhancement capabilities will be exercised to improve operational speed considerations at reduced power. An analysis that demonstrates the cost of the new concept is commensurate or less than existing sonar towed arrays will be performed. The company will provide a Phase III development plan to transition the technology to Navy use.

PHASE III: Should a Phase III contract be awarded, and after successful prototype testing in Phase II, the completion of development of a low power acoustic sensor array configuration using embedded sensors will be accomplished, and an advanced development model will be provided to the Submarine and Surface Towed Array Advanced Development Program for in water evaluation within a relevant environment. The company will support the Navy for possible transition to Fleet use if test results are satisfactory.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Towed low power/low noise acoustic sensors would be of great interest to the seismic oil and natural gas exploration industries. Low power, spatially oversampled sensors can be used to increase survey speeds (and thus reduce costs) for sub bottom mapping in oil exploration and other water-borne geophysical applications.

REFERENCES:
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KEYWORDS: Towed Array; Telemetry; Embedded Sensors; Self Noise; Life Cycle Cost; Low Power Reliability

N121-049 TITLE: Reliable, High Temperature Superconducting (HTS) Tape Connections

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 501, LCS Program, ACAT 1

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

OBJECTIVE: The objective is the development of an innovative approach and any associated manufacturing process to enable reliable field connections for superconducting tape joints for use in naval applications.

DESCRIPTION: The Navy is developing several superconducting systems for use in future ships and submarines to reduce system weight, energy usage, and installed volume. These systems such as degaussing and power distribution systems rely on superconducting cables housed in a flexible cryostat to pass current and power from one source to another. Current cable designs consist of multiple High Temperature Superconductor (HTS) tapes bundled together within semi-flexible cryostat housing. It can be difficult to terminate these tapes within the confined spaces inside the flexible cryostat (less than 1 inch). A reliable HTS tape connection technology is desired for repair and installation of HTS cables. The ability to repair cables in the field in lieu of replacing the entire length of cable (as is currently done) necessitates the development of a reliable, alternative method of creating HTS tape connections. An alternative approach to connecting superconducting tapes together to form tape joints could greatly enhance the attractiveness of HTS systems by increasing the ease of installation and repair as well as reducing the cost of materials.

The Navy seeks technology and the associated manufacturing processes to provide for improved field connections of HTS tape joints. Of particular emphasis are concepts providing low electrical losses (< 2 micro Ohms), high connection reliability (no failures), and a quick and simplified method of connecting these joints where the cryostat cable link together (under 1 hour for all tape connections). The use of soldering is not preferred due to the time and space required to connect multiple HTS tape joints in a confined space (less than 1 inch). Given the application, the proposed concepts should be rugged in order to survive in a shipboard environment. A technical challenge will be achieving the proper joint pressure to minimize electrical contact resistance while maintaining the integrity of the HTS tape. It is anticipated that 10-20 tapes will need to be used per cable assembly and would need to be able to withstand up to 500VDC. The method for connections would need to be completed by a nonskilled laborer in the field with little to no special tooling required.

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

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

PHASE III: Upon successful Phase II completion, the company will work with the Navy to transition the HTS tape connection technology into an operational degaussing (or other cryogenic application requiring tape connections) system aboard a Navy ship. The company will support the Navy in an effort to install any necessary components required to allow for use of this technology in an extended shipboard testing operational environment. The company will also support the Navy for test and validation to certify and qualify the technology for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A simple field connection of HTS tapes may be of use in land-based superconducting power cables and power delivery applications. When land-based HTS power cables transition from R&D projects to commercial installations, there may be instances of tight spaces where utilizing this type of design would benefit overall installation.

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2. American Superconductor, “High Temperature Superconductor Degaussing Coil System,” www.amsc.com, 2010.

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KEYWORDS: cryogenics; superconductor; cryostat; degaussing; HTS; High Temperature Superconducting;

N121-050 TITLE: <u>Atom Interferometric Surface and Subsurface Inertial Measurement Unit (IMU)</u>

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS 6.0; Inertial Navigation System (INS) Improvement

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 Navy seeks to improve the Inertial Measurement Unit (IMU) in Naval surface and subsurface inertial navigation systems by achieving an order of magnitude improvement in error budget, accuracy, and improved stability through the use of enhanced atom interferometry.

DESCRIPTION: Interferometric Inertial Measuring Units (IMUs) have been in production for several decades. IMUs form the heart of an Inertial Navigation System (INS). Optical interferometric gyroscopes measure the interference between counter-rotating laser beams in a gyroscopic plane. Current U.S. Navy shipboard IMU's use laser beams reflecting off mirrors (Ring Laser Gyroscope - RLG). Beams traveling through fiber optics (Fiber Optic Gyroscope - FOG) are the current commercial navigation technology (state of the art).

Long periods of accurate INS position estimation are critical for long-duration submerged voyages and other GPS-denied environments as articulated in the Navigator of the Navy Navigation Vision 2025. In addition, there are stringent position, attitude, and velocity requirements for missions conducted by Navy ships and systems that use the ship's INS. These missions require very accurate position and reference frame alignment along with highly stable position, velocity, and attitude data. The power spectral density must be confined and/or have a low mean value in order to achieve the required precision.

The Ring Laser Gyro (RLG) technology currently deployed in the fleet has reached its performance and accuracy limits. The current Fiber Optic Gyro (FOG) technology, which could provide some improvements in accuracy, has some of the same limitations as the RLG. Because new mission areas require highly accurate and reliable IMU performance, new technologies are needed to meet the need.

DoD has sponsored research on atom interferometric sensors and application to IMU via DARPA and the Army Research Lab. Areas that require further innovation to enable practical application to Navy ships include maintenance of coherence long enough for the interferometric pattern to be measurable, non-destructive ways to cause an interferometric pattern, continuous operation, INS mechanization, and size, weight, power, and ruggedness for Navy shipboard application. Phase I will not be classified; however, Phase II may be classified because of certain performance parameters of the current INS system. Analysis and data collection on the prototype system may contain classified data.

PHASE I: This Phase will be unclassified. The company will develop and demonstrate concept feasibility for a prototype atom interferometric IMU sensor and mechanization suitable for Navy ship Hull, Mechanical and Electrical (HM&E) and Reliability, Maintainability, and Availability (RMA) requirements. Feasibility demonstrations will include analytical modeling and , where possible, material testing. The demonstrations will also provide derivations and estimates of sensor measurement noise, stability, power spectral density, and angular random walk with performance at least an order of magnitude better than current commercial FOG-based IMU. Mechanization concepts should take into account IMU operational modes such as indexed versus strap-down, vibration isolation, and indexing. The concepts should also account for environmental factors and systematic uncertainties such as pressure factors, temperature, parasitic noise reduction, and shock survival as well as other considerations for operation in surface ships and submarines. Defined performance goals and methods to measure their achievement will be required. A Phase II development plan with performance goals and key technical milestones will be required.

PHASE II: This Phase and any subsequent phases will be classified. Based on the results of Phase I and the Phase II development plan, the company will develop and fabricate the prototype sensor and verify performance goals. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase I and the Navy requirements for shipboard INS's. System performance will be demonstrated through analytical methods, prototype evaluation, and modeling 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. Certain performance parameters of the current system are classified. Analysis and data collection on the prototype system may contain classified data. A Phase III development plan to transition the technology to Navy use will be required.

PHASE III: If Phase II is successful and if a Phase III award is made, the company will be expected to support the Navy in transitioning the technology to Navy use. The company will develop a production model atom interferometric IMU and demonstrate performance in technical and operational evaluation. The awarded 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 derivative system may provide performance improvements in commercial ship Inertial Navigation Systems (INS). This will improve ships' abilities to navigate by improving position determination and reduce reliance on GPS.

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2. Berman, P.R. (ed.), Atom Interferometry, Academic Press, 1997

3. McCarthy, Wil, This Looks Like a Job for Superatoms, IEEE Spectrum, August 2005

KEYWORDS: atom interferometry; navigation; Inertial Measuring Unit (IMU); Inertial Navigation System (INS)

N121-051 TITLE: Automated Video Screening Techniques for Operator Workload Reduction

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: PEO IWS 5.0, Aircraft Carrier Tactical Support Center (CV-TSC), ACAT III

OBJECTIVE: The Navy seeks to design, develop, and evaluate innovative algorithms, techniques, or system approaches to rapidly and automatically screen large volumes of various types of streaming video and to provide appropriate tagging of events of interest in order to reduce operator workload and complexity of interaction, and to focus attention on events that increase situational awareness.

DESCRIPTION: With the evolution of Navy systems, significant new or additional data sources are providing high volumes of additional information to more highly integrated systems. At the same time operational manning levels are expected to remain at current levels or be reduced in the future. Operators can often become overwhelmed during their vigilant analysis of large quantities of FLIR (forward looking infrared) and ISAR (Inverse synthetic aperture radar) video recordings. Overwhelmed operators can delay the decision-making process since critical data is not properly analyzed. For instance, a system like the AN/SQQ-34C Aircraft Carrier – Tactical Support Center (CV-TSC) has added processing from several heterogeneous sensor streams, such as ISAR and FLIR. These new interfaces introduce significant volumes of streaming video data when helos are deployed. The Navy desires to have these multiple sources analyzed and cue (bell ring) the operator to high interest events. This topic is different from current "smart video" systems since it must incorporate analysis of the various feeds and not just the transmission of the data from the helicopter back to the carrier.

The Navy seeks innovative concepts to reduce operator workload relative to data screening activities for the many sources and modes of video data, thus reducing the volume of data the operator has to sift through to find the important information. Potential solutions might focus on automatically identifying, detecting important features and events within the video streams, potentially tagging those events, and/or presenting events in prioritized fashion for operator review and concurrence. There are many video analytics and smart video systems approaches that have been applied in the commercial security industry to detect change, provide object identification and recognition, and even perform object behavior discrimination. Most have been focused on human features, vehicle tracking, and perimeter or space security. Algorithmic approaches to object detection, tracking, and identification from the video sources as well as innovative display and presentation solutions for rapid operator detection, discrimination, review, and assessment are all potential solutions. Products from the video review stream should be sufficient to support automated association or automated tagging operations to support downstream fusion and significantly reduce operator interaction time, time to detect, and/or increase holding time, and improve tracking or classification performance.

Successful technology transition will provide improved performance and reduced cost for ASW command and control systems on surface combatants, carriers, and shore command facilities.

PHASE I: This research will develop algorithms and/or approaches for rapid screening of streaming videos for ISAR and FLIR. It will provide object recognition and detection on video clips. An analysis of the feasibility of implementing the proposed concept using simulated or real data will be conducted. A Phase II development plan with performance goals and key technical milestones will be created.

PHASE II: Implement the plan developed in Phase I by developing, evaluating, and validating the Phase I solution in a prototype software baseline suitable for real-time operation. A proof of concept will be conducted with simulated and pre-recorded test data. The performance will be assessed using quantitative measures of performance. An innovative data visualization approach will be identified and defined that will enable the migration of compliant software into a single geospatial framework without loss of functionality. The approach should facilitate interoperability between geospatial objects (GO) and diverse client applications. System performance will be demonstrated through prototype evaluation and modeling. The evaluation should show the prototype meets Navy requirements. A Phase III development plan will be prepared to show how the technology will transition into fielded Navy systems.

PHASE III: If a Phase III contract is awarded, the company will integrate and test their prototype software in a real-time environment via the CV-TSC. The company will support the Navy for test and validation in a real-time setting to certify and qualify the system for Navy use and support the production and installation of their technology into fielded Navy Systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Rapid video review and assessment technologies have a wide array of commercial and federal uses in video security, forensics, product quality monitoring, traffic and pedestrian tracking and behavior monitoring, access and perimeter control systems, wide area surveillance, and intelligence gathering.

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2. T. Lindeberg (2008/2009). "Scale-space". Encyclopedia of Computer Science and Engineering (Benjamin Wah, ed), John Wiley and Sons IV: 2495–2504.

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4. Zhai, L., Dong, S., and Ma, H. 2008. Recent Methods and Applications on Image Edge Detection 2008 international Workshop on Geoscience and Remote Sensing - Volume 01 (December 21–22, 2008).

KEYWORDS: Automated Video Monitoring; Video Analytics; Command and Control; Video Display; Video Object Detection; Video Image Detection

N121-052 TITLE: Data Compression for Bandwidth Constrained Environments

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: Virginia Class PMS 450 (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: Improve the efficiency of data collection and distance support systems through the use of advanced data compression techniques and bandwidth optimization strategies.

DESCRIPTION: Troubleshooting and support of electronic systems aboard US Navy submarines could be greatly improved by an efficient and meaningful off-hull support system. Currently, the support system does not use sufficient data compression techniques and therefore incomplete message traffic is transmitted and data packets are lost, which decreases the accuracy and efficiencies of the system. This SBIR will investigate and develop a key enabler for submarine distance support-data compression techniques and bandwidth optimization strategies for the transmission of subsystem health and status data. Unlike surface ships, submarines face unique bandwidth constraints due to their limited number of communications antennas and time spent with those antennas above water. As a result, submarine subsystems generally do not transmit health and status data off-hull. If it is collected, this data is stored natively and off-loaded in port. This topic is to develop data compression techniques and/or bandwidth optimization strategies that will enable the reliable transmission of such data off-hull in the current bandwidth-constrained environment.

Due to the data throughput rates of submarine communications hardware and the relative priority of health and status data to other more critical data, an innovative solution that will maximize data transmission through available bandwidth is required. Commercially available data compression algorithms alone are not sufficient to transmit required information across the available data link. Unique research and development will be required to achieve the required data compression threshold to transmit data off-hull through current communications hardware. A combination of data compression algorithms and bandwidth optimization strategies may be required.

The work in Phase II may require access to classified information because of the nature of the data to be processed. Phase I efforts would not need secure access and would be unclassified.

PHASE I: The company will develop concepts for improved communication of health and status data through currently existing hardware. This will involve the investigation of data compression algorithms and bandwidth optimization strategies for communicating 1.1GBytes of data in a 1MByte equivalent package. 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 demonstrations will include analytical modeling / simulation. Concepts must be capable of meeting all requirements for the existing system. The company will provide a Phase II development plan with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype suitable for demonstration. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase 1. System performance will be demonstrated by the prototype evaluation. The evaluation will indicate data compression ratio and data throughput of the proposed solution using supplied system health/status data. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. The company will develop a data compression / bandwidth optimization package for evaluation to determine its effectiveness in an operationally relevant environment. This will likely be a TEMPALT suitable for installation aboard a US Navy Submarine. The company will support the Navy for test and validation to certify and quantify the system for Navy use. The company will participate in planning efforts with applicable working groups (such as NAVSEA's System Architecture Working Group) to assist with transition to Fleet use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technologies developed in this SBIR have potential commercial applications in the shipbuilding and communications industries. An effective data compression / bandwidth optimization strategy could enable more robust communications for commercial ships utilizing low bandwidth or intermittent satellite communications links. It could also enable troubleshooting, distance support, and associated logistical efforts through the communication of health and status data.

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2. Chen, et al. "Non-threshold Based Node Level Algorithm of Data Compression over Wireless Sensor Networks." International Conference on Signal Processing Systems, 2010.

3. Maluf, et al. "Effective Data Representation and Compression in Ground Data Systems." IEEE Aerospace Conference, 2008.

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KEYWORDS: Data Compression; Data Prioritization; Bandwidth Optimization; Distance Support; Troubleshooting; ROHMS;

N121-053 TITLE: <u>Near-Time Effluent Quality Sensor Technologies for Organics and Bacteria for Shipboard Wastewater Treatment Systems</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: NAVSEA (SEA 05P5) Afloat Environmental Quality Program

OBJECTIVE: The objective is to develop sensors to measure or provide accurate predictive capabilities for five-day Biochemical Oxygen Demand (BOD5) and/or Fecal Coliform (FC) values of effluent from blackwater and graywater marine sanitation devices (MSDs) in near time.

DESCRIPTION: Environmental regulations controlling the discharge of shipboard wastewater are becoming increasingly strict worldwide. Type II MSDs have been installed on most commercial and some government owned vessels for many years to allow ships to operate within restricted waters (<3nm of shore). These systems require operations and maintenance support to make sure they work properly and produce effluent that meets established standards. The Navy is starting to integrate Type II MSDs in newer ship designs, such as the T-AKE, LCS, and JHSV Classes; however it does not have the technology to determine in less than 5 days if the MSD is performing within operational parameters.

The Navy performs evaluations of Type II MSD technologies in laboratories and onboard ships. During these evaluations, the lack of capability to get real time responses increases the cost to evaluate operational parameters, to study degradation of components, and to evaluate system improvements. The Navy needs an innovative, cost effective technology that is suitable for a marine environment, can be operated and maintained by Navy personnel with minimal training, and which will provide near-time measurement of these two key effluent quality parameters.

The standard laboratory methods to measure BOD5 and FC require a minimum 5 days and 24 hours, respectively, to complete the analyses. For the BOD5 test, five days is required and cannot be reduced while using the standard method. A new technology that can accurately predict BOD5 values, the organic content of the effluent, would need to be developed. The standard method for FC requires laboratory space for petri dishes, trained technicians and 24 hours for processing. A new technology to accurately predict FC or which simplifies the process significantly would need to be developed. The delayed reporting of effluent quality prevents a timely and cost effective assessment of the treatment system's performance. Once adjustments and maintenance are performed, test results cannot verify the effectiveness of the effort for at least 5 days.

Innovative sensors are desired that are capable of quantitatively and accurately measuring or predicting BOD5 and/or FC in near-time (preferably on the order of minutes), or within a few hours. Regulations require values of BOD5 and FC in shipboard MSD effluent of 25 to 50 milligrams per liter (mg/L) or less, and 20 to 250 colony forming units per 100 milliliters (cfu/100ml) or less, respectively. Minimum detectable limits required are less than 5 mg/L for BOD5 and 3 cfu/100ml for FC. The sensor must be robust, simple, compact, fully automated, low cost, and require low maintenance and use of consumables.

PHASE I: Develop a sensor package concept and perform controlled environmental evaluations to confirm the feasibility of proposed technologies and approaches to accurately measure or predict BOD5 or FC at realistic levels with representative effluent samples. Obtain data that can be used to model and propose a sensor package concept for Phase II consideration that addresses the attributes discussed above. Create a plan showing performance goals and key milestones for Phase II development.

PHASE II: Based on the results of Phase I and the Phase II development plan, further refine the approach to measure minimum and maximum BOD5 or FC levels and obtain maximum precision and accuracy. Develop and construct prototype sensors for evaluation in the laboratory. In coordination with the Navy, evaluate the sensors in a controlled laboratory environment with simulated MSD effluent and measure performance (accuracy, precision, and time required to measure parameters). After successful laboratory evaluation, in coordination with the Navy, evaluate the sensors with MSD effluent and measure performance, durability, ease of use, and maintenance requirements. Develop predictions of unit production and operational costs.

PHASE III: The contractor will transition the final sensors to the Naval Sea Systems Command for implementation and perform further advanced development and integration. Based on the evaluations completed under Phase II, the contractor will make further modifications, improvements, and optimizations to the sensors, as required, and conduct full scale shipboard evaluations on Navy/marine vessels with operating MSDs in conjunction with the Navy customer.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of sensors to measure effluent BOD5 and FC in near-time would be of significant interest to both commercial industry and the military in the development and evaluation of current and future Type II MSDs.

REFERENCES:
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2) Annex IV of MARPOL 73/78, Regulations for the Prevention of Pollution by Sewage from Ships.

3) 33 CFR 159 Department of Transportation (DoT), U.S. Coast Guard (USCG) Directives, "Marine Sanitation Devices," 3 February 2003.

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KEYWORDS: biochemical oxygen demand, fecal coliform, sewage, blackwater, graywater, marine sanitation device

N121-054 TITLE: <u>Small Unmanned Surface Vehicle Propulsion System</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 406, Modular Unmanned Surface Craft Littoral; non-ACAT

OBJECTIVE: The objective is to develop a propulsion system and energy storage system for a small, man-portable USV (X-class, per the 2007 Navy's USV Master Plan) that simultaneously achieves competing requirements for low size and weight, high speed, and long endurance.

DESCRIPTION: A man-portable USV propulsion and energy storage system must be suitable for military operations. It must be durable and robust to withstand repeated operations over the expected life of the vehicle. The Navy is seeing innovation in new and exotic materials and technologies that can produce high-speed, lightweight, and durable energy storage and propulsion systems for USVs. In addition to propulsive power, the system will be used to provide electrical power to payloads and sensors, and this must be considered in developing the system.

A need currently exists for Naval forces to conduct Intelligence, Surveillance, and Reconnaissance (ISR) missions in the shallow water and riparian environments. These missions include real-time monitoring of suspicious vessels, personnel, and activity along waterways, along the shoreline, or under bridges and piers. A "point man" to run ahead of manned, host craft is required to search for improvised explosive devices (IEDs), to locate enemy threats, and to survey the hydrographics of the waterway. One materiel solution to meet these needs is a small, man-portable unmanned surface vehicle (USV) with an ISR sensor suite. USVs reduce risk to manned forces, perform tedious and repetitive ISR tasks, and provide force multiplication. An X-class USV can easily be transported, deployed, and recovered from host craft during missions.

The Navy has identified requirements for a militarized, man-portable USV with ISR sensors, capable of high speeds and long endurance missions. However, when developing the propulsion and energy system for such a craft, the objectives of small size and weight, high speed, and long endurance compete with each other in the design space and usually drive trade-offs in performance with each other. Consequently, optimizing the design presents challenges for technical innovation given state-of-the-art and current Commercial Off the Shelf (COTS) technologies, especially in the small scales required for an X-class USV. For example, small, lightweight, remote controlled (RC) boats achieve very high speeds, but endurance is measured in minutes. Additionally, such RC boat propulsion systems are not robust for a military environment. Efficiencies of these systems are typically poor, batteries provide limited power, and fuels are too volatile for military use. On the other hand, commercially available personal watercraft and jet skis are capable of high speeds and endurance, but are heavy and not man-portable. The optimization of small size/weight, high speed, and long endurance, coupled with robustness and reliability, requires an innovative solution for an X-class USV. Additionally, for operator safety reasons, no open propellers can be used. The use of volatile fuels such as gasoline, hydrogen, propane, methanol, or similar fuels cannot be permitted. Electric or multi-fuel (Diesel fuel marine, JP5, or JP8) variants are acceptable.

Proposals for new or alternate hull forms will not be considered under this topic and will be treated as non-responsive. Proposals must be based on the assumption of a basic, prismatic planing hullform.

For reference, the current point design described below is representative of one craft:
- Length Overall: 66 in.
- Breadth Overall: 24 in.
- Total Craft Weight (inclusive of hull, propulsion, energy storage, sensors): 86 lbs
  - Total Structural Weight: 16 lbs
  - Payload Weight: 20 - 30 lbs
  - Propulsion and energy storage system weight (including fuel): not to exceed 40 lbs

Propulsion and energy system should be developed to power a craft with representative size and weight listed above, and the following performance parameters:
- Unrefueled endurance: 6 hours (threshold), 12 hours (objective)
- Speeds: loiter less than 5 knots, 15 knots cruise speed with burst speeds up to 25 knots
- Operational speed profile: 10% loiter / 20% sprint / 70% cruise
- Annual operating hours: 600 hrs
- Temperature, Ambient: 40 to 140°F
- Operating environment: Riverine (fresh, brackish, and salt water)

• Wave height: 0 – 1 ft
• Cooling water take-off
• Reversing capability
• Efficiency: Overall Propulsion Coefficient (OPC) greater than 40%
• Expected nominal power required for sensors and hotel services: 80W

PHASE I: Develop concepts for a man-portable USV propulsion and energy storage system. Provide convincing evidence of the feasibility of the concepts with regard to reliability, capability to survive the marine environment, and suitability for military use. Demonstrate the feasibility of developing the concepts into technology that can be used by the Navy in a man-portable USV. Provide supporting analyses to optimize competing, priority requirements for small size and weight, high speed, and long endurance. Define system architectures and identify key material items. Perform bench top experimentation where applicable to demonstrate concepts. Develop a conceptual design that addresses the needs and parameters provided in the topic description. Prepare a development plan for Phase II with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, build a prototype for laboratory evaluation. Evaluate the prototype in a laboratory environment to determine its potential in meeting the performance goals defined in Phase I and the discussed in the topic description. Refine the prototype and evaluate operation in a representative environment using a Government furnished USV hull and provide results. Develop a cost benefit analysis and a Phase III installation, testing, and validation plan.

PHASE III: If Phase II is successful, the small business will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. Based on the Phase II results, the small business will develop a full-scale prototype and install onboard a Government selected USV. Conduct extended testing to verify USV capabilities in an operational environment. Support qualification and certification for Navy use and integration into USVs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential applications of a small USV propulsion system exist for research institutions (universities, NOAA), oil and gas industries, hydrographic and environmental surveys, and search and rescue operations (life guards).

REFERENCES:
1. U.S. Navy USV Master Plan. http://www.navy.mil/navydata/technology/usvmppr.pdf

2. Hollosi, C., Jane's Unmanned Maritime Vehicles and Systems, Issue Four. IHS Global Limited, 2010.

3. MacPherson, Donald M., Reliable Speed Prediction: Propulsion Analysis and a Calculation Example. http://www.hydrocompinc.com/knowledge/publications/MacPherson%202004%20Propulsion%20Analysis.pdf

4. Kularatna, N. Rechargeable batteries and battery management systems design. Proceedings from IECON 2010

KEYWORDS: Lightweight propulsion; lightweight energy storage; unmanned surface vehicles; long endurance; X-class USV; high speed

N121-055 TITLE: Affordable Scalable Acoustic Panel Arrays

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS397 Ohio Replacement Program and PMS450 Virginia Class

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 an open systems scalable acoustic panel array architecture for Navy submarines that will enable common building blocks across all panel array systems.

DESCRIPTION: Current panel arrays are stove piped systems with complex installation and calibration processes. Systems such as bow arrays are constructed with thousands of individually mounted sensors requiring precise location of mounting studs to maintain channel to channel phase performance (see references below). This approach is costly to install and maintain and requires a significant number of outboard cables to interconnect the sensors and sensor electronics. Variants of wide aperture arrays are based on unique optical sensor technology that requires dry docking to replace and recalibrate the sensors. Modern technologies in the areas of electronics, composite materials, data multiplexing, and innovative sensors and processing techniques have the potential to reduce cost, improve reliability and performance. However, these technologies do not properly address modularity and commonality issues necessary for increasing design and capability flexibility while reducing installation and maintenance cost. As a result, submarine panel array systems, such as bow arrays and high frequency arrays, do not share common systems and subsystem components. Commonality between planer and spherical arrays are particularly difficult.

The Navy seeks technology development to provide common open systems acoustic array panels to reduce the total life cycle cost of all acoustic hull arrays for the Ohio Replacement and VIRGINIA platforms. Achieving this goal requires research and development in the areas of advanced systems architectures, packaging, and the integration of sensors and sensor electronics into low cost high availability panels. The goal for the next generation hull mounted array should be a 50% reduction in life cycle cost over current designs. Furthermore, the solution should be robust enough to be applicable for planer and spherical arrays. Designing for reliability also is a priority throughout this SBIR topic. In addition, the design could use modern telemetry methods which would potentially allow synchronization of multiple shipboard arrays.

PHASE I: Develop concepts for submarine acoustic array panels that use open-system and open-architecture principles. Demonstrate the feasibility of the concepts to reduce life cycle costs and to meet Navy acoustic array performance requirements. Demonstrate the feasibility of developing concepts into actual acoustic array panels. Development should include the use of innovative sensors, materials, packaging techniques, and system architectures. Concepts must incorporate low-cost sensors and sensor electronics in array panels that can be deployed for a 20 year operational life. Develop a Phase II development plan with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, develop a prototype acoustic array panel for laboratory evaluation. Laboratory evaluation will assess the ability of the prototype to meet the performance goals established in Phase I, and to reduce array life cycle costs. Based on the prototype evaluation, develop a Phase III development plan to transition the technology into a system that can be acquired by the Navy.

PHASE III: If Phase II is successful, the small business will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. Based on the Phase II results, develop a production design package for the acoustic array panel. Demonstrate its compliance to performance requirements, its functionality, and its manufacturability in an engineering development model. Support the Navy in transitioning the system to Navy submarines.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Low cost scalable panel arrays have direct application to fixed array harbor surveillance and drug interdiction operations.

REFERENCES:
1. Van Trees, H.L., Optimum Array Processing: Detection, Estimation and Modulation Theory, Part IV, Wiley, 2002.

2. A. Dandridge, A.B. Tveten, and A.M. Sansone, "Flow Noise Performance of Air-backed Plastic Mandrel Hydrophones on the KAMLOOPS Buoyant Test Vehicle," JUA(USN) 50, 601-625 (2000).

KEYWORDS: Commonality between planer and spherical arrays are particularly difficult.Furthermore, the solution should be robust enough to be applicable for planer and spherical arrays.

N121-056 TITLE: Improved Capabilities for an Integrated and Robust System for Dynamic Ranging and Increased Radio Frequency Coverage of Fiber Optic Signals

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMS397 Ohio Replacement Program

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OBJECTIVE: The objective is to develop technologies that will allow for wideband RF distribution over fiber optics in a reliable and cost effective manner.

DESCRIPTION: An overall fiber optic system concept capable of transmitting and receiving 3kHz to 300GHz RF signals is not available commercially and is the focus of this SBIR. Current commercial state of the art fiber solutions are capable of distributing RF over Fiber (RFoF) and Intermediate Frequency (IF) over fiber within narrow frequency bands and are in general isolated to the 1GHz to 40GHz range. The submarine industry requires the use of RF across the entire RF spectrum. Fiber optic technologies on board submarines today are primarily used for distribution of digital data aboard submarines. Even though they have provided multiple technical benefits and some financial benefits, they do not currently have the ability to solve the problem of receiving and transmitting across the entire RF spectrum. Submissions to this SBIR should propose innovative approaches to develop a system or family of systems that can reliably and cost effectively handle the distribution while maintaining current solution performance.

Coaxial cables and waveguides are currently used in the Navy for transmission of RF signals across the RF spectrum. These products are selected based on their ability to support set frequency ranges and the signal end user requirement for signal strength. Standard militarized coaxial cables tend to have the worst attenuation characteristics and waveguides have the best. Conversely waveguides are the most difficult to design into space constrained platforms and coaxial cables as a whole provide for better flexibility. There is a significant quantity of coaxial cables and waveguides designed into platforms and installed aboard vessels in the fleet at a significant cost to the taxpayer. While coaxial cables are physically more flexible than waveguides and current fiber optic cabling, they are also more susceptive to electromagnetic interference. Electromagnetic physical separation requirements are documented in “The Handbook of Shipboard Electromagnetic Practices, S9407-AB-HBK-010”. A substantial amount of effort is expended in the design of the submarine and surface fleet to address these separation requirements. Waveguides are generally used when the signal end user requires virtually no signal loss and are highly specific in their frequency coverage. While waveguides are effective in providing maximum signal strength they also require substantial design work because they are very rigid and take up a lot of space.

The need for a fiber optic based solution to handle wideband RF distribution and multi signal processing simultaneously is very much financial driven and would ultimately have to prove fiscally beneficial as compared to the design, installation, and maintenance costs of the currently employed systems. The new system of systems or family of systems capability could potentially prove to have multiple benefits such as substantial cost savings capable of enabling open architecture concepts with current and future platform systems, decrease signal attenuation, reduce or eliminate electromagnetic interference design efforts, increase crew habitability, and decrease overall platform weight.

PHASE I: The company will develop concepts for and determine the feasibility of a wide band RF fiber optic based solution. The company will demonstrate the feasibility of their concepts in meeting Navy needs including fiscal concerns, and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility demonstrations can include analytical modeling. The company will provide a Phase II development plan with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a scaled prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase I and the Navy requirements for the RF Systems. System performance will be demonstrated through prototype evaluation and modeling. 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 should a Phase III award be made. The company will develop their RoF 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: Innovations in the area of radio frequency distribution over fiber optic networks will benefit the telecommunication industry and airline industries. For example the airlines also have to process multi RF signals and realize many of the same design constraints as navy vessels such as being weight, size, and arrangements limited.

REFERENCES:
1. Brawner, M; Network Centric Radio Frequency Distribution; Proceedings of the 2009 Submarine Technology Symposium

2. Brawner, M; A Case for Optical Distribution of Platform Radio Frequency Signals; Proceedings of the 2010 Maritime Systems and Technology Conference America

3. Handbook of Shipboard Electromagnetic Practices, S9407-AB-HBK-010

KEYWORDS: Dynamic ranging; radio frequency; fiber optic; integrated; cost saving; communications

N121-057 TITLE: Advanced Hull Forms for Landing Craft

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Cross Platform Systems Development (CPSD) NAVSEA 05T ACAT IV

OBJECTIVE: Develop innovative concepts and technologies applicable to the highly constrained hydrodynamic environment of the high capacity beaching landing craft.

DESCRIPTION: Displacement hull beaching landing craft have been a staple component of the overall amphibious capability for over sixty years. The high capacity and long range properties remain extremely useful in a wide spectrum of operations, including Noncombatant Evacuation, Humanitarian Assistance and Disaster Relief, and some Irregular Warfare missions.

A heavy-lift displacement hull landing craft is inherently forced into a highly restricted design space for hullform geometry and hydrodynamic performance. Length and beam are constrained by the dimensions of amphibious ships' well decks. The heavy cargo load tends to drive the craft towards a deep draft, but beaching capabilities are improved by a shallower draft. This has driven the legacy craft to a high block coefficient barge like hullform that minimizes draft for a given length, breadth, and displacement, but reduces attainable water speed and beach accessibility.

Through the use of advanced innovative hydrodynamic technologies and analyses not available since the existing generation of craft was designed, new hydrodynamic concepts for designing an efficient displacement hull beaching landing craft are possible. Current hydrodynamic analysis tools provide the capability to accurately model fluid flows across complex surfaces, which allows for a broader range of innovative and feasible hull geometry designs. Advanced concepts must address the major performance shortfalls of the legacy craft while also incorporating state of the art energy efficiency concepts for reduced Total Ownership Cost (TOC).

The primary performance-limiting factors common to displacement hull beaching landing craft are transit speed and beaching ability. Due to the barge-like hull needed to achieve load capacities and support the bow ramp, performance is limited to ~11 knots with beaching gradients limited to ~1:40.

This project seeks the development of innovative hull form hydrodynamic concepts for a high cargo capacity landing craft. The proposed concepts should maximize speed, beaching capability (in terms of gradient), and range, while minimizing installed power and maintaining the capability to interface with amphibious ships' well decks. Special attention should be paid to minimizing TOC and meeting applicable environmental regulations. Apart from the interface requirement, no specific geometry or design approach is stipulated.

Proposed concepts must scale to sizes capable of delivering at least two main battle tanks in a drive-through configuration (~165 short tons). Simplicity, ruggedness, and a low power-to-weight ratio for a given water speed are highly desirable.

PHASE I: Develop hydrodynamic concepts for an innovative hull form capable of exceeding one or more of speed and beaching capability of legacy displacement hull landing craft while maintaining range and well deck compatibility. Some increase in installed power relative to legacy designs is acceptable, but increases to engine weight, acquisition cost of the prime movers, and fuel consumption should be minimized. Concepts should provide validation of design feasibility by means of either computational fluid dynamic (CFD) results or model test data supporting the improvements conferred by the candidate technology and concept level integration of the technology into an overall craft architecture. Provide a Phase II development plan with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, fabricate and instrument a "proof of concept" prototype model to evaluate the benefits of the proposed technology with regard to speed, beaching capability, range, maintenance and energy costs, and performance goals defined in Phase I. Provide a plan for Phase III development, installation, testing, and validation of an initial conceptual design for transition to Navy use.

PHASE III: Using results from Phase II and the Phase III plan, build a full scale prototype with other craft features required for operational use for open water testing and demonstrate the increased performance of the hydrodynamic concept. Correct any shortcomings identified during the craft T&E. Support the Navy in certifying the craft for Navy use. Develop operational and repair training instructions. Generate full-scale manufacturing, fleet introduction, and fielding and training as required.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A limited number of landing craft hulls are in civilian service as ferries, research craft, and in other roles. The overall technology of shallow water craft is applicable to these fields as well as to inland navigation.

REFERENCES:
1) Bosworth, Michael L. et al. Supporting Affordable and Sustainable Amphibious Assault and Utility Capabilities with a Revitalized High-Low Mix of Platforms. ASNE Day 2009 Presentation.
http://www.navalengineers.org/publications/symposiaproceedings/2009proceedings/pages/ASNEday2009proceedings.aspx

2) MCRP 3-31B Amphibious Ships and Landing Craft Data Book. United States Marine Corps 2001. http://www.marines.mil/news/publications/documents/MCRP%203-31B%20Amphibious%20Ships%20and%20Landing%20Craft%20Data%20Book.pdf

3) Friedman, Norman J. U.S. Amphibious Ships and Craft: An Illustrated Design History. Naval Institute Press, 2002.

KEYWORDS: Landing Craft, Ship-to-Shore Movement, Amphibious Warfare, Logistics, Hydrodynamics, Energy Efficiency

N121-058 TITLE: Surface Combatant Composite Mid-Frequency Sonar Dome

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: PEO-IWS 5.0 for the AN/SQQ-90 Undersea Warfare System, ACAT I

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OBJECTIVE: The goal of this project is to develop innovative materials for improved surface ship sonar domes by utilizing unique methods for co-mingling fibers into fabrics, and manufacturing composite parts from these unique fabrics using state-of-the-art manufacturing processes.

DESCRIPTION: In order to meet requirements to improve performance and lower acquisition and maintenance costs of sonar domes, the Navy is seeking new materials and fabrication techniques for sonar domes that will be installed on future combatants. The current baseline mid-frequency sonar dome material for certain surface combatant classes is Glass Reinforced Plastic (GRP). Although this is a proven material, the Navy believes improvements can be made in the mechanical robustness, acoustic performance, and ease of manufacturing of sonar domes. Such advances could be accomplished by utilizing more advanced composite materials that mix and align (co-mingle) different types of fibers. One of the challenges will be to apply this new composite material technology to the unique shape and size of future surface combatant mid-frequency sonar domes, while taking advantage of the potential performance improvements.

This Navy seeks to utilize state-of-the-art composite materials and manufacturing processes for mid-frequency sonar domes. The investigation should include material science innovation and finite element modeling of proposed designs. This work should include building and testing (mechanically and acoustically) coupons and panels of new, high strength, low insertion loss sonar dome composite materials for mid-frequency sonar applications.

PHASE I: The focus will be on conducting studies and analyses of innovative, co-mingled composite materials and sonar dome designs. The feasibility will be assessed by conducting material testing and analytical modeling of small-scale test coupons and panels. This testing and modeling will include mechanical and acoustic testing on the test specimens and will lead to further development in Phase II. A Phase II development plan with performance goals and key technical milestones will be provided.

PHASE II: Based on the results of Phase I and consistent with the Phase II development plan provided in Phase I, mechanical and acoustic testing on larger-scale panels of the developed composite material(s) will be conducted, and a full-scale prototype of a future surface combatant sonar dome will be built. The prototype will be evaluated to determine the ability to meet Navy requirements. A Phase III development plan to transition the technology to Navy use will be provided.

PHASE III: If a Phase III contract is awarded, the contractor will build and conduct testing on an optimized (taking into account Phase II test results), full-scale, sonar dome that has the potential for ship installation and testing. The company will support at-sea testing and data analysis for incorporation into Navy systems. The company will also conduct studies for further acoustic and mechanical optimization of the dome.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology has potential applications in the underwater oil exploration industry by developing improved composite materials that can be used in towed and hull mounted acoustic systems.

REFERENCES:

1. Kinsler, Frey, Coppens and Sanders, Fundamentals of Acoustics, John Wiley & Sons, New York, 1982.

2. Urick, Principles of Underwater Acoustics, McGraw-Hill, New York, 1983.

3. Jones, R.M., Mechanics of Composite Materials, Hemisphere Publishing Corporation, New York, 1999.

4. MIL 17 The Composite Materials Handbook, Volume 3: Polymer Matrix Composites: Materials Usage, Design, and Analysis, 2002.

KEYWORDS: sonar; composites; domes; acoustics; windows; undersea

N121-059 TITLE: <u>High Power Ultra-Short Pulse Bulk Laser Amplifier at Eye Safer Wavelengths</u>

TECHNOLOGY AREAS: Sensors, Electronics

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

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OBJECTIVE: The objective is to develop a robust, high power (10’s of mJs), kHz repetition rate ultra-short pulse (~100fs) laser amplifier at eye safer wavelengths within the 1.5um – 1.8um atmospheric transmission window.

DESCRIPTION: Numerous physical processes that are useful for defense and commercial applications have been demonstrated using energetic (~100 mJ) ultra-short pulse (USP) lasers. Laser systems demonstrating these processes can create Terawatt peak powers and very broadband emissions, typically using Ti:Sapphire gain media and Master Oscillator Power Amplifier Chirped Pulse Amplification (MOPA CPA) architectures (see references 1, 2, and 3). Thermal issues, however, typically limit the power amplifier repetition rates for such systems (see reference 4), and 800nm wavelengths generated using Ti:Sapphire crystals are not considered eye safe. Other gain media have shown great promise for scaling to high average power for kHz-class repetition rates, such as Yb-doped thin disks (see reference 5) and cryogenically cooled laser systems (see reference 6), but these systems operate at 1 um and are not eye-safe. Furthermore, the bandwidth for these systems is still limited in crystals suitable for high power. There is a need to develop a high power ultra-short pulse gain material and laser architecture for the atmospheric transmission window between 1.5um and 1.8 um. The issue being addressed by going to these wavelengths is one of collateral damage and ready acceptance of these as items of use in the military, for at these wavelengths accidental eye damage is far less likely than at shorter wavelengths. Furthermore, pulse lengths of ~ 100fs should be obtained. A scaling path to achieve pulse energies on the order of 100mJ is required. An initial repetition rate of 100’s of Hz and a clear path for repetition rates exceeding 1 kHz or greater are also desired.

Several companies have commercialized ultra-short pulse fiber oscillators that operate at 1.55 microns. It is envisioned that the proposed solutions may include a previously developed oscillator followed by a high power bulk laser amplifier in a MOPA configuration to achieve the desired pulse energies.

PHASE I: Develop an innovative concept for a laser amplifier and demonstrate the feasibility of the concept through either laboratory experiments and physical measurements or citing existing proof-of-principle laboratory physical measurements. Demonstrate the feasibility of scaling the concept to a 100 mJ, 1 kHz, 100fs laser system at an eye safer wavelength. Provide a Phase II development plan that includes performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, an ultra-short pulse laser system will be built and used to demonstrate 100fs pulses of more than 50mJ at an eye safer wavelength within the 1.5 um transmission window. This can be done either single pulse or at low repetition rates. A conceptual design will be developed, based on the demonstration, for a laser system which would operate at repetition rates in excess of 1 kHz, pulse times of the order of 100fs, and pulse energies exceeding 100mJ. The scaling path for achieving this system will be detailed.

PHASE III: If Phase II is successful, the contractor is expected to support the Navy in further development of the laser amplifier should a Phase III contract be awarded. The focus of Phase III would be a full scale prototype demonstration to support transition of the amplifier to Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a substantial market of ultrafast laser vendors who could seek to enhance their core technology by making use of next generation laser amplifiers. Ultrafast lasers can be utilized in a variety of commercial applications, including surgical, manufacturing, and laser processing.

REFERENCES:
1. Wille, et. al., “Teramobile: A Mobile femtosecond-terawatt laser and detection system”, Eur. Phys J. AP 20, pp183-190 (2002);

2. Rohwetter, et. al. “Filament induced remote surface ablation for long range laser-induced breakdown spectroscopy operation”, Spectrochmica Acta Part B 60 pp 1025-1033 (2005);

3. S.L. Chin, “Propagation of powerful femtosecond laser pulses in optical media: physics, applications, and new challenges:, Can J. Phys 86 pp 863-905 (2006).

4. Gaudiosi, et. al., “Multi-kilohertz repetition rate Ti:Sapphire amplifier based on down-chirp pulse amplification”, Opt. Exp. 14(20), (2006) 99277; Backus, et.al. “High power ultrafast lasers”, Rev. Sci. Inst. 69(3) pp 1207-1223 (1998)

5 Metzger, et. al., “High-repetition-rate picosecond pump laser based on Yb:YAG disk amplifier for optical parametric amplification”, Opt. Lett 34(`4) pp. 2123-2125 (2009)

6. Rand, et. al., “Picosecond pulses from a cryogenically cooled, composite amplifier using Yb:YAG and Yb:GSAG”, Opt. Lett. 36(3) pp. 340-342 (2011).

KEYWORDS: Laser amplifier; high power laser; high energy laser; laser; ultra-short pulse laser; directed energy

N121-060 TITLE: <u>Efficient and Lightweight Cryogenic Thermal Energy Storage System</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: LCS Program, PMS 501, ACAT 1

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OBJECTIVE: Develop a compact, efficient, light-weight cryogenic thermal energy storage system for use in naval superconducting systems applications.

DESCRIPTION: The Navy is developing several superconducting systems for use in future ships and submarines to reduce system weight, energy usage and installed volume. These systems, such as degaussing, propulsion motors, electrical generators and power distribution systems rely on the use of cryogenic helium gas for operation. Current Navy superconducting systems rely on the mass of the system itself as thermal energy storage. This works well for rotating machines where the thermal constants are very large; however, in cable applications such as degaussing and power distribution this poses a real problem. Superconductors require cryogenic temperatures in order to benefit from zero electrical losses during operation. If the cryogenic system were to lose power and cease to provide any cooling, the temperature of the superconducting material would rise, superconductivity would be lost, and the material could undergo a catastrophic event. Maintaining cryogenic temperatures is paramount to superconducting systems. Significant amounts of heat from 100-3000W in the 20-120K range need to be removed from these systems on a continuous basis. The current state of the art in cable systems uses large tanks of liquid nitrogen as backup systems in the event that active cryogenic cooling is lost. This is not feasible on a ship because of the requirement to vent the gas when the system warms up and to provide make-up gas to recharge the system. If a cryogenic energy thermal storage system could be developed to allow the superconducting systems to handle transient heat loads and more rapid cool down times, the overall system efficiency, size and weight could be decreased.

This topic seeks innovative approaches to the development of compact, low-weight, high-capacity, cryogenic, thermal energy storage that is compatible with helium gas cooling at a high pressure (up to 25 bar) and temperature ranges (20 - 120K). In addition, proposed cryogenic thermal energy storage concepts must be able to provide better weight to volume density than what is now commercially available with the use of liquid nitrogen. Proposed concepts should also be rugged in order to handle a shipboard environment. Proposed concepts should be sized to be scalable from 100W to 3000W for up to an hour over a wide range of temperatures from 20-120K to maximize potential use of this technology. Thermal energy storage solutions such as salts and phase changing solutions exist at higher operating temperatures but do not exist at cryogenic temperatures or may not be suitable for use in a naval environment.

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

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

PHASE III: Upon successful Phase II completion, the company will support the Navy in transitioning the technology to military and commercial cryogenic or superconducting applications. Working with government and industry, install onboard a selected Navy ship and conduct extended shipboard testing. The company shall support the Navy in tests and validations to certify and qualify the technology for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A cryogenic thermal energy system may be of use in land based HTS power cables and power delivery applications. As land based HTS power cables transition from R&D projects to commercial installations, these thermal systems will save on system downtime should a catastrophic event occur and cause a system-wide outage.

REFERENCES:

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

2. American Superconductor, “High Temperature Superconductor Degaussing Coil System,” www.amsc.com, 2010.

3. R. Kniep, H. Klein, and P. Kroschell, “Hydrated Mg(NO3)3/NH4NO3 Reversible Phase Change Compositions,” Patent Application 244785, September 1994.

KEYWORDS: Cryogenics; thermal energy storage; degaussing; superconductors; high temperature superconductors; HTS

N121-061 TITLE: Physics Based Multi-Touch Movement Interface Creation for 3D Modeling and Simulation

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: NAVSEA 07TL, Submarine Training System; R&D training; Non-ACAT Program

OBJECTIVE: Develop physics based multi-touch for 3D Modeling and Simulation to advance training beyond basic Commercial Off The Shelf (COTS) multi-touch hand movement operations.

DESCRIPTION: The growing advancement of training on multi-touch Liquid Crystal Displays (LCD)/Light Emitting Diode (LED) is limited to very basic Commercial Off The Shelf (COTS) multi-touch hand movements. The multi-touch hand movements are currently limited to panning, zooming (maximum two finger input), rotate (maximum two finger input), and flick. The ultimate goal is to develop a more advanced physics based multi-touch software capability including measurement of pressure to manipulate complex 3D objects (i.e. removing a push pin or operating a torque wrench), and for navigation within a 3D environment. The end state for this development is to create a software repository of complex multi-touch pressure sensitive hand movements for current and future use in multi-touch training applications. Examples of some of the multi-touch hand movements that would be developed include a gripping (hold an object in place), lasso (select/group several objects), check (mark item complete). A complete library of multi-touch pressure sensitive hand movements will be provided in Phase II. The main technical challenge in the development of multi-touch multi-movement is multi-threaded event processing (distinguishing unlimited simultaneous hand movements). The software for multi-touch hand movement development should be reusable across other software development platforms.

PHASE I: Define and develop a new and creative multi-touch pressure sensitive movement interface approach/concept which allows for complex input including up to six degrees of freedom. This approach will broaden multi-touch interface development beyond panning, zooming, rotate and flick. An example would be a hand movement for operating a torque wrench. The multi-touch movement could be to use three or more inputs on the torque wrench, and based on the pressure applied to the side of the handle of the wrench (combined with the direction of motion), would result in movement of the torque wrench. Demonstrate the feasibility to simultaneously recognize distinct positions of input touches combined with a motion and pressure as a unique input.

PHASE II: Develop, test, and evaluate the new multi-touch multi-hand movement software on multi-touch pressure sensitive hardware (prototype). Demonstrate sample multi-touch pressure sensitive hand movement (defined by the Program Office). Creatively demonstrate how several users can manipulate the defined multi-touch pressure sensitive movements simultaneously, with more complex interactivity than currently available. Develop a process and demonstrate the ability to easily adapt this software code to other software coding languages.

PHASE III: Upon completion of Phase I and II this new technology will be transitioned to commercial developers and government research and development facilities responsible for design and building of future modeling and simulation devices. Specifically, transition and test these movements into the Weapons Launch Console Team Trainer (WLCTT). The awardee will integrate and support testing of the the multi-touch movement software into the WLCTT. Additionally, the company will demonstrate that the developed multi-touch movement will interface/operate on the Program Office specified objects in a 3D space. Provide new specification to use multi-touch movement in future simulation training such as team and/or maintenance training specifically the Virginia torpedo room on the Weapons Launch Console Team Trainer (WLCTT). The Program Office will assist the company in meeting goals/requirements of the Navy.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology has tremendous applicability and value to the gaming, personal computing, and training industry. Multi-touch displays and their associated hand movements are the emerging technology that will soon replace single touch input screens. The physics algorithms used to aid in the development of this technology are used in the development of many Xbox, Wii, and PS3 games.

REFERENCES:
1) "7 Things you need to know about Multi-Touch interfaces."
http://net.educause.edu/ir/library/pdf/ELI7037.pdf

2) "Windows Touch: Developer Resources."
http://code.msdn.microsoft.com/WindowsTouch

3) Eden, Joel. "Designing for Multi-Touch, Multi-User and Gesture-Based Systems."
http://www.drdobbs.com/architecture-and-design/216402697

4) "Game Physics Simulation."
http://bulletphysics.org/wordpress/

KEYWORDS: multi-touch; hand movement; training; interactive training software; modeling and simulation; physics for gesture devices;

N121-062 TITLE: Spectrally Compliant Waveforms for Navy Communication Systems

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMW 160, Tactical Networks

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 spectrally compliant communication signals that are capable of making coherent use of fragmented spectral bands to maximize data rate with minimal compromise in transmission efficiency.

DESCRIPTION: Evolving Navy applications require continually increasing communications data rates which, in turn, require corresponding increases in communications spectral bandwidths. Growing spectral crowding caused by expanding commercial and military radio frequency (RF) usage, however, makes it necessary to share the available designated spectral bandwidths with other systems. Increased spectral bandwidth generally exacerbates the degree of conflict with other systems due to spectral crowding. To co-exist with expanding commercial and other military RF systems, it is necessary to identify the sub-bands occupied by these other systems and confine the communication signals to sub-bands that are free of such conflict. Beside the need for sufficient isolation among the sub-bands used for communications and neighboring sub-bands used by competing systems, the challenge also exists to maximize the data rate by operating coherently through a fragmented spectrum, and by maximizing the transmission efficiency and the corresponding signal-to-noise ratio by optimizing the peak-to-average-power-ratio (PAPR), thereby helping to minimize the error rate. Communication systems that attempt to increase the data rate by generating parallel independent transmissions in different sub-bands, suffer unacceptable PAPR. In extreme cases this PAPR can be so high that the transmitted signal through the broad band fragmented spectrum cannot even match the throughput of un-fragmented narrower band channels. To maximize efficiency this topic seeks innovative techniques that utilize the fragmented spectrum in a coherent fashion as a single transmit channel and generate corresponding high data rate signals of constant amplitude. The techniques developed are also required to adjust the communication signals in near-real-time so as to effect timely adjustments to changes in application radio frequency (RF) environments.

PHASE I: Define and develop one or more alternate concepts for communication waveforms capable of utilizing fragmented spectra as a single, coherent, constant amplitude, or near-constant amplitude channel. Analyze the performance of each developed technique in terms of data rate, error rates, transmitter efficiency and channel isolation. Compare the techniques against existing techniques and quantify the performance differences. Analyze the implementation issues and determine the theoretical feasibility of each technique in steady and varying RF environments. Develop a Phase II plan with tasks and milestones to demonstrate the concept(s) of Phase I.

PHASE II: Produce prototype hardware based on Phase I communication system analysis in the Phase II plan. Mechanize the waveform generation scheme and demonstrate its performance in a controlled environment. Generate a number of alternative sets of such waveforms across several different notional fragmented spectra. Validate the selected technique, or techniques, by implementing the selected waveforms in the communication system prototype, together with a more conventional technique, and demonstrating its advantages. The work in this Phase may require access to classified information.

PHASE III: Should a Phase III contract be awarded, the company will build upon the results of the Phase II effort, further refine the validated communication technique, automate it, and prepare it for insertion into a candidate communication system. Insert the technology into suitable candidate communication system identified by the Navy and effect transition of the new communication technique into that system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications include communication systems utilized by all branches of the DOD, FAA, Homeland Security, etc.

REFERENCES:
1. IEEE Standard 802.16d-2004

2. IEEE Standard 802.16e-2005

3. Gulliver, T. and Felstead. E., "Anti-jam by Fast FH NCFSK-Myths and Realities', IEEE Milcom'93, Oct. 1993, 187-191

KEYWORDS: Communications; Waveforms; Spectral-Compliance; Fragmented Spectra; Spectral Crowding; Sub bands

N121-063 TITLE: Lightweight, Low Cost, Multiweapon Missile Canister

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO IWS 3.0, ACAT II (VLS MK 41; VLS MK 57) Vertical Launchers

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OBJECTIVE: Develop a light weight solution for the current steel multipack canisters used with MK 41 and MK 57 Vertical Launching Systems (VLS).

DESCRIPTION: The MK 41 and MK 57 VLS (Vertical Launching Systems) utilize unique missile specific canisters for the safe transport, storage, and launch of missiles. Once a missile is canistered, the canister must provide an environment that is safe throughout the lifecycle of the missile. When the missile is fired, the canister serves as its launching rail. It is also an integral part of the gas management system. The canisters must be weather tight, very straight, impact and drop resistant, and able to survive a restrained-fire event (when the ignited missile fails to egress from launch canister) without the risk of sympathetic detonation of the adjacent round. Canisters must also safely withstand a near miss shock event as defined by MIL-STD-901 and maintain integrity with internal pressures up to 100 psi created by missile egress from the launcher. Although the canister's internal components are unique to interface with specific missiles, the exterior interface of all canisters is identical. This common exterior interface allows for placement of any missile canister in any location in a launcher and minimizes the need for unique handling equipment.

One of the most unique canisters in the Navy inventory is the MK 25, an approximately 25-inch square steel canister over 225 inches in length and weighing over 3200 pounds. This canister has four sub canisters each housing a separate Evolved Sea Sparrow Missile (ESSM). New missile systems, such as those being developed as follow-ons to the current ESSM, tend to grow in size and weight to address increasingly capable threats. To maintain the total system weight of missile plus canister at approximately the same level, the canister becomes a useful opportunity for weight reduction to offset weight gain in the missile. Fabricating major canister components from composites (or other lightweight materials) can provide a technically sound approach to a lower canister weight, but manufacturing costs run the risk of being prohibitively high. The overall square geometry with small radius corners is crucial to maintain fit with existing USN Vertical Launching System infrastructure and to provide ample internal space to package missiles and their control surfaces. Durability and life cycle costs are also issues that need to be addressed.

Summarizing, the existing steel canisters need to be replaced with lighter material(s) such as composites, fabricated through lower cost manufacturing such as pultrusion, and cost effective through possible reduced parts count based on unique design. The innovation is to identify and develop material(s) that can meet the severe requirements described above (i.e., missile launch environment, adjacent launch environment, near miss shock, low weight etc). Innovation will also be needed in the fabrication of the canister.

PHASE I: Develop a concept including materials for a light weight replacement for the current MK 41 VLS canister, meeting or exceeding the key performance parameters of this baseline configuration. Assess this concept with respect to innovative manufacturing process automation, performance in the launch environment, potential for enhanced full life-cycle affordability in acquisition, operation in the fleet, and maintenance. Develop a Phase II development plan with milestones and tests.

PHASE II: Based on the Phase I results and the Phase II plan, finalize the canister concept, produce test hardware, build a prototype, and conduct testing and evaluation to affirm the ability of the prototype to meet the critical parameters driving the design selection. Project production cost of the composite hardware in low rate production. Develop Phase III plan to transition the technology.

PHASE III: Should a Phase III contract be awarded, the company will work with the Navy and the prime canister design agent to transition the newly developed light weight canister. This means the small business will participate in the development and testing of a full scale canister, followed by eventual fielding in a Program of Record.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Light weight square geometry pressure vessels have potential for Automotive, Air Transportation applications and low-cost, lightweight structural/hydrostatic building materials for commercial construction.

REFERENCES:
1. Zu, L., Koussios, S. and Beukers, A. 2008. "Optimal Shapes and Winding Parameters for Filament Wound Articulated Pressure Vessels," Proceedings of the American Society for Composites: Twenty-Third Technical Conference, Memphis, TN, September 9-11, 2008.

2. Legowick, Ronald, 2001,"Next Generation Composite Canister for Missile Defense Applications," presented at the Defense Manufacturing Conference.

3. http://www.fas.org/man/dod-101/sys/ship/weaps/mk-41-vls.htm

KEYWORDS: Composite materials, missile canister, automated manufacturing, missile launcher, pultrusion, filament winding

N121-064 TITLE: Terahertz Imaging for Detection of Corrosion and Defects Under Hull Coatings

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO-SUBS VIRGINIA Class Submarine Program

OBJECTIVE: The object is to develop a Terahertz (THz) imaging system suitable for in-situ defect detection in commonly used ship hull coatings and rapid, non-destructive detection of corrosion, hull coating delamination, and hull surface gouges recessed into the hull metal through still-attached hull coatings/panels.

DESCRIPTION: THz imaging is an evolving technology currently in niche markets in industry with the potential to transition into Non-Destructive Evaluation (NDE) testing in many markets.

The Navy employs hull coatings, which present inherent difficulties for more traditional forms of non-invasive imaging such as ultrasound. Traditional methods for detecting corrosion defects under hull coatings involve costly removal and replacement of the coatings for visual inspection of the underlying surface. THz imaging could provide a potential alternative to current imaging technology because of its ability to penetrate hull coatings (as it is electromagnetic radiation) with much finer spatial resolution than possible with microwave-frequency electromagnetic imaging options. THz imaging (a pulsed technology) has many advantages when compared to somewhat faster millimeter-wave and sub-millimeter-wave imaging (non-pulsed, continuous-wave technologies), including multiple-decade higher signal-to-noise-ratio (SNR) across a broad bandwidth resulting in finer resolution due to penetration at higher frequencies for a given target material/coating and highly accurate depth measurement capability to better define volume and interface (delamination) defect location. These significant advantages over the previous technology may enable detection of defects that were not possible up to now.

THz imaging research has shown promise with Navy-relevant materials, specifically in characterizing the THz absorption coefficient and refractive index as an important step toward allowing corrosion inspection of ships without removal of the hull coatings. If this topic is successful, the technology developed could save the Navy millions of dollars per ship inspection, which is in line with the Navy’s Reduction of Total Ownership Cost (RTOC) initiatives.

This topic focuses on development of technologies that will support a system that can image corrosion and defects through coatings rapidly enough to support a statistically sampled portion of a submarine hull. The system should be man-portable, support sufficiently rapid data acquisition to support a survey of the entire hull or portions of interest, be capable of expected system movement without need for recalibration more frequently than once annually, be resilient to shipyard environmental factors (i.e., salt air ambient), and deliver sufficient (maximum) SNR for normal-incidence surface imaging.

PHASE I: Develop a system concept approach for THz imaging suitable for detection of defects defined as hull surface corrosion, hull surface gouges, and various coating material volume/interface defects (bubbles, improper material-material and material-metal interface adhesion, pockets of improperly cured material, and unintentional foreign objects) through coatings on a submarine hull without removal of the coatings to meet with unrestricted operation (URO) maintenance requirement card (MRC) specifications. If an URO MRC specification does not exist for a particular defect, a "good faith" effort shall be made to provide detection capability of that defect for the smallest defect size possible. Detection of a defect is defined herein as the ability to accurately distinguish the defect from surrounding regions which do not contain the defect and display the location and size of the defect in a software image. Demonstrate the feasibility of the concept to detect these defects through hull coatings. Demonstrate the feasibility of developing the concept into technology that can be used by the Navy for detecting these defects. Concept feasibility will be supported by appropriate analyses and laboratory experiments. Provide a Phase II development plan that includes performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, develop prototype suitable for evaluation. Evaluate the performance of the prototype with regard to the goals defined in Phase I on submarine hulls or representative structures. Based on the results of the evaluation, refine the prototype into a conceptual design. Prepare a Phase III development plan to transition the technology into a system that can be acquired by the Navy. The Phase III plan should include testing, validation, certification, and qualification for Navy use.

PHASE III: If Phase II is successful, the small business will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. Based on the Phase II results, develop a THz hull defect detection system for testing onboard a submarine. Support the Navy in testing, validating, certifying, and qualifying the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The results of this effort should lead to improved inspection of submarine hulls for corrosion and defects under coatings, and should have applicability to other types of ship hulls as well. Resulting THz system SNR and speed performance improvements should benefit all applications which use the same region of the THz spectrum including space shuttle fuel tank hull and insulated pipe corrosion inspections.

REFERENCES:
1. Robert F. Anastasi, Eric I. Madaras, and Jeffrey P. Seebo, Stephen W. Smith, Janice K. Lomness, Paul E. Hintze, Catherine C. Kammerer, William P. Winfree, and Richard W. Russell, “Terahertz NDE Application for Corrosion Detection and Evaluation under Shuttle Tiles.” Nondestructive Characterization for Composite Materials, Aerospace Engineering, Civil Infrastructure, and Homeland Security 2007 (Proceedings of SPIE Volume: 6531), http://spie.org/x648.html?product_id=690256&origin_id=x4318&event_id=725046

2. Robert F. Anastasi and Eric I. Madaras, “Terahertz NDE for under paint corrosion detection and evaluation.” The 4th International Workshop on Ultrasonic and Advanced Methods for Nondestructive Testing and Material Characterization, June 19, 2006 at UMass Dartmouth, N. Dartmouth, MA (published in www.ndt.net).

3. NAVSEA T9081-AE-MMO-010 - URO MRC SSN 774 Class

KEYWORDS: Terahertz; imaging; corrosion; defects; hull coatings; nondestructive evaluation

N121-065 TITLE: Multivariate Algorithm for Insensitive Munitions (IM) Hazard Mitigation

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO-IWS3A (Standard Missile / SM-6), ACAT I

OBJECTIVE: Develop automated real-time estimates of energetic material (EM) environmental hazards, unplanned ignition thresholds, and mitigation impacts to improve system safety and lessen susceptibility to IM hazards.

DESCRIPTION: Currently the Navy does not have sensors or controls for monitoring the health or responses of energetic materials to Insensitive Munitions (IM) hazards. This topic requires innovation to develop a multivariate algorithm for a system solution which includes a network of sensors, processors and communication and control measures to provide real-time estimates of EM health, warning signals, and avoidance/mitigation options. The developed system will enable required operator actions to prevent or alleviate safety related incidents and IM events. Advances in sensor technology for measuring environmental states including thermal, gas, and shock/vibration provide a set of potential information inputs that can be used to develop real-time situational awareness of the safety thresholds for multiple EM types. This includes quantities embedded in complex systems including land or sea-based multi-weapon launchers or transporters and forward temporary storage areas. While each additional information source nominally increases situational awareness, the operator is currently limited in ability to assess the information.

The Navy has looked at various options such as Chemical Sensor Initiators (CSI) and heat and humidity sensors; however, they are only a subset of the scope of capability needed. For example, automation of sensing and condition reporting are innovations that are required. This topic seeks innovative concepts that will enable automation to maintain current safety or improve shipboard safety. For real-time tactical or logistical missions requiring rapid response to emergent IM safety threats from accidents or adversarial actions, the operator must understand how much time is available and the expected impact of available avoidance and/or mitigation measures that can be used to prevent catastrophic hazards to equipments, platforms, military personnel, and civilians. It is critical that EM response predictions be robust to prevent mission failure and loss of lives and property. A multivariate system approach is needed based on: (a) EM behavior in elevated heat and mechanical environments (possibly based on health monitoring), (b) knowledge of sensor technologies and capabilities, and (c) impacts of passive or active avoidance/mitigation measures.

Results from this topic will enable system designers to develop high payoff avoidance/mitigation strategies given that sensors are available to measure environmental factors important to EM behavior. These multivariate algorithms will also enable system designers to develop needed types of sensors, capabilities, and preferred placement thereby providing the operator with the best situational awareness. Matching multi-sensor products to understand and predict EM time-to-event opens the design space for avoidance/mitigation of EM response. Knowledge of these characteristics and their real time EM response estimates will enable investment in new sensor technologies and capabilities.

PHASE I: The company will define a concept for an automated multivariate system that meets the above objective. It will conduct an assessment on the concept, and perform a preliminary analysis to establish the feasibility of an EM health monitoring system (to determine the response to unplanned ignition thresholds for EMs). The company will define the architecture and concept of operation, and identify the algorithm requirements to provide the desired capabilities. The company will provide a Phase II development plan with key technical milestones and performance goals.

PHASE II: Based on the Phase I findings and the Phase II development plan, the company will develop a prototype of the automated EM health monitoring system, and integrate it into an analytical test bed (Navy asset not required). The company will demonstrate the maturity of the proposed solutions by numeric trials and validate performance using available Navy EM characteristics data. The company will conduct trials on simulated/surrogate launcher/magazines to evaluate acceptability of proposed solutions. Results from these trials will be used to refine the health monitoring system into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition this technology for Navy use.

PHASE III: Based on successful Phase II results, the company will work with the appropriate Navy Program Offices (PEO-IWS, PEO-Ships) to transition the technology to Navy use, if a Phase III award should be made. The company will develop a health monitoring system and help in its evaluation to determine its viability to be used as upgrades to missile launchers and ship magazine spaces. 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: Successful outcome of this topic would be beneficial to military systems, space launch systems, commercial transport of weapons and weapon components containing EM (or other potentially explosive material), global counter-terrorism, and homeland security including emergency response.

REFERENCES:
1. Swierk, T.E., "IM Maturity — A Systems Perspective," Proceedings, Insensitive Munitions & Energetic Materials Technology Symposium, Bristol, UK, April 2006.

2. Jones, D. A., et. al., "Expedited Transition of Propulsion Modeling & Simulation Capability — Enabled by a Knowledge Structure," Proceedings, Insensitive Munitions & Energetic Materials Technology Symposium, Munich, Germany, November 2010

KEYWORDS: Insensitive Munitions; Energetic Material; Mitigation; Health Monitoring; Survivability; Sensors.

N121-066 TITLE: Transparent Armored Windows for Ships

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: LPD 17 Program, PMS 317

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 a next generation, transparent armored window using advanced materials and/or innovative manufacturing process improvements for use onboard naval ships.

DESCRIPTION: Transparent armor windows are specially designed to protect the ship’s crew from ballistic or fragmentation penetration and to allow for visibility during night and day operations. Transparent armor windows are installed on surface ships where visibility of the topside environment is needed for performing navigation and mission requirements such as flight operations. Window panels range in size from small square panels (2.5 ft x 2.5ft) to large rectangular panels (2.5 ft x 5.5ft), and the overall weight is a function of the window thickness (ref (3)). LPD 17 Class ships have transparent armor windows installed on the bridge, in debark control, in the helicopter control tower, in the well-deck control and vehicle conflagration stations. The window design requires protection from threats while arresting fragments that could injure personnel, as well as the ability to handle the marine environment of surface ships. Current window systems are outfitted with window wipers and embedded heating elements. Some are treated with a radar cross-section reduction film. The current technology for the production of transparent armored windows produces high stress-concentrations (bi-axial) within the laminated panel sections. It should be noted that the current TAW design meets the ballistic testing requirements as outlined in ref (4); however, the built-up, embedded stresses as a result of the materials and manufacturing process usually “releases” after the TAW is installed on the ship. Thus, thus the interlayer striations and stressors within the laminate schedule contribute to the manifestation of internal, post-manufacturing surface defects which in turn leads to early failure of the windows. The cracks, crazing, and chemical attack (caused by some onboard cleaning products) all contribute to TAW failures and jeopardizes the ballistic protection properties and negatively impacts visibility. TAW’s are a long lead manufacturing material item (18-24 weeks after receipt of the purchase order). Because of their weight and location, they cannot be repaired, only replaced, and replacement requires a depot level capability. The current TAW design is more than 20 years old. Since the inception of this TAW design there has been significant improvements in ceramic development, nanotechnology, etc. as well as in manufacturing processes.

This topic seeks to explore the application of advanced materials and/or innovative manufacturing processes to produce large panel, transparent, armored windows for use onboard naval ships. It is anticipated that the utilization of advanced materials (such as but not limited to, nanotechnologies, glass, laminates, and films) and /or manufacturing processes (assembly of laminate schedules, autoclaving processes, etc) will improve the current life-cycle of TAW panels. Of particular interest are concepts that address improvement in current manufacturing processes and provide increased resistance to chemical attack as well as providing shorter manufacturing lead times. Additionally, there is interest in concepts that incorporate the ability to provide embedded heating elements or have material properties/characteristics that provide equivalent ice phobic functionality without the use of embedded heating elements while meeting performance requirements as specified in MIL-STD-662 (ref (4)). Proposed concepts shall be manufactured and delivered in such a manner as to be readily installable into the existing footprint of the current LPD TAWs. Using the LPD 17 Class ship specification 625d, 095-625, MIL-PRF 46108C, type II construction methods as guidance (ref (2 and 3)), the proposed TAW concepts shall meet or exceed all of the applicable ship specifications such as optical qualities, visible light transmittance , Electromagnetic Interference (EMI), shock, vibration, applied static pressures, allow for the use of night vision goggles and have the capability to integrate with existing ship service support systems (ref (1 and 2)). Finally, proposers shall describe how radar cross-section films could be incorporated into the proposed concept and will consider any resultant impact of the films on any prospective manufacturing process concepts. Proposed concepts should be robust enough to withstand off-gassing/curing of shipboard construction materials (i.e. curing of paint coatings within a confined space) and should be compatible with standard shipboard cleaning products and processes.

PHASE I: Develop an innovative concept for transparent armored windows through the application of advanced materials and/or innovative manufacturing process and demonstrate the feasibility of developing the concept and meeting shipboard armor protection for large, transparent, armored windows. Perform bench top experimentation, where applicable, as a means of demonstrating the identified concepts. Identify materials, manufacturing process and performance goals to develop the next generation of TAW's. Establish validation goals and metrics to analyze the feasibility of the proposed solution. Finally, describe the approach that will be used in Phase II to perform material qualification of test samples.

PHASE II: Develop, demonstrate and build prototype window coupons, as identified in Phase I, for laboratory evaluation. In a laboratory environment, demonstrate and evaluate the ability of prototype coupons to meet the performance goals established in Phase I. Develop manufacturing techniques in accordance with US Navy specified requirements for safety and protection as identified in the reference material. The contractor will be expected to develop manufacturing control procedures, produce test samples of a specified size using selected manufacturing techniques, conduct quality assurance inspection, and report results. Develop a cost benefit analysis identifying window manufacturing cost, and a Phase III installation, testing, and validation plan. Successful window prototypes/coupons will be subjected to MIL-STD 662 in Phase III.

PHASE III: If the Phase II effort is successful, the contractor is expected to support the Navy in transitioning the armored windows to shipboard use should a Phase III award be made. Specifically, in accordance with the Phase III testing and validation plan, the contractor will manufacture window coupons and test in accordance with MIL-STD-662. The contractor will manufacture transparent armored window coupon(s) using approved design and manufacturing techniques, develop first article test procedures, and conduct testing in accordance with US Navy specified qualification requirements. Provide report of final test results for qualification. Once validated, windows will be manufactured and installed onboard a navy ship for evaluation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Improved TAWs could be used in any work environment requiring ballistic window protection such as banks, portable police shield, residential security, and limousines/cars.

REFERENCES:
1) LPD 17 Class Bridge Compartment and Helo Control Compartment Design, Available at www.dodsbir.net/sitis.

2) LPD 17 Class Section 625 Specification – Shipboard Window Requirements, Available at www.dodsbir/net/sitis.

3) MIL-PRF 46108C, Performance Specification: Armor Transparent. Available at http://www.everyspec.com/MIL-PRF/MIL-PRF+(030000+-+79999)/MIL-PRF-46108C_20160/

4) MIL-STD-662, V50 Ballistic Test for Armor. Available at http://assist.daps.dla.mil/quicksearch/

KEYWORDS: TAW; armored window; ballistic protection; transparent armor; blast fragmentation resistant; bullet resistant glass

N121-067 TITLE: High Energy Density Chemistry Source for Temporary Torpedo Electrical Power

TECHNOLOGY AREAS: Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: PMS 404: Undersea Weapons Programs (MK 54 and MK 48 torpedo programs.)

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

OBJECTIVE: Identify and develop a high power density chemistry source with low profile and volume attributes for Navy applications.

DESCRIPTION: The MK48 Torpedo requires a temporary bridge power supply until main engine activation and alternator power becomes available. The power density requirements to maintain active memory, telemetry, ongoing processing, and weapon fuzing competes within the existing volume of the torpedo for the new functionalities being planned. An innovative application of new temporary energy storage technology would provide a solution as well as support economical and environmental Navy goals. The existing costs for portable and expendable power systems is $3K per unit and yearly estimated procurement cost of $2.1M.

A new high density power chemistry source could entail research in areas such as high energy density alloys; smart materials; and mixtures combining materials such as graphene based crystalline structures to bend, expand, or contract to hold more resident voltage or shaped memory polymers with martensitic-heusler phase change properties coupled for high energy storage applications.

Concepts should be based on novel approaches to improve temporary energy storage capabilities as opposed to the thermal based battery technology being used. The effort would culminate in the development of a low cost, highly reliable, maintenance free, and long shelf life solution for the power source that is ecologically supportive. Power source key performance parameters are single electrical event activation that is less than or equal to 0.775 seconds, delivery of 225 VDC to 300 VDC into a load of 450 Watts for a period of 11 seconds, reliability of 0.99, and life expectancy greater than 12 years.

Development efforts involve performing a preliminary review of the design concept(s), producing prototype units for land and in-water evaluation and validation testing, conducting an assessment of readiness for production, and providing detailed drawings and documentation specifying the performance of the solution.

Phase II efforts may be classified because the company may need access to secure information. Phase I concept development will not require secure access and will be unclassified.

PHASE I: The company will develop concepts for high power density power sources in the range of 225 VDC to 300 VDC. The concepts should be capable of driving a 1.5 Amp load current for 11 seconds with a reliability of 0.99. The feasibility of the concepts in meeting Navy requirements will be demonstrated through experiments and analyses. A Phase II development plan with performance goals and key technical milestones will be provided

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will produce prototype high energy power sources capable of delivering 225 to 300 VDC into a 450 Watt load. The company will evaluate the prototype to determine if the prototype is capable of meeting Navy requirements and the performance goals established in Phase I. Compatibility with the torpedo interface will be established. Based on the evaluation results, the prototype will be refined into conceptual designs for Government review. Additional prototypes based on the conceptual design may be built and evaluated to validate intended performance. The evaluation shall include several demonstration tests of effectiveness to include temperature range, pressure, vibration, and shock testing and cycle (high) demand testing for USN verification. A Phase III development plan to transition the technology to Navy use will be provided.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. The company will support the Navy in tests and validations to certify and qualify the new power source for Navy use. The power source will be tested in an operationally relevant environment to determine its effectiveness, conformance to Navy requirements, and readiness for shipboard use. The company will support any necessary shipboard tests.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Product potentially has applications in other military weapon systems and commercial markets requiring a standalone, low cost, long shelf life, high energy, short duration power source.

REFERENCES:
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3. Candace K. Chan, Hailin Peng, Gao Liu, Kevin McIlwrath, Xiao Feng Zhang, Robert A. Huggins & Yi Cui, High-performance lithium battery anodes using silicon nanowires, Nature Nanotechnology 3, 31 - 35 (2008)

4. Crossover Battery, Configuration Item NAVSEA Specification 6300534

KEYWORDS: high density power chemistry source; stand alone temporary power system; torpedo energy source; short duration power source; long shelf life; low profile volume power

N121-068 TITLE: Improved High-Power Performance in Fiber Laser Systems

TECHNOLOGY AREAS: Sensors, Electronics

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

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OBJECTIVE: The objective of this effort is to greatly reduce nonlinear effects, such as Stimulated Brillouin Scattering (SBS), Four-Wave Mixing (FWM), and Stimulated Raman Scattering (SRS), to enable a simplified, robust, and reliable high-power fiber laser weapon.

DESCRIPTION: The Navy is interested in two technical approaches that reduce nonlinear effects and increase laser power. One technical approach that has demonstrated effectiveness is to counter-pump the fiber amplifiers, to input the pump power at the exit of the fiber amplifier. This requires a fiber combiner capable of simultaneously handling both the pump power and the output power. Previous experiments of the counter-pump technology conducted have demonstrated fiber amplifiers in reverse pumping up to 1kW, with no nonlinear effects; however, the beam quality was only about 1.3 times the diffraction limit. To take advantage of laser capabilities it is important that they have beams which are as near the diffraction limit as possible, and thus can be focused to the smallest possible spot size. Thus an operational fiber laser weapon system must have a more nearly diffraction-limited beam, to improve beam quality and provide more tightly-focused energy on target. The second technical approach that has demonstrated effectiveness is the passive phase-locking of the fiber laser amplifiers, to produce a nearly diffraction-limited coherent output beam. The purpose of this effort is to develop the technologies of fiber laser amplifier counter-pumping to enable the realization of high power, high-quality, output beams.

PHASE I: Phase I will include development of detailed modeling tools for analyzing the performance of fiber combiners for counter-pumping in passive phase-locking systems. The issues that impact and limit the performance of the fiber combiners will be identified. The results of the modeling will be used in Phase II to develop prototype combiner samples. The deliverables will be computer modeling tools and a report of the analysis results, discussing power scaling limits and expected performance in terms of beam quality and efficiency. The analysis should consider the practicalities of the material processing required to produce the fiber combiner. Options for fiber combiner fabrication for Phase II must be considered. The final report shall include the development plan, with performance goals and key milestones, for Phase II.

PHASE II: In the first year, based upon the results of Phase I and the Phase II development plan, combiner samples will be fabricated and subjected to low power (a few hundred watts) evaluation. Careful measurements of the beam quality achievable will be made, along with thermal and splice performance data. In the second year, high-power combiners will be fabricated and evaluated at a level of 2 KW. Data on beam quality and thermal performance of the combiner and splices will be collected. The goals will be a reduction of beam quality to 1.1, and demonstrated operating times of 10 minutes or more at high power. The final report shall include all data collected, and a discussion of any remaining steps required to develop a high power shipboard demonstration.

PHASE III: The contractor will support the transition of this effort to a shipboard laser system and will further develop the laser technology to support system integration for shipboard implementation. A shipboard laser system will likely be comprised of a number of these lasers which are coherently beam combined into a militarily useful power level.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The primary applications of counter-pumping at high power are defense related. However, the techniques employed in counter-pumping of fiber laser amplifiers can find use in applications such as high speed cutting and welding, broadband communication, and free space satellite data streaming.

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3. S. Shakir, "Dynamic Characteristics of Passively Phased Fiber Amplifiers Arrays," in the Proceedings of the Solid-State Diode Laser Technology Review (SSDLTR), Albuquerque, NM. June 2008

4. S. Shakir, " Mode Locking of an Array of Fiber Lasers," in the Proceedings of the Solid-State Diode Laser Technology Review (SSDLTR), Newton, MA. June 2009

5. Erik Bochove and Sami A. Shakir, "Theory of Passively Phased Systems", IEEE JQE, vol.15, 320 (2009)

KEYWORDS: Fiber Lasers;Stimulated Brillouin Scattering;High Power Lasers;Non-Linear Effects;Fiber Amplifiers;Counter Pumped Fiber Laser Amplifiers

N121-069 TITLE: Three Dimensional Imaging for Passive Ranging

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: Integrated Submarine Imaging System (ISIS), ACAT III

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

OBJECTIVE: Develop an image processing system using the technologies of three dimensional imaging to support passive ranging of targets.

DESCRIPTION: Ranging of targets is an essential capability requirement of submarine imaging and electronic warfare systems. Passive ranging is normally conducted manually by an operator using a stadimeter overlaid on the image or periscope view. Current implementation of passive ranging adds to operator workload and is subject to error as the operator must estimate between ticks of the stadimeter. Active ranging is conducted via laser or radar emission, and active transmission is undesirable in many circumstances. An increase in the fidelity of passive ranging and automation of the process of passive ranging will reduce the requirement for active transmission.

Three-dimensional imaging technology, using image data collected from multiple offset cameras, may be able to passively provide the automated ranging capabilities to the war fighter that were previously only available through active systems that risked the possibility of counter-detection in their use. Current state of the art three dimensional imaging is used in the movie industry and in an increasing number of commercial underwater exploration applications. This technology is currently used by the Navy to produce visually appealing video, but should be directly applicable to passive ranging.

The Navy is seeking innovative approaches and algorithms for passive ranging using multiple cameras to address and increase platform stealth. Innovation should first have the ability to determine the appropriate camera geometry to allow for passive ranging. Innovation should also have the ability to identify algorithms that can be used to extract range data from the image stream. The company will also determine if the required components will operate within the existing imaging mast architecture or if a new architecture will be required.

PHASE I: Determine the feasibility of using an automated passive ranging algorithm and develop the concept, including the required camera geometry and processing algorithms. Propose the optimal geometry of multiple cameras to provide the optimal ranging solution. Propose candidate algorithms for evaluation. Provide predictions as to the accuracy of the algorithms.

PHASE II: Develop a proof-of-concept processing suite for evaluation by the Navy. This suite would consist of cameras and appropriate processing algorithms to demonstrate passive ranging. Demonstrate the ability to passively range targets using the algorithms. Develop an approach to transition the algorithms in phase III.

PHASE III: Upon the success of Phase II, the company will support the Navy in transitioning the algorithms as part of the TI/APB process. The architecture and algorithms would be refined, would be documented, and incorporated into the Navy’s TI/APB process. The developer will support algorithm refinement and testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In a situation where multiple cameras are utilized, this application would allow for locating targets of interest. This could be used in surveillance applications to determine where an object is located relative to the surveillance equipment. Combined with other data (such as Global Positioning System) the target could be located at specific coordinates.

REFERENCES:
1. Comparison of passive ranging integral imaging and active imaging digital holography for three-dimensional object recognition, Yann Frauel, Enrique Tajahuerce, Osamu Matoba, Albertina Castro, Bahram Javidi, Applied Optics, Vol 43 No 2, 10 January 2004.

2. 3D Ranging and Virtual View Generation using Omni-view Cameras, Kim C. Nga, Mohan M. Trivedia, and Hiroshi Ishigurob, Computer Vision and Robotics Research Laboratory, University of California-San Diego, Department of Social Informatics, Kyoto University, Japan

KEYWORDS: ranging; passive; location; 3Dimensional; imaging; holography

N121-070 TITLE: SIGINT Interfaces and Processing Infrastructure for Submarines

TECHNOLOGY AREAS: Sensors

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

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

OBJECTIVE: The objective is to develop innovative new interfaces and the processing architectures that facilitate the transfer of terabytes of data per second from the digitizers of the signal acquisition front end to the processing resources of the EW system.

DESCRIPTION: The current stovepipe processing segments of SIGINT sensors drive size, weight, power, and logistical costs in many Electronic Warfare (EW) architectures that are comprised of several Receiving/Processing equipment sets. The System Commands (SYSCOM) have identified a need to reduce size, weight, power (SWaP), and cost while improving overall system performance and reducing operator workload.

As analog to digital converters (A/D), firmware processing, and CPU capabilities improve, there is an opportunity to develop new robust modular architectures with the ability to transfer terabytes of data per second. One issue with realizing this capability is that data transport from the RF digitization function to the algorithm processing function is currently “just right sized” with respect to interface bandwidth and is generally implemented as a point to point interface. This topic focuses on developing interface and processing architectures that will facilitate the ability to transfer terabytes of data over extended ranges (greater than 200 feet). Developmental efforts will include backplanes and both inter-chassis and intra-chassis interfaces to support the transfer of high speed, real time data between acquisition components and processing elements. Data types and throughput requirements should be sufficient to support a full SIGINT suit under stressful operational conditions. These products must be able to handle sustained data throughputs in excess of 5 Million Pulses per second per channel and be capable of moving Pulse Descriptor Words (PDW’s), Digitized IF (I/Q) data, Burst Digital IF (BDIF) and Continuous Digital IF (CDIF) in electronically dense environments. The products must be modular (developed to adhere to open standards) and must be low cost and low power devices. Interfaces must allow for the data to be moved from the digitizer components to the processing components in point to point and point to multi-point modes of operation.

The Navy is seeking technical innovation for transport interfaces that support sustained transfer rates of terabytes per second, point to multi-point distribution of these vast amounts of data, and the architecture to support enough processing to use these large amounts of data.

PHASE I: Develop concepts for extremely high speed data transfer mechanisms from multiple sensors. Demonstrate the feasibility of the concepts in transferring terabytes of data per second over 100 feet. Demonstrate the feasibility of technology development to achieve the objective. Develop and evaluate breadboard concepts of key technology components. Prepare a Phase II development plan with performance goals and key developmental milestones and identify risks and risk mitigation efforts.

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

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are significant civilian / commercial applications that can utilize the ability to transfer terabytes of data per second. The gaming industry is one such industry that would benefit from being able to transfer and process tremendously large amounts of data. Another industry that would benefit from this effort is the Video industry.

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4. Introduction to Electronic Warfare Modeling and Simulation; David L. Adamy; SciTech Publishing (October 6, 2006); ISBN-10: 1891121626 /ISBN-13: 978-1891121623

5. Electronic Warfare in the Information Age; D. Curtis Schleher; Artech House Publishers (June 30, 1999); ISBN-10: 0890065268 / ISBN-13: 978-0890065266

6. EW 101: A First Course in Electronic Warfare; David L. Adamy; Artech House Publishers; 1 edition (February 2001); ISBN-10: 1580531695 / ISBN-13: 978-15805316967. EW 102: A Second Course in Electronic Warfare; Artech House Press, David L. Adamy, 2004

KEYWORDS: high speed data transfer; flexible open architectures; RF Digitizers; Optical interfaces; Electronic Warfare; point to multi point connections;

N121-071 TITLE: High Voltage Metal Insulator Metal (MIM) Capacitor Technology

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PEO IWS 2.0, Air and Missile Defense Radar (AMDR)

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 capacitance Metal Insulator Metal (MIM) capacitor that has high voltage breakdown and utilizes a high-k dielectric with low thermal activation energy for Gallium Nitride (GaN) Microwave Monolithic Integrated Circuits (MMICs).

DESCRIPTION: DOD systems under development such as active phased array radars and communication systems will utilize Gallium Nitride (GaN) Microwave Monolithic Integrated Circuits (MMICs). GaN MMIC thin-film processes currently in use were leveraged from Gallium Arsenide (GaAs) MMIC technology, which normally operates under 12 Volts, and utilizes Plasma Enhanced Chemical Vapor Deposition (PECVD) Silicon Nitride (SiN) as the dielectric for the MIM capacitor. The PECVD SiN dielectric has proven to be inadequate at greater than 12 Volt MMIC operation. To achieve a higher capacitor voltage breakdown, MMIC foundries have resorted to stacking multiple MIM capacitors in series, taking up sizable MMIC area, and increasing the MMIC cost.

This topic seeks innovative materials and processes leading to a replacement of the SiN dielectric with a high-k dielectric (e.g., Tantalum Pentoxide or Hafnium Oxide) with high voltage breakdown that reliably supports 50 Volt DC GaN MMIC operation. Currently, there are no high-k dielectric MIM MMIC capacitors at foundries. MIM capacitors that use the SiN dielectric have been yield drivers for GaAs and GaN MMICs and have driven up MMIC costs and adversely affect system reliability. The higher operating voltage of GaN will require capacitors with breakdown voltages greater than 200 volts for reliable operation. Of particular interest are technologies such as Atomic Layer Deposition (ALD) that can replace existing deposition processes (e.g., sputtered materials and PECVD) and can result in smaller capacitors with fewer defects. For example, ALD deposited thin film stack-ups of defect free high-k dielectrics could reduce capacitor size and increase the voltage breakdown.

PHASE I: The company will develop innovative research and development concepts that demonstrate the feasibility of the proposed approach to develop MIM high-k dielectric capacitors for GaN microwave power amplifiers. The company will demonstrate the feasibility of the proposed approach via analysis and/or fabrication of a MIM capacitor. Feasibility demonstrations will include material fabrication and testing and/or analytical modeling. Proposed concepts must demonstrate the potential to meet all requirements for MIM capacitors. The company will provide a Phase II development plan with performance goals, key technical milestones, and testing.

PHASE II: Based on the results of Phase I and consistent with the Phase II development plan, the company will develop MMIC MIM capacitors for evaluation. The company will evaluate the prototype MIM capacitors to determine their ability to meet the performance goals defined in Phase I. Capacitor performance will be demonstrated through prototype evaluation over the required range of parameters (e.g., voltage breakdown, temperature, capacitance per unit area, footprint, and so forth). Evaluation results will be used to refine the prototype material and the deposition process into an initial MMIC fabrication process that will be compatible with GaN MMIC fabrication. Testing of the new capacitor will include reliability testing. The company will also conduct a cost model of MIM capacitor fabrication. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: In Phase III the small business will transition the developed MIM material(s) and process(es) directly into the GaN MMIC foundries that fabricate MMICs for Navy radar systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: GaN power amplifier technology has significant commercial potential for the cell phone industry, WiMAX (Worldwide interoperability for Microwave Access), commercial radars and commercial communication systems.

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KEYWORDS: Atomic Layer Deposition (ALD); Metal Insulator Metal (MIM) Capacitor; Gallium Nitride (GaN); Microwave Monolithic Integrated Circuit (MMIC); Thin-Film Technology; High-k Dielectrics

N121-072 TITLE: Shipboard Cardboard Preprocessing for Navy Pulpers and Incinerators

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: PMS-312, Non-Propulsion Engineering Systems

OBJECTIVE: The objective is to develop a low cost, high reliability and safe capability to automatically, and with minimal manual intervention, break down cardboard boxes to approximately 20x40 inch size pieces or smaller and eliminate any plastic tape and labels affixed to the boxes in preparation for pulping or incineration on U.S. Navy ships.

DESCRIPTION: Shipboard operations accumulate large quantities of cardboard (3,000 lb/day average) on Aircraft Carriers and the amount of cardboard is increasing. Boxes must be quickly broken down by Sailors in preparation for pulping and incineration. The preparation is labor-intensive, rigorous, and a hazardous task because staples, bands and other fasteners in the cardboard and use of box cutters can cause frequent cuts and other injuries. The volume of cardboard to be disposed increases substantially during underway replenishment, in which the quick disposal of cardboard is required because of time limits on underway disposal. To add to the burden, operators must remove all plastic tape and labels from the cardboard before it is loaded into and processed by the Navy pulper to reduce the probability of machinery performance degradation.

Carriers typically spend 35 man-hours daily breaking down and removing labels/tape from corrugated cardboard boxes -- all by hand. Most tape and plastic labeling must be identified and removed from the cardboard prior to processing in the pulper, to reduce the risk of machinery performance degradation. Not only is this a tedious and time-consuming task for already overworked Sailors, but it often causes long lines and delays outside solid waste compartments, which unnecessarily ties up shipboard personnel, impedes other ship operations, and creates safety hazards.

Commercially available equipment assessed and evaluated to date through the Environmental Technology Identification and Assessment Program cannot reduce the labor requirements of cardboard pre-processing while also meeting shipboard requirements [see Reference 5]. While no technology currently exists for this maritime operational requirement, it is believed that there are analogous systems commercially available in disparate industries which might provide some insight. One such example is that of the hardwood log industry, in which knots, imperfections, and defects in wood are recognized using laser scanners and graphic user interfaces (GUI) [see Reference 4]. The recycling industry also utilizes optics to sort plastics, and additional machinery to remove and sort the labels.

The technical challenge is to reliably identify and remove the adhesive-backed plastic tape and labeling materials with a minimum of Sailor manpower using mechanical, chemical, or other means while maintaining or exceeding the current capabilities of pulpers aboard ships (single-wall, double-wall, and up to 65x43x36 inch triple- wall corrugated cardboard). Solid waste size reduction and cardboard processing with minimal sailor intervention (to facilitate processing by the pulper and incinerator) are published needs in the NAVSEA 05P5 Environmental Quality Needs Database. The Navy seeks a low cost, high reliability technology or technique that will facilitate this breakdown process while reducing the manual labor effort required by 50 percent or more. This technology must be compact enough to fit in existing solid waste equipment compartments, light-weight, user-friendly and safe to operate; it should not add to the ship’s maintenance burden. The Navy has been assessing commercially available solutions but the technologies do not exist to meet reliability, labor or cost requirements.

PHASE I: Develop a concept for cardboard pre-processing that meets the requirements described above for Navy pulpers and incinerators. Demonstrate the feasibility for cardboard pre-processing, technology development and shipboard use. Propose a system concept using new technologies capable of reducing manpower by 50 percent, with minimal size and weight, and is easy to safely use. Provide an estimate of the system size, cost, process rate, labor burden, required utilities, technology maturity at the end of Phase I, safety risk, and development risks. Create a plan, with key milestones, for Phase II development.

PHASE II: Based on the results of Phase I and the Phase II development plan, build a prototype for land-based evaluation. Develop an evaluation plan and evaluate the ability of the prototype to safely reduce manpower requirements and to be easy to use. Refine the concept based on land-based evaluation results with any modifications necessary to meet the required capabilities described in Phase I. Develop a refined estimate of the system size, cost, process rate, labor burden, required utilities, consumables, technology maturity, safety risk, and development risks.

PHASE III: If Phase II development is successful, the contractor is expected to support the Navy in transitioning the cardboard preprocessor to Navy use should a Phase III award be made. The contractor will support qualification and certification tests and other efforts required for shipboard installation. Operational and training manuals will also be required for operators. Tests could include shock, vibration, electromagnetic interference, and power system compliance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic will also be directly applicable to commercial shipping/packaging as well as cruise lines and shipping companies.

REFERENCES:
1. Large Pulper Technical Manual, S9593-C2-MMM-010

2. NSTM 593, S9086-T8-STM-010

3. http://www.fas.org/, The Federation of American Scientists Website provides multiple articles on cardboard processing and pulpers.

4. A Graphical Automated Detection System to Locate Hardwood Log Surface Defects Using High-Resolution Three-Dimensional Laser Scan Data, http://www.nrs.fs.fed.us/pubs/gtr/gtr-p-78papers/11thomasp78.pdf

5. NSWCCD-63-TM-2010/10, Technical Assessment of Shredder for Processing Cardboard and Comparison to the Navy Solid Waste Shredder and Navy Large and Small Pulpers, May 2010

KEYWORDS: Cardboard pre-processing; solid waste management; pollution prevention; cardboard shredding; cardboard cutting; cardboard sizing

N121-073 TITLE: Combined Nondestructive Evaluation (NDE) and Electrical Characterization of Missile Radomes

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PEO IWS 3.0, Standard Missile / SM-6 (ACAT I); FNC: STK-FY09-03

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 method of characterizing tactical missile radomes that will reveal manufacturing defects that may impair electrical and structural performance and that will provide localized information on dielectric properties which can be used to predict insertion loss and boresight error.

DESCRIPTION: Radomes are a key missile component. Their costs are in the many tens of thousands of dollars. Part of the costs are related to yields, which are a function of the current process used to determine the characterization of the radomes. This process consists of pairing the radome with the seeker in the factory to generate a correction table for seeker target location thus compensating for boresight error.

The Navy is seeking improvements in the process, particularly with respect to electrical characterization without use of actual seekers, through the application of new technology. If extensive electrical characterization could be minimized by use of new technology, the costs of integrating the radome with the seeker would be reduced. If the technology sought in this topic is successful, it would be used to improve manufacturing yield and reduce production costs of radomes in several missile programs. The technology could also reduce costs in the development of future radomes.

Defects in a radome have a significant impact on seeker performance; therefore, radome characterization is key. The current process of characterization in which the radome and seeker must be tested in the factory is costly. Development of the technology under this topic would advance the state of the art in NDE (Non Destructive Evaluation) of composite and ceramic radomes but more importantly would reduce, if not remove, the level of testing of the assembled seeker and radome in the factory.

Radomes on tactical missiles protect the antennas and electronics underneath. Radomes have strict requirements on transmission properties. Transmission through a radome is governed by the thickness, dielectric constant, and loss tangent of the wall material. Local variations of any of these parameters result in distortion of the transmitted signal, which leads to boresight error. Boresight error is the deviation in the apparent signal direction as seen by the seeker antenna when scanning through the field of regard.

The Navy is seeking innovation in technologies such as terhertz radiation that will permit scanning of radomes to generate a map of the local transmission properties of a radome. The instrument needs to be capable of imaging defects such as thickness variations, voids, inclusions, and localized variation in the proportion of constituents (such as fiber/matrix volume fraction in composites). It is envisioned that this instrument would be approximately the size of an office desk. Proposed concept should be capable of detecting defects having length scales of 500 micrometers, and preferably smaller. The current use of sonic techniques cannot give this resolution. The relationship between the instrument scanning wavelength and properties of the missile operating radar should be taken into account. This will involve theoretical physics or experimental measurements. Missile frequencies of interest range from 1 to 100 GHz.

The technique should be capable of characterizing polymer, polymer composite, ceramic, and ceramic composite materials. The output should include an image of the mapped defects including information regarding their character, a map of local transmission characteristics, and an estimated boresight error map.

PHASE I: Conduct analyses and develop concepts and instrument parameters for conducting experiments demonstrating characterization capability on coupons of radome materials. Conduct experiments using breadboard components demonstrating the capability to detect and image defects in coupons of radome materials. Develop understanding (empirical and theoretical) of relationship between proposed instrument measurements and dielectric properties at missile frequencies. Develop a concept to scale the process from coupons to full radomes. Develop a Phase II plan with milestones and testing to verify the feasibility of the technology as well as the concept to meet the Navy need.

PHASE II: Based on the Phase I results and consistent with the Phase II plan, develop a prototype instrument capable of measuring effective electrical thickness (measured at measurement instrument design frequencies and converted to the thickness at the frequency of interest, in X, Ka, or W bands) and mapping defects. Verify performance of the instrument on notional developmental radomes, or actual tactical units, depending on availability. Verify by experiment the correlation between prototype instrument frequencies and Gigahertz properties on radomes. Conduct an analysis showing the cost savings of using this new instrument versus the current process of radome characterization. Prepare a Phase III development plan to transition the technology to Navy and DoD prime contractor use.

PHASE III: There are two possible options to the Phase III. One option is to develop, test, and deliver a fully automated instrument to the Navy that in turn the Navy would provide as GFE to defense prime contractors or radome producers. The second and more likely option is to develop, test and deliver (i.e., sell) the aforementioned instrument directly to defense prime contractors or radome producers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Although the technology has been described as specific to radomes, the general NDE aspects and the electrical measurement aspects could find use in many commercial applications. The applications of composites are many, including automobiles for example. The NDE techniques could be used on many manufactured materials and components. The electrical measurements could find application in electronics components such as substrates and circuit boards.

REFERENCES:

1. Radome Engineering Handbook, J.D. Walton, Ed.; Marcel Dekker, Inc. 1970

2. Antenna Engineering Handbook, 4th ed. Pp. 53-1 - 56-25. McGraw Hill Publishing, 2007

3. Nature Photonics, Volume 3, pp 630-632 (2009)

KEYWORDS: nondestructive evaluation; terahertz radiation; radomes; dielectric constant; loss tangent; boresight error

N121-074 TITLE: <u>Fat Line Towed Array Straightening System</u>

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS401 ACAT IV Programs: TB-16 Fat Line Towed Array and TB-34 Next Generation

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OBJECTIVE: The objective is to develop a system that would keep the Fat Line (TB-16 series and TB-34) arrays straight and horizontal while towed at speeds as low as 1.5 knots to improve array effectiveness and reduce damage in shallow waters.

DESCRIPTION: Towed Fat Line arrays are being used in shallow water and with SSN/SSGN add-on systems like the Advanced SEAL Delivery System (ASDS) that require very slow (near hovering) towing speeds. Fat Line arrays are not effective at tow speeds below three (3) knots. At those tow speeds (and slower), the Fat Line array “droops” from front to back and also becomes less straight. These distorted spatial configurations (from both straight and horizontal) each reduce the array’s acoustic effectiveness. The Ship Safety/Self Protection that the Fat Line array would normally provide to the SSN/SSGN is greatly degraded. This degradation is especially exaggerated with the use of the newest Fat Line, the TB-34. This array has higher frequency capability which requires more precise knowledge of the individual sensor locations and renders it more susceptible to spatial distortions. Lastly, very slow speed towing can greatly contribute to the likelihood of damage by contact with the ocean bottom.

Low speed front to back droop must be less than 20 feet and off-axis distortions (straightness) must be less than 1 foot per 10 feet of length. Examples of methods could include but not be limited to a drag inducing drogue, aft pulling propulsion system, active buoyancy control, and array hose wall stiffness adjustment using rheological fluids. Consideration should include the ability to transfer the straightening system from array to array versus being embedded into the array itself.

There is significant innovation required to develop any of these concepts to the point where they become integrated with the Fat Line towed array and the submarine Fat Line stowage tube. The aft drogue or propulsion system must be stable at all speeds up to submarine flank, propulsion has to be powered by the host sonar through the array, and all concepts must fit within the SSN Fat Line Stowage Tube. In addition any active control needs to interface with the A-RCI host sonar suite and must use either legacy (to the array) sensors or provide proper sensors and data connection as part of the developed system. Concepts shall not impede high speed towing stability.

PHASE I: Develop concepts for straightening Fat Line arrays and for removing front to back droop under low speed towing conditions. Demonstrate the feasibility of the concepts to straighten Fat Line arrays and to remove droop within the requirements described above. Demonstrate the feasibility of developing the technology to meet the Navy need. Feasibility calculations, modeling, and modest demonstrations should be used to identify optimum concepts for consideration under Phase II. Develop a Phase II development plan with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, develop a prototype system to straighten Fat Line towed arrays and to remove droop. Evaluate the prototype in a controlled environment to assess the ability of the system to meet performance requirements described above and the performance goals identified in Phase I. Based on the prototype evaluation, determine the refinements needed to produce a final full-scale system. Develop a Phase III development plan to transition the technology into a system that can be acquired by the Navy.

PHASE III: If Phase II is successful, the small business will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. Based on the Phase II results, the contract will develop and incorporate the selected straightening system into an in-service array for shipboard testing and evaluation in the desired end-use environment. Continue technology development to support shipboard qualification tests and requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology innovations under this topic could have commercial application in seismic oil or gas exploration systems.

REFERENCES:
1. Paper on theoretical work for towed array control:
http://audiophile.tam.cornell.edu/randpdf/qdmathu1.pdf

2. TB-16 Fat Line Towed Array:
http://www.globalsecurity.org/military/systems/ship/systems/tb-16.htm

3. Towed array spatial factors:
http://www.globalsecurity.org/military/systems/ship/systems/towed-array.htm

KEYWORDS: Drag inducing drogue; aft pulling propulsion; active buoyancy control; rheological fluids; towed array droop; low speed towed arrays

N121-075 TITLE: <u>Submarine Unmanned Aerial System (UAS) Digital Radio for Ad-Hoc Networked Communications</u>

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: Combat Control System AN/BYG-1, PMS-425, 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 research innovative approaches to provide digital radio and ad-hoc networked communications between a submarine and a very small (~2.5 pound) unmanned aerial vehicle.

DESCRIPTION: Submarines currently do not have a fielded capability to obtain unmanned aerial system (UAS) data/video. The radio systems currently being used for UAS demonstration are limited in range to line of sight (LOS), are easily intercepted, and can only control one unmanned aerial vehicle (UAV) at a time.

The Navy is seeking innovative high data rate RF communications for existing very small unmanned aerial vehicles (UAVs) to allow video and data to be collected and transmitted from over the horizon (OTH). This will provide submarines the capability to receive OTH data from multiple UAVs without compromising their position . The video and command and control (C2) channels are digital and can support the operation of encryption for data/video to prevent easy access by hostiles in the collection zone.

Ultimately, this radio system would possess the following characteristics: 1) The equipment on board the submarine will be capable of controlling multiple types of UAVs. 2) The UAV equipment would be able to relay C2, video and data through other UAVs enabling the submarine to utilize an UAV that is not within its RF line of sight 3) The equipment on board the UAV will have a small form factor and weight so it does not affect the flight performance of the UAV.

PHASE I: The company will develop concepts for an ad-hoc networked digital communications system for small UAVs meeting the requirements described above. The company will demonstrate the feasibility of developing the concepts into a useful product meeting Navy needs. Approaches should consider the use of existing systems, new technologies, modeling and simulation in the assessment. The company will provide a Phase II development plan with performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype. The prototype will be evaluated to determine its ability to provid submarines with digital radio and ad-hoc networked communications links to a very small deployable UAV as identified in Phase I. The company will demonstrate a full bench deployment of each prototype to evaluate system performance. Final design work, development of the materials and methods for production, and demonstration of a proof-of-concept prototype are to be completed. The company will provide a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will support transition of the technology into Navy use. The company will provide three sets of equipment that can be incorporated into UAVs and submarines for at-sea deployment and demonstration. A set is defined as equipment for one submarine and five UAVs. The company will support test and validation to certify the system for the Navy including environmental qualification.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Has applicability to emergency disaster responder where traditionally heavy radio usage would hinder communications. A network of UAVs would cover a large disaster area providing timely information without endangering the ground control station or human flight crews.

REFERENCES:

1. Basso, B., Love, J., & Hedrick, J. K. (2011, April). Airborne, Autonomous & Collaborative. Mechanical Engineering. Retrieved from memagazine.asme.org

2. Elston, J., Frew, E. & Argrow, B (2006, 22 August). Networked UAV Command, Control and Communication. Presentation retrieved from http://recuv.colorado.edu/netuas/data/publications/2006-%5Belston%5D-networked_uav_c3_presentaiton.pdf

KEYWORDS: Digital; Radio; Network; Ad-hoc; UAV; Communications

N121-076 TITLE: Adding Communications Mode Capability in the Periscope Detection Radar (PDR)

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PEO IWS 5E, Aircraft Carrier Tactical Support Center (CV-TSC), ACAT III

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

OBJECTIVE: The objective is to develop a robust Anti-Submarine Warfare (ASW) communications mode in Periscope Detection Radar (PDR).

DESCRIPTION: Current PDR systems do not support a dual mode ASW search and communications capability. Because of the PDR's high gain and high bandwidth, it appears that communications to nearby ASW platforms can be added to the PDR. A review of current technology shows that microwave and radar towers are used to relay data and communications over short distances. This is a single mode versus the dual mode the Navy desires. The cost per tower for land based systems is high in comparison to other available transmission paths; however, there are not many radar communication systems because they are cost prohibitive in relation to other communication methods. Since the radar system already exists (i.e., AN/SPS-74, a PDR) it is possible to add this capability for just the cost of software without adding additional hardware. Innovation to add additional capabilities to existing hardware installed on naval vessels will help fill an ASW command and control need within the fleet, especially during hostile actions where US Forces do not have assured satellite access.

The Navy seeks innovative approaches to providing both communication and sensing modes while maintaining the sensing capability accuracy, probability of detection, and false alarm rate, but greatly increasing the functionality of the current system and the utility of its allocated bandwidth. Proposed solutions should support significantly lower costs and weights for shipborne ASW installations. The capability will include a communications mode using existing system components, although a nonrotating antenna which increases communications availability while maintaining or lowering cost is also acceptable. These systems will serve to both ensure timely distribution of the ASW Common Tactical Picture (CTP) to all surface combatants with higher bandwidth and lower latency than currently available, even in a satellite denied area. They will also support ubiquitous deployment of high performance ASW radars to all combatant ships.

Solutions that are compatible with the utilization of the allocated band spectrum of the PDR radar and support the existing bandwidth of that radar are preferred. Proposed approaches should scale to highly directional antennas to support robust communications, mitigate interference, and deliver required sensor resolutions. The research should focus on the unique requirements of adding a communications mode to an existing system with large antenna gain and high fractional bandwidth in order to deliver effective new military capabilities, new components, or even a new system. Some of the technical issues to be explored are signaling schemes, resource sharing concepts (time, frequency, and scan allocation), directional reception issues, platform-to-platform placement/visibility, nonrecurring engineering risk/impact, and impact on sensor operation.

PHASE I: The research shall develop detailed system concepts for the technology approach, including the radar and communications modes and the beamformer/control architecture that can meet the requirements of the high gain, high bandwidth system sought. A demonstration of the feasibility of the concepts and associated technology will be provided by developing rough order of magnitude cost estimates and technology roadmaps. A Phase II development plan with performance goals and key technical milestones will be provided.

PHASE II: Based on the results of Phase I, a communications mode that can communicate between two nodes at a minimum of 1 Mbps at 10 nmi with the existing PDR technology that can be scaled to full antenna and radar capability will be developed, fabricated, and evaluated. Discrete components may be utilized for array elements prior to development of any integrated components required for full scale prototype. The company will evaluate the prototype to verify that it meets the Navy's requirements without degrading the PDR capabilities of the existing radar. System performance will be demonstrated through the evaluation and modeling of the prototype. The results will be used to refine the prototype into an advanced development model to verify that the system meets the Navy's requirements. The company will prepare a Phase III development plan for the company to transition their technology into fielded Navy systems including life cycle cost estimates.

PHASE III: Should a Phase III contract be awarded after a successful prototype evaluation in Phase II, the company will complete the development of a full scale system and provide an advanced development model for test and evaluation. The company will support the Navy in test and validation to certify and qualify the system for Navy use and support the production and installation of their technology into fielded Navy Systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Dual use radars can support civil government applications including mobile communications for disaster response, maritime and border security, and weather and air control radars.

REFERENCES:
(1) Bookner, E. (2010) "Never Ending Saga of Phased Array Breakthroughs", 2010 IEE International Symposium on Phased Array Systems & Technology, 10/12/2010

(2) Ousborne, J, Griffith, D., Yuan, R. (1997) "A Periscope Detection Radar", Johns Hopkins APL Technical Digest, Volume 18, Number 1, 1997

(3) The AN/SPS-74 Periscope Detection Radar System, by Ian Barford, Mark Tadder, and Christopher Gorby, NAVSEA Leading Edge, Sensors Development, 2003

KEYWORDS: Communication; command and control; Radars; ASW Sensors; periscope detection; netted ASW

N121-077 TITLE: Modular Superconducting Cable Assembly

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: PMS 501, LCS Program, ACAT 1

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

OBJECTIVE: Develop a modular, superconducting cable assembly that will allow for affordable, quick and reliable installation in naval shipboard applications.

DESCRIPTION: The Navy is developing several superconducting systems for use in future ships and submarines to reduce system weight, energy usage, and installed volume. These systems, such as degaussing and power distribution systems, rely on superconducting wires housed in a flexible cryostat to pass current and power from one source to another. The superconducting cable is the combination of the superconducting wire and the thermal insulation system (cryostat) necessary to keep it at cryogenic temperatures. The current state of the art in superconducting cable consists of an inner corrugated tube which contains both the superconducting tapes (conductor) and a cryogen (helium gas) for cooling for operation in the 40 to 80 K range at a working pressure up to 150 psig. This inner tube is encased in multi-layer insulation (MLI) radiation shielding as well as being supported with a thin twisted polymer to reduce contact with an outer corrugated tube. The outer corrugated tube contains a vacuum space maintained at 10-6 Torr, encapsulates the inner corrugated tube and has a thermal heat load of ~1 W/m. These cable assemblies are made in the factory at precise predetermined lengths, which can be a problem during shipyard installation if the cables need to be rerouted because the length is fixed and cannot be modified during installation. Should a problem arise, the cables would need to be uninstalled and the correct length made and re-installed at a later date. The current state of the art, fixed length cables, meets the requirements for system operation in terms of vacuum levels, helium containment, and a reasonable installation time (it takes approximately 20 man hours to install a 60 m cable length). Fixed lengths, however, create installation problems and cryostats cost more than $400/m, which are drawbacks and impediments to shipboard implementation.

The Navy seeks innovative approaches to the development of an improved, affordable, modular, superconducting cable assembly. Innovation needs to address numerous technical challenges, which include, but are not limited to installation in a high-humidity, unclean shipyard environment; 30 year service life without maintenance; obtaining and maintaining ultra-high vacuum levels of 10-6 Torr without active vacuum pumping; containment of pressurized cryogenic helium gas without leaks; thermal heat loads of less than 110W for a 100 meter cable including joints and terminations; weight requirement of less than 600 lbs for a 100 meter cable including joints and terminations; bend radius of less than 6 inches; and material cost(s) under $400/m. Given the nature of the application, concepts should consider the impact of a rugged shipboard environment.

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

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

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A modular design may be of use in land-based High Temperature Superconducting (HTS) power cables and power delivery applications. Although land-based HTS power cables currently are small-scale R&D projects, as this technology matures it will transition into the commercial power delivery sector. A modular cryostat capability would be attractive commercially as it would allow a HTS-based power delivery solution to be modified in place when needed (e.g., routing around objects, expansion of line, allowance for construction), rather than requiring a replacement of the entire HTS cable.

REFERENCES:

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

2. American Superconductor, "High Temperature Superconductor Degaussing Coil System," www.amsc.com, 2010.

3. Victaulic Company, "IPS Carbon Steel Pipe – Pressfit System: Design Data Pressfit® Qualification Tests," www.victaulic.com, 1996.

KEYWORDS: cryogenics; superconductor; cryostat; degaussing; HTS; High Temperature Superconducting

N121-078 TITLE: <u>Enhanced Summarizations of Streaming Text</u>

TECHNOLOGY AREAS: Information Systems

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OBJECTIVE: To develop methods and tools that produce real-time topic-focused summaries of streaming text data sources.

DESCRIPTION: Researchers and analysts often have to extract meaningful information from large collections of unstructured text. They do not have the time to spend reading irrelevant documents that are not pertinent to their topic. Thus, algorithms and tools that will automatically summarize the documents with little or no loss of information are highly desirable. We seek innovative theoretical, methodological, and technical approaches for real-time summarization of text, where the summaries are relevant to a specific topic.

Text-based data sources that arrive in a streaming manner or have a time stamp associated with them include, but are not limited to news casts, tweets, chats, and blogs. These types of data sources are often noisy, short, bursty, and use non-standard language, which makes the problem more challenging. The ability to exploit and to account for the time attribute associated with the document summaries will speed up and enhance the analytic process.

Conventional summarization can be thought of as generic or topic-focused, where the later generates summaries that are related to a given topic. Recent research efforts in academia are addressing the problem of updating summaries at each time step that take the current summary into account. For example, content from prior documents that has already been read by users should not be included in the summary.

The goal of this effort is to research and develop novel techniques and tools that will update topic-focused summaries of noisy individual texts from a large streaming corpus. Of additional interest is to expand these approaches to provide the ability to extract and update topic-focused summarizations of related corpora, track and connect the important content in the documents, and provide some measure of associated uncertainty. The approaches and methodologies developed under this effort should be able to work with existing text analytic and natural language processing techniques and tools.

PHASE I: Research and develop new methods and approaches for real-time summarization of text, where the summaries and documents are relevant to a specific topic.

PHASE II: Implement promising methods in a prototype software tool and demonstrate that it meets performance needs, such as real-time processing, production of cogent summaries, and the ability to work with streaming data (e.g., broadcast media). Consideration should be given to customizing the system for domain and user preferences.

PHASE III: Productize the system to cover multiple domains and very large corpora.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A system capable of assisting users to ingest and understand large amounts of information would be very useful to researchers and analysts in the legal, journalism, medical, business, and economic domains.

REFERENCES:
1. Li, X., et al., "Graph-based marginal ranking for update summarization," SIAM Conference on Data Mining (SDM 2011), pp. 486-497

2. http://www-nlpir.nist.gov/projects/duc/duc2007/tasks.html

3. Wan, X., "TimedTextRank: Adding the temporal dimension to multi-document summarization," Proceedings of SIGIR 07, pp. 867-868

4. Lin, C. and E. Hovy, "The automated acquisition of topic signatures for text summarization," COLING 2000, Proceedings of the 18th Conference on Computational Linguistics

5. R. M. Aliguliyev, "Clustering techniques and discrete particle swarm optimization algorithm for multi-document summarization," Computational Intelligence, 2010

KEYWORDS: Paraphrase generation; text analytics; text summarization; natural language processing; text mining; data mining

N121-079 TITLE: <u>Design an Expert System to Automate Cool-down of Superconducting Electronics</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ONR Silk Thread FNC FY13 start

OBJECTIVE: Determine a set of environmental criteria and design an expert system programmed to automatically decrease the temperature of a digital superconducting circuit through the transition temperature of the electrode material so that there is no flux trapping and produce a method of self-testing the circuit performance. The goal is to avoid the requirement of a highly trained operator to use such circuits in a naval radio frequency (RF) transceiver context.

DESCRIPTION: Superconducting electronics have the potential to enable development of superior performance, acquisition and logistics cost saving, ultra wide band, all purpose RF systems. First packaged prototypes have demonstrated technology readiness level (TRL) 5 capabilities in DoD labs when started and left running for months. However, to be interesting for fielded applications, they need to be operated with little to no human interaction. While NASA has remotely operated passive systems based on the same cryo-coolers for some years, little is known regarding the details of the thermal cool-down influence resultant RF system performance. There is also no standardized method of confirming such a system is operating properly. Thus the objective of this effort would be to establish a quantitative test for the occurrence of flux trapping and experimentally determine the relationship between such an occurrence and the system's thermal history.

Current State-of-the-Art: The existing cooler device is turned on and after the circuit reaches 4 Kelvin an expert tests whether the one-of-a-kind system is behaving as expected. If not, the temperature is recycled to above 10 Kelvin and back down. Currently, there is no diagnostic that can be run warmer than 4 Kelvin to determine whether a given die will need 1 or 5 thermal cycles to operate properly, nor is there any automated or standardized test for how well it is operating.

PHASE I: Develop and demonstrate the technical concept for how the ambient magnetic field will be measured, how the temperature of the circuit will be monitored and controlled, and how the circuit performance will be measured. Methods involving conduction cooling rather than immersion or convection cooling are more appropriate for the expected scale of deployed naval systems.

PHASE II: Demonstrate an integrated cryopackaging system that includes the techniques developed in Phase I and uses a closed cycle cooler to handle at least one working analog-to-digital convertor (ADC) die (to be supplied as government furnished equipment). Document the success of the self-test module and generalize the requirements regarding the magnetic environment when the transition temperature is crossed. Assess additional issues expected for dramatically larger multi-chip modules and how to combine with both active B field cancellation and the desire to change circuit modules while the rest of the system stays cold.

PHASE III: Future naval capability programs at ONR are expected to contain field demonstrations of superconducting RF hardware. It is very desirable that these demonstrations be performed with remotely operated hardware.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Superconductive electronics has the potential to dramatically improve RF sensitivity and linearity and to produce higher energy efficiency, high throughput computing, of both conventional logic and quantum styles. The RF applications are particularly relevant to multi-user telecom ground stations. The computing applications require circuits more than a 1000 fold more complex than today's die to be fabricated and deployed. Without the ability to remotely operate both kinds of systems, the commercial applications will be very limited.

REFERENCES:
1. Y. Polyakov , S. Narayana and V. K. Semenov "Flux trapping in superconducting circuits", IEEE Trans. Appl. Supercond., Vol 19, pp. 640-643 (2009).

2. Supradeep Narayana and V.K. Semenov," Comparison of flux trapping in power independent and RSFQ D flip-flops", 15th US workshop in Superconducting devices and circuits (2007).

3. Bermon, S., Gheewala, T. "Moat Guarded Josephson SQUIDS", IEEE Transactions on Magnetics, Vol. 19 Issue 3, pp. 1160 – 1164 (May 1983).

KEYWORDS: flux trapping; thermodynamic processes; low magnetic fields; thermal and magnetic fluctuations; expert systems; circuit self-test

N121-080 TITLE: <u>Authorship Analysis for Cognitive Information Operations</u>

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PEO C4I & Space and OA Enterprise Services EC Product

OBJECTIVE: Use authorship analysis to obtain signatures of individuals and groups to gain an understanding of their thoughts and perceptions, thus providing methods for optimizing feature selection to profile authors across online media forms and languages.

DESCRIPTION: Authorship analysis includes author identification, characterization and similarity detection. It relies on lexical, syntactic, structural and content-specific features. Progress has been made over many years in identifying relevant writing features [ref. 1]. Examples of writing features include: 1) lexical word or sentence length, 2) syntactic frequency of words, 3) structural paragraph length, and 4) content-based on key words. The features that are relevant for signature detection vary based on document forms and language. Additionally, accuracy of authorship classification varies greatly based on author writing samples and number of authors; however, accuracy as high as 70 to 90% has been seen.

The global nature of terrorism necessitates tracking individual online communication across media forms (e.g., email, chat, blogs, newsgroups) and languages. The anonymous nature of online message distribution has made identity tracing important and the size of the Internet a much more challenging problem. Most author identification research has been done on the English language. A few studies have been done on Chinese [ref. 1] and Arabic [ref. 2]. The most popular language on the Internet is English at 35.8%, followed by Chinese at 14.1% [ref. 1]. Authorship analysis needs to be advanced across languages thus gaining insight into cognitive information. Methods of authorship analysis rely on statistical analysis and machine learning [ref. 3]. Recent work indicates potential for cognitive insight into author in-group and out-group alignment [ref. 4]. The specific topic technical challenges include: 1) identification of features that are useful to establishment of authorship, 2) development of clustering algorithms that can separate authors based on authorship features, and 3) development of a tool that can run against document streams. The Navy is interested in innovative research and development solutions that include technical and scientific merit and involve technical risk.

PHASE I: Develop methods to determine document author signatures from features derived from text. Identify a group of the most promising features as well as key technical risks and track risk-mitigation through the measurement of key technical parameters. Explore how selected features can be generalized across languages. Conduct a proof-of-concept demonstration. Results from the model development and tests are to be documented in a technical report and presented at a selected conference.

PHASE II: Produce a prototype system that is capable of ingesting more than two data type sources. The prototype system will be able to automatically process and group documents by author or group. The model(s) and techniques are to include analysis of data available besides text content such as selection of formats, styles, hyperlinks and image types. A proof-of-concept should be shown with relevant document corpus with a 90% goal for detection accuracy and missed declarations of no greater than 10%.

PHASE III: Produce a system capable of deployment and operational evaluation. Package the developed application as an Ozone Widget ready for incorporation into the Distributed Common Ground Station program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are many commercial applications including law enforcement, business activity monitoring, and security monitoring. Presently, there is a strong need to protect military and civilian personnel from gangs and terror cells. Developed systems should operate in a net-centric environment and provide reliable performance. Commercial value and cost savings is enhanced by operation in a distributed service oriented architecture with other applications.

REFERENCES:
1. Rong Zheng, and Jiexun Li, Hsinchun Chen and Zan Huang, “A Framework for Authorship Identification of Online Messages: Writing-Style Features and Classification Techniques”, Journal of the American Society for Information Science and Technology, 57 (3): 378-393, 2006.

2. Ahmed Abbasi and Hsinchun Chen, “Applying Authorship Analysis to Extremist-Group Web Forum Messages”, Homeland Security IEEE Computer Society 1541-1672/05, Sept/Oct 2005, www.computer.org/Intelligent.

3. Efstathlos Stamatatoes, “A Survey of Modern Author Attribution Methods”, Journal of the American Society for Information Science and Technology, 60 (3): 538-556, 2009.

4. Marion Ceruti, Scott McGirr, and Joan Kaina, “Interaction of Language, Culture and Cognition in Group Dynamics for Understanding the Adversary”, NSSDF, Las Vegas, July 2010.

KEYWORDS: Authorship Analysis; Document Signatures; Cognitive Science; Writing Styles; Natural Language Processing; Lexicalization

N121-081 TITLE: Lightweight IED Blast and Momentum Bypass/Mitigation

TECHNOLOGY AREAS: Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: Marine Corps Systems Command, PEO Land 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 active technologies to mitigate combat and tactical vehicle underbody Improvised Explosive Devices (IED)/mine blast damage through unique shaping/wave propagation deflection and momentum mitigation techniques.

DESCRIPTION: IEDs and roadside bombs are currently one of the greatest threats to warfighters, who are most often targeted while driving in combat and tactical vehicles. These vehicles must be functional, in that they must be able to carry personnel and gear, while also not being encumbered with a great deal of additional heavy or bulky features. Today's vehicles are currently reaching saturation in terms of the vast array of new equipment and armor being mounted on them. Nonetheless, a solution is sought to mitigate the shock and acceleration/momentum forces experienced when high-pressure gas and associated momentum from soil ejecta media from an explosion forces a vehicle upward. These forces cause a large number of head, neck, lower leg, and spinal injuries, and are separate from the injuries suffered from shrapnel and debris penetrating the undercarriage and sides of the vehicle. A lightweight approach is sought to relieve or vent the high-pressure gas, preferably by redirecting it past the vehicle and mitigate the acceleration/momentum imparted to the vehicle. It should also be possible to apply the approach several times before needing to re-arm/replace it. With respect to retro-fitting and upkeep, the approach should be conscious of cost, weight, materials, time, and maintaining the vehicle's functionality.

State-of-the-Art: There are a number of techniques currently being applied to counter IEDs, including: armor to protect against penetration; angled undercarriages to deflect shock waves; and vent concepts to help dissipate high-pressure gases. The focus of this topic is to identify an alternative or complementary technology to vent the gases past the vehicle to eliminate or mitigate the volume penalty in the engine/passenger/cargo portions of the vehicle and mitigate acceleration/momentum transfer to the vehicle and its occupants.

PHASE I: Perform the basic research to demonstrate the technologies to mitigate shock and acceleration/momentum forces and conduct modeling and simulation to demonstrate a concept approach to the reduction in shock and acceleration/momentum forces exerted on a simulated underbody.

PHASE II: Investigate and determine realistic size, weight, power, volume, and cost for the concept technologies of Phase I. Conduct a preliminary and detailed design of the concept demonstrated in Phase I and fabricate a generic sub-scale underbody to demonstrate reduction in shock and acceleration/momentum forces. Characterize event duration, system performance and any electromagnetic signatures generated by the concept system geometries to assess any undesirable frequencies that may interfere with on-board electronic systems.

Though Phase II work may become Classified, the Proposal for Phase II work will be UNCLASSIFIED.

PHASE III: Further develop and demonstrate the concept through tests on surrogate systems, progressing to full-size mock-ups, and ultimately culminating in full test and evaluation efforts on actual systems, including the integration of the system, along with any required electromagnetic-shielding and insulation technologies, that have already been developed for various platforms. Develop a plan to provide any necessary shielding/insulation approaches to prevent direct coupling/arcing to sensitive systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There exists potential use in the civilian sector by police special forces for the purpose of approaching and breaching fortified bunkers that potentially contain explosives.

REFERENCES:
1. K. Kremeyer, S. Nazarenko, A. Newell, Shock Bowing and Vorticity Dynamics During Propagation into Different Transverse Density Profiles, Physica D, Vol. 163, Issue 3-4, pages 150-165, 2002.

2. K. Kremeyer, K. Sebastian, C.W. Shu, Computational Study of Shock Mitigation and Drag Reduction by Pulsed Energy Lines, AIAA Journal, Vol. 44, No. 8, August 2006

3. Avasarala, Srikanti Rupa, Blast Overpressure Relief Using Air Vacated Buffer Medium, MS Thesis, MIT, June 2009.

KEYWORDS: underbody blast; vehicle underbody acceleration mitigation; IED; Improvised Explosive Device; mine blast

N121-082 TITLE: A Cognitive Architecture for Naval Mine Countermeasures (MCM)

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: Mine warfare Environmental Decision Aid Library (MEDAL), PMS-495, PEO-LCS

OBJECTIVE: Develop a cognitive architecture for naval MCM planning and re-planning that will significantly reduce the time required to re-plan and produce plans with a measurable decrease in risk to the warfighter via better management of uncertainty.

DESCRIPTION: MCM missions involve both objective and subjective decisions by military commanders that balance risk versus time and are based on many factors all with non-trivial uncertainty. A staff then translates this commander's intent into actionable orders using a combination of judgment and automated algorithms. This process is manpower intensive, poorly quantifies/articulates uncertainty, and is not well-suited to real-time re-planning. Cognitive architectures are designed to address these deficiencies in general yet have never been investigated for MCM. The aspects of MCM to be investigated include mission planning for highly dynamic and uncertain environments and constraints, real-time reasoning on both mission progress and how/when to re-plan, and fluidly interfacing with human operators to enable better decisions as well as instill trust in the underlying algorithms and computer-generated solutions. The overall goals of this effort are to: reduce mission re-planning time; better articulate uncertainty, context, and constraints to human operators; and, provide a transparent interpretation between (mission-level) commander's intent and (unit-level) actionable orders. A successful development will have two paths for transition; the first is to transition directly to the fleet's tactical decision aid used for MCM planning and evaluation, the Mine Warfare and Environmental Decision Aids Library (MEDAL). The second path is to transition to MEDAL via an FY13-start ONR Enabling Capability program that will modernize and expand the functionality of these tactical decision aids and their underlying algorithms.

State-of-the-Art: The maturity, effectiveness, and employment of cognitive architectures have been expanding significantly in recent years. Their benefits over alternative approaches include representations that are more easily/naturally understood by humans and the ability to reason/operate on complex problems with uncertain and incomplete information. However, cognitive architectures have yet to be applied to MCM even though their benefits are well matched to MCM's current deficiencies. References are provided for general information; however, there is no preferred or prescribed architectural solution associated with this solicitation.

PHASE I: Investigate the processes for MCM planning, evaluation, and re-planning; identify the most appropriate, highest payoff areas; and develop an initial high-level architecture design.

The option period will initiate a detailed architecture design and begin modeling key elements. The government will provide relevant MCM information to Phase I recipients (after award) and relevant MCM databases to those awarded the option--detailed knowledge of MCM is not required prior to Phase I award and need not be demonstrated in the proposal. All work in this phase will be UNCLASSIFIED.

PHASE II: Develop a prototype cognitive architecture to be fully functional with government-provided databases, simulation capabilities, and interface descriptions. Initial development will be standalone with a goal of integration into the program of record.

The option period will be used to expand the scope of the MCM problem addressed by the architecture and to integrate into the program of record. Work in this phase may be done at the UNCLASSIFIED level; however, the ability to handle SECRET databases would add significant flexibility.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability is applicable to undersea survey (e.g., petrochemical, geological, etc.) as well as non-maritime search and survey. It is also applicable to the general problem of supervision of multiple robotic or unmanned systems.

REFERENCES:
[1] Langley, P., Laird, J. E., & Rogers, S. (2009). Cognitive architectures: Research issues and challenges. Cognitive Systems Research, 10, 141-160.

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[3] Pearson, D. J., Laird, J. E. (2005). Incremental Learning of Procedural Planning Knowledge in Challenging Environments, Computational Intelligence, 21:4, 414-439.

KEYWORDS: cognitive architecture; human-system interface; mine countermeasures; mission planning; re-planning; uncertainty

N121-083 TITLE: <u>Novel Fluorine-Containing Solid Rocket Motor (SRM) Propellant Component</u>

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-259; PMA-242

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

OBJECTIVE: Identify and develop synthesis routes for a new fluorine-containing propellant component for SRM propellants which will lead to increased impulse density, long service life (> 20 years), increased specific impulse (Isp) relative to state-of-the-art (SOTA) SRM propellants, and support a 1.3 hazard classification and insensitive munitions compliance.

DESCRIPTION: A typical SOTA propellant is aluminized hydroxyl-terminated polybutadiene (HTPB) and ammonium perchlorate (AP) with Isp = 264 sec and density = 1.8 g/cc. The DoD requires a measurable increase over these values and requires increased performance, density, and Isp as well as long service life solid propellants for use on tactical, strategic, and boost missile systems. A challenging requirement is to achieve these goals while maintaining suitable mechanical properties throughout a long service life. Currently available ingredients do not provide all of the objective characteristics.

The addition of fluorine into solid propellant systems may occur through an oxidizer, plasticizer, or binder. Propellant property gains from these ingredients include increased density and/or increased energy, but generally maintain a hazard classification demonstrating sensitivity. The increased density of fluorine-containing compounds is well known. Isp increases seen when fluorine is added to the combustion environment are partly attributed to the increase in the metal oxide removal rate from metal particles that are present, as well as an increase in the overall energy release. However, it has been seen that the Isp increases are accompanied by propellant sensitivity without extinguishing. New fluorine-containing propellant components may be a direct route to a solid propellant formulation.

PHASE I: Design research strategies and experimental approach to synthesize and characterize key physical properties. Utilize semi-empirical methods to calculate the heat of formation, heat of combustion, and heat of reaction with aluminum powder for potential synthetic candidates. Utilize gained relative information to determine synthetic goals. Prepare, at a minimum, 2 gram quantities of the new fluorine-containing propellant component at the laboratory scale, to verify, at a minimum, ingredient structure, thermal stability, and hazard sensitivities. Potential hazards associated with the compound synthesis and its use will be submitted. Hazard analysis will include friction, impact and electrostatic discharge (ESD) analysis to identify potential risks to personnel or facilities throughout synthesis procedures, transport, and storage.

PHASE II: Develop and refine a laboratory scale-up synthesis procedure to produce at least 100 grams of the new compound, at a minimum of 97% purity with a goal of > 99% purity, for verification of the Phase I chemical and physical properties and for further evaluation in a solid propellant formulation. New compounds will be shipped to an ONR designated laboratory for evaluation and characterization in a candidate solid propellant formulation.

PHASE III: Design a research strategy to allow for multi-pound production of the new ingredient so that it can be formulated into propellants tailored for specific boost, tactical or strategic missile system applications. Deliver a scale-up process and development package with demonstrated production reproducibility and properties for selected new fluorinated materials.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Due to the nature of these materials in their formulation and final form, commercial application will be limited. Commercial space launch would be a potential customer.

REFERENCES:
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2. Kuo, K., Young, G., “Characterization of Combustion Behavior of Newly Formulated NF2-Based Solid Propellants,” Proc. of the Combustion Institute, Vol 29, 2002, pp. 2947-2954.

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KEYWORDS: Fluorine, Solid Propellant; High Energy Density Ingredients; Energetic Materials; Plasticizer; Binder; Oxidizer

N121-084 TITLE: Processing of Large Wide Area Airborne Sensor (WAAS) Data Streams in Hardware

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors

ACQUISITION PROGRAM: Persistent and Surgical Persistent Surveillance (FY12 new start)

OBJECTIVE: Develop and demonstrate a set of exploitation algorithms that can operate in real-time power-efficient hardware against gigabit-per-second data streams with performance equivalent to existing server-based applications.

DESCRIPTION: Day/night WAAS payloads for tactical unmanned aircraft system (UAS) platforms in development can generate gigabytes to terabytes of data-per-hour. Operational requirements exist for these payloads to generate and disseminate actionable intelligence from the platform. When matured, this capability can be integrated into any of the current WAAS programs including the ONR developed Wide Focal Plane Array Camera (WFPAC) sensor that will begin an operational deployment in fiscal year 2012. On-board processing tasks to be considered by this topic include the detection of watchbox and tripwire violations, cued tracking of movers responsible for the generation of an alert, and, if possible, full-scene tracking of movers.

Trackers and software to detect specific alert conditions have been developed and demonstrated to keep up with 7 gigabit-per-second WAAS data streams and are rapidly maturing. These wide area trackers run in software on power-intensive high-end servers which are not suitable for tactical on-board processing environments. Innovation is needed in order to enable trackers and behavior recognition algorithms that currently run in software on large distributed servers to run in real-time in firmware. Proposers should consider leveraging state-of-the-art field programmable gate arrays (FPGAs) that have the ability to handle gigabytes-per-second streams and state-of-the-art multi-core digital signal processors (DSP) that have the processing power of much larger servers. This hardware environment should be exploited in order to meet the transition program requirement for a processing board that weighs only a few pounds and consumes less than 50 watts. Successful proposers will also consider how to incorporate the filters ground track processors use to prevent spurious detections from being included in a track or declared an alert condition. These spurious detections often result from dead pixels or from in-scene contrast variations. Matured on-board exploitation will achieve 90% true alert detections (e.g. trip wire violation) with only 10% false alerts and will fuse tracklets as needed to produce tracks consisting of at least 80% of the ground truth track. Challenges of this topic include: 1) processing very large data streams in real-time, 2) hosting trackers and behavior recognition algorithms in firmware, 3) meeting size, weight and power goals, and 4) achieving acceptable tracking/alerting performance.

PHASE I: Develop and mature a technical approach towards on-board processing of data from very large focal plane arrays in power and weight restricted hardware. Identify key technical risks, develop risk mitigation and track progress on key technical parameters. Select or develop exploitation software and model its performance in flight-suitable hardware (FPGAs/DSPs) simulators paying careful attention to performance.

PHASE II: Port promising exploitation software to hardware and demonstrate acceptable performance. The prototype should meet size and power requirements while achieving high accuracy alerts and tracks with a high completeness.

PHASE III: Transition the developed product to a specific tactical wide area sensor program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial market for this technology includes border security and law enforcement. The detection of persons moving across a border is only actionable if detected in real time. Bandwidth availability generally prevents gigabyte-per-second data links from being operated over long distances.

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2. Representative Specification for an Advanced Digital Signal Processor, http://focus.ti.com/paramsearch/docs/parametricsearch.tsp?family=dsp&familyId=132§ionId=2&tabId=57.

3. Aviation Week; 2/4/11; "Shadow Punches Above its Weight" (background on the WFPAC program)

4. Relevant platform specifications for the Shadow UAS, http://www.aaicorp.com/products/uas/shadow_family.html.

KEYWORDS: On-board processing; video exploitation; wide area sensors; exploitation; firmware; digital signal processors; field gate programmable arrays

N121-085 TITLE: Head Worn Display (HWD) Augmented Reality for Military Training Applications

TECHNOLOGY AREAS: Information Systems, Electronics, Human Systems

ACQUISITION PROGRAM: N2IT, Augmented Immersive Team Training (AITT) EC, CMP-FY11-02 PMTRASYS

OBJECTIVE: Develop a lightweight, low-cost, high-performance device to superimpose computer generated information on an individual's view of the real world.

DESCRIPTION: Augmented reality is a technology that places virtual computer-generated objects into a person's field of view. It can be an aircraft heads-up display (HUD) that shows symbology and information or it can project virtual characters into the real world as demonstrated in the Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD). Placing virtual characters, objects, and effects in the real world has the potential to revolutionize training. Currently, one of the biggest challenges to using augmented reality technologies in dismounted applications is the head worn display (HWD). There is a need for augmented reality HWDs that have the form factor of sunglasses or ballistic goggles and can operate for hours without needing to be recharged. These HWDs need to have bright images in all lighting conditions, must have a large field-of-view, and must be inexpensive. The commercial sector is rapidly developing augmented reality applications for smart phones, but a consumer grade HWD is needed for serious military training applications.

State-of-the-Art: The Vuzix Wrap 920AR is the current consumer grade HWD ($2,000), but it only has a 31 degree diagonal field-of-view and it uses video see-through technology which adds latency. The high-end Rockwell SimEye as used in Army Helicopter trainers is too expensive ($100K), too bulky, and too fragile for use outside of a simulated vehicle.

PHASE I: Develop a concept for a low-cost, high-performance device to superimpose computer-generated information on an individual's view of the real world. For simplicity, we will call this a Head Worn Display (HWD), but this does not preclude other approaches including contact lenses.

PHASE II: Prototype the HWD in a laboratory environment. Demonstrate that the robustness, size, weight, and power requirements are sufficient for training applications.

PHASE III: Produce the HWD system at low-cost and in volume.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Because of the improvements to smart phones within the last couple of years, augmented reality has jumped into the public stage. Unlike traditional military uses of augmented reality which use an HWD, the commercial marketplace uses the camera of the smart phone and the screen to provide a poor man's handheld augmented reality display. If there is a successful HWD in the form factor of normal sun glasses, the commercial market would be tremendous. An individual could have information correctly geo-positioned instantly available and non-obtrusive.

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2. Muller, Schmorrow, and Buscemi, The Infantry Immersion Trainer: Today's Holodeck, Marine Corps Gazette, September 2008, p. 14-18.

3. Muller, Cohn, and Nicholson, Immersing Humans in Virtual Environments: Where's the Holodeck?, Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) 2004, Paper No. 1773.

KEYWORDS: HWD, Augmented Reality, HMD, Training, Simulation, Virtual Reality

N121-086 TITLE: Large-scale Electromagnetic Metamaterials for Shipboard Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ships, Integrated Topside INP

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: Establish approaches and develop techniques to design and manufacture low-cost, large-scale artificially structured metamaterials operating in the radio frequency (RF)/microwave band.

DESCRIPTION: An electromagnetic (EM) metamaterial is an engineered composite material that reacts to incident EM radiation with a response that cannot be found in conventional materials. Electromagnetic metamaterials are often constructed of periodic arrays of conducting resonators (e.g., split-ring resonators and/or wires) which respond to the applied field to produce the electromagnetic properties beyond what is found in nature. The structural arrangement of the resonating elements gives the desired electromagnetic properties. Ideally, the matrix in which the resonators are embedded would have permittivity and permeability close to free-space and low loss at the frequencies of interest, to minimize reflection and absorption.

Recent scientific and technical advances in the field of EM metamaterials have demonstrated materials with simultaneously negative effective permittivity and negative magnetic permeability, yielding a negative refractive index. This opens up entirely new possibilities for the manipulation of electromagnetic waves over a very broad spectrum from the visible, through the infrared (IR), to the microwave. One major barrier to employing this technology in the Navy fleet is the need for low cost, low loss, large volume fabrication technology. Thus there is a need to research and develop techniques to manufacture these metamaterials on a cost and size scale relevant to defense applications for ground and sea vehicles. The interplay between the specific design of the metamaterial and the fabrication concept will need to be investigated as part of the approach.

PHASE I: Develop innovative concepts for low-cost, high-volume fabrication of artificially structured EM metamaterial for use in composite structures with linear dimensions on the order of 1 meter. Identify materials and methods of fabrication that would lead to a robust structure capable of meeting design requirements of permittivity and permeability for practical applications. Propose a demonstration metamaterial application of interest to the Navy, which will incorporate the innovative fabrication concept and would require meter scale metamaterial composites.

Critical aspects would be designs that are lightweight, low loss, broadband, and at the lowest possible cost. Tolerances of the typical unit cell patterns produced must equal or exceed those of standard printed circuit board technology, which are approximately 1 mil (25um). Thermal stability of the substrates used should not exceed a ~2% change in linear dimensions over the range -65oC to 185oC. The substrate dielectric materials should have dielectric uniformity tolerance of <2 %. Layer-to-layer registration of metamaterial layers should have a tolerance of less than 5% of the unit cell linear dimensions. The resulting metamaterial composite must be compatible with naval fire safety and structural requirements for shipboard applications.

PHASE II: Build a prototype of the necessary tooling and demonstrate the fabrication concept developed in Phase I. Use the innovative fabrication technique to demonstrate a meter scale prototype metamaterial topside application functional in the microwave band. The metamaterial composite prototype will be tested against proposed electromagnetic and structural performance criteria.

PHASE III: The small business will work with the Navy and industry to transition metamaterials to relevant shipboard and military environments. Low cost, low loss, large scale electromagnetic metamaterials fabrication is an enabling technology with potential applications in a number of integrated topside design systems. For example, antenna isolation surfaces, low observable antennas, frequency selective surfaces, radar absorbing materials, compact waveguides, beam forming lenses, and impedance matched radomes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Electromagnetic metamaterials with tailored permittivity and permeability have many uses where one wants to control or direct the propagation of radiation. A useful application is for antenna isolation surfaces for clusters of antennas and structures where interference is likely, such as cell-phone base stations and cluttered commercial communication systems. Lightweight beam forming lenses for communications satellites is another potential commercial application.

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1. R. A. Shelby et al. Science, 292, p 77 (2001).

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KEYWORDS: Metamaterials; Microwave; Electromagnetic; Magnetic Permeability; Electric Permittivity

N121-087 TITLE: Infrared Transmitting Aspheric Window Optics

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Free Electron laser INP and Airborne Fiber laser FNC

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 infrared (IR) transmitting glass or ceramics, with good environmental durability, that can be molded or cast into domes and aspheric shapes using spin casting, sintering or other techniques. Perform complete characterization of the material, optimize the fabrication process, and fabricate a full-size hyper-hemispherical dome using this glass/ceramic for IR sensing applications.

DESCRIPTION: IR optics such as lenses, domes, and hyper-hemispherical domes (domes greater than 180o) are needed for military and commercial applications of IR sensing, thermal imaging and threat warning systems and high energy laser propagation. Traditional IR transmitting optics are manufactured by cutting and polishing glasses into the desired shape. This is a costly and lengthy process. Additionally, typical IR dome materials, such as ZnS and CaF2, are difficult to polish due to crystalline grain boundaries, are soft and prone to environmental degradation, and are difficult and expensive to form into hyper-hemispherical dome shapes.

The goal of this project is to develop improved IR glass or ceramics that can be molded at low cost by spin casting or sintering and which has good environmental durability. The advantage of spin casting is that the inner surface of the part remains pristine and highly smooth and should not require any additional polishing. Glass hardness should be greater than ZnS and CaF2 and have good transmission to 5 microns. Transmission into the visible is also desirable. In order to be used by optical designers, the glass properties including optical, mechanical, and thermal should be measured.

The ability to produce various shaped optical elements at low cost opens up new design possibilities such as wider field of view sensing for threat warning and conformal shapes for reduced aero drag. The Navy is interested in the free-electron-laser (FEL) as a ship self-defense weapon and airborne lasers for small boat and other target engagement. Based on these desires, there is a need for robust materials and low cost fabrication processes for IR for optical window components.

PHASE I: Develop a robust fabrication process for IR transmitting glass or ceramics having improved hardness and durability, and measure its optical, thermal and mechanical properties. Determine technical feasibility of spin casting or other technique by fabricating a small 3” reagent grade hyper-hemispherical dome.

PHASE II: Based upon the results from Phase 1, optimize the fabrication method including studying wall thickness as a function of spin casting parameters such as melt volume, spin time, temperature and speed. Fabricate a prototype mid-scale (6”) IR asphere using this approach. Then, fabricate, polish and characterize a full scale (12” diameter) hyper-hemispherical dome.

PHASE III: Designs of IR optics and domes will be implemented for specific military requirements. Full-scale IR optics will be fabricated using the developed processes. The SBIR effort will be transitioned into a product that will enable the development and acquisition of low cost IR optics.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications include aircraft threat warning systems, homeland security IR systems, and thermal imaging systems.

REFERENCES:
1. Harris, D.C., "Materials for Infrared Windows and Domes - Properties and Performance," SPIE Press, Bellingham, WA, 1999

2. “Progress toward an athermal HEL optical window”, Billman, Kenneth W.; Tran, Danh C.; Levin, Ken H.; Daigneault, Steven M.; Edwards, Nathan J. Proceedings of the SPIE, Volume 5647, pp. 207-223 (2005)

KEYWORDS: IR domes; moldable IR glass; IR window materials; ceramic windows; free-electron-laser (FEL); IR asphere

N121-088 TITLE: Compact Airborne Acoustic Device (CAAD)

TECHNOLOGY AREAS: Sensors, Battlespace, Weapons

ACQUISITION PROGRAM: PMS-495: COBRA Block III; ONR: FNC SHD-06-03

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

OBJECTIVE: Develop and demonstrate an innovative compact airborne acoustic source that can be flown on the Fire Scout Vertical Takeoff and Landing Tactical Unmanned Aerial Vehicle (VTUAV) for use as an insonification device.

DESCRIPTION: Buried objects can be detected by systems that combine an acoustic source to excite the ground and a laser-based electro optic imaging technique. In order to develop an airborne detection capability a flyable acoustic source is required. The acoustic source must provide adequate energy on the ground from significant altitudes. Preliminary tests show that a sound pressure level above 100 dB is required on the ground. This acoustic energy on the ground must be in the low frequency regime as shown in references. There is interest in deploying the compact acoustic source from an unmanned airborne vehicle (UAV). The acoustic source and the laser-based electro optic imaging system together will be integrated onto this platform so size and weight are of prime importance. Buried objects can be detected by systems that combine an acoustic source to excite the ground and a laser-based electro-optic imaging technique. In order to develop an airborne detection capability, a flyable acoustic source that provides adequate energy on the ground from significant altitudes is required. Preliminary tests show that a sound pressure level above 100 dB is required on the ground. This acoustic energy on the ground must be in the low-frequency regime as shown in the references. There is interest in deploying the compact acoustic source from an unmanned airborne vehicle. The acoustic source and the laser-based electro-optic imaging system will be combined and integrated onto this platform. Size and weight are of prime importance; therefore, the acoustic source must be compact and provide adequate acoustic energy on the ground in the correct frequency bands.

Currently available acoustic sources don't achieve the energy levels needed to excite the ground at the desired altitudes and are not compact when operating in the low frequency regime. Even very loud hailing devices are limited in total output and in the region over which they operate. Insonification of buried objects to generate motion requires a significant energy level which must be provided in certain optimal frequency bands.

Innovative approaches are sought to develop an acoustic source capable of achieving sound pressure levels (SPLs) approaching 170 dB plus equivalency (as referenced to 20 micro Pascal at 1 meter) in order to provide adequate SPLs at ground-level when flying at altitudes up to 1000 feet. These SPL levels must be provided at various pure-tone frequencies, on the ground, in the low-frequency regime of 90 to 400 Hz. An analysis of alternatives will be done to trade device size, frequency range, output sound pressure level, output waveform, and operational repetition rate. Innovative approaches that can overcome inverse square law losses such as creating near-field effects that mitigate these losses in order to help with long-range output should be considered. Other innovative approaches such as air cannons should also be considered. Trade-off should be considered for the acoustic device output delivery modes to include: individual narrow-band frequencies delivered as continuous and repeatable single frequency tones, multiple frequencies delivered as continuous and simultaneous or as repeatable swept multi-frequency tones, broadband impulses, shock waves, etc. The device should be capable of a sustained operational rate on the order of 10-20 cycles per second to be compatible with typical laser-based electro- optic imaging systems. Higher repetition rates can be considered. An emphasis on compactness, weight, and power will be critical due to platform limitations. Approaches can include the use of electro-mechanical acoustical systems, combustion chambers, prop-fans, or other techniques as appropriate if they can be designed to achieve the desired output.

PHASE I: The contractor will design and develop a concept for a flyable compact acoustic source capable of achieving the performance requirements listed in the description. The contractor will validate the concept using performance modeling. In the Phase I option the contractor will include the initial layout and a description of the performance specifications of the source that will be fabricated in Phase II.

PHASE II: The contractor will fabricate, demonstrate, validate, and deliver the prototype acoustic source developed in Phase I.

PHASE III: Integration of the prototype acoustic source onto the demonstration platform with a laser-based electro-optic imaging system, flight test the complete system, and integrate into the Sea Shield FNC and/or the COBRA acquisition program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The ability to enhance detection of buried objects would be extremely useful for humanitarian de-mining, IED detection, general buried object detection, detection of buried pipelines and cables, detection of buried items in natural disaster assessment, and advancement of hailing devices.

REFERENCES:
1. Steve Moran, et.al, Lite Cycles Incorporated (USA), Rapid overt airborne reconnaissance (ROAR) for mines and obstacles in very shallow water, surf zone, and beach; SPIE Proceedings 5089, 214 (2003).

2. J. M. Sabatier and N. Xiang, Laser-Doppler-based acoustic-to-seismic detection of buried mines; SPIE Proceedings 3710, 215 (1999).

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4. J. M. Sabatier, H. E. Bass, L. N. Bolen and K. Attenborough, Acoustically induced seismic waves; J. Acoust. Soc. Am. 80 (4), 646-649 (1986).

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6. D. M. Donskoy, A. Ekimov, N. Sedunov and M. Tsionskiy, Nonlinear seismo-acoustic land mine detection: Field test; J. Acoust. Soc. Am. 110, No. 5, Pt. 2, 4pPA2, 2757 (2001).

KEYWORDS: Acoustic Source, Insonification, Littoral MCM, Airborne Reconnaissance, Buried Mine Detection, IED Detection

N121-089 TITLE: Enhanced Universal Access Transceiver (UAT) Autonomy for Unmanned Aerial Systems (UAS)

TECHNOLOGY AREAS: Air Platform, Information Systems, Electronics

ACQUISITION PROGRAM: FNC FNT-FY10-02: Actionable Intelligence Enabled by Persistent Surveillance

OBJECTIVE: Develop and demonstrate technologies that leverage Automatic Dependent Surveillance-Broadcast (ADS-B) and Universal Access Transceiver (UAT) to safely and securely govern the fully autonomous control of coordinated unmanned systems.

DESCRIPTION: Many enhancements in current technology are required in order to fully realize autonomous flight. One challenge with the current technology is bandwidth limitation in unmanned systems communication. The 1030-1090 MHz transponder send/receive frequencies currently allocated for the military and general aviation cannot support the expected growth in integration of unmanned systems in the near- and long-term future.

The recent emergence of ADS-B infrastructure by the Federal Aviation Administration (FAA) using the UAT provides an opportunity for further research and development into how these new communication strategies can be used and enhanced for partial or fully autonomous vehicles. ADS-B can provide increased situational awareness and a means for cooperative aircraft collision avoidance, while UATs operating at 978 MHz can handle more traffic with more detailed communication. However, serious technical limitations still exist. For instance, ADS-B signals sent using UATs lack encryption and can readily be spoofed.

ADS-B is a mature technology in which a GPS-based vector is broadcast either on 1090 MHz or 978 MHz that is primarily used to enhance situational awareness for both manned and unmanned aircraft. Recently ADS-B has been used to develop cooperative collision avoidance algorithms for aircraft, but it may not be able to stand alone as a means for collision avoidance due to limitations on signal integrity. UAT is a newly developed technology for the next generation of transponder equipped aircraft and will operate on 978 MHz, a much less congested frequency band.

This effort will address how to improve ADS-B and UAT to insure signal integrity and overcome the issues with False Response from Unintended Interrogations currently experienced at 1090 MHz.

PHASE I: The contractor will develop strategies and techniques to optimize the reliability of UAT for use on UAS intended to be operated in the National Airspace System (NAS) with manned aircraft. Areas to be investigated include the current lack of UAT encryption and the susceptibility of the system to spoofing or jamming. Since the primary application for NAVAIR is the use of ADS-B as the cooperative tracking element of a Sense and Avoid (SAA) system, investigations of how it can be optimized for this application will be pursued. Phase I will result in a prioritized list of improvements which can be pursued under this effort.

PHASE II: The Navy will select which Phase I improvements are of the greatest impact to UAS self-separation maintenance and collision avoidance, and will then proceed to address these areas which may be algorithmic, involve signal processing improvements, or additions to the basic waveform which can lead to improved performance. The contractor will then be expected to develop these capabilities to the level where they can be demonstrated on an airborne platform operating in a representative environment.

PHASE III: By Phase III a specific UAS platform will have been identified for the airborne demonstration, and the funding will be used for integration on this platform and testing in realistic environments. Since this is a cooperative system (i.e., requires participation from all other cooperative platforms in the airspace), it will have to be integrated with a non-cooperative sensing system for the ultimate self separation/collision avoidance demonstration. A critical part of this demonstration will be the algorithms and processing needed to provide UAS situation awareness for the operator, as well as for manned platforms operating in this airspace.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed will be useful for a wide variety of commercial applications using manned and unmanned aircraft. In the future it is envisioned that Cargo UAS platforms will operate over regularly scheduled routes, more border and urban surveillance will be accomplished by UAS platforms, and the UAS will have greater involvement in addressing national emergencies (e.g., rescues in floods, earthquakes, volcanoes, hurricanes). It is also expected that UAS platforms may be used to remedy special conditions such as operating in areas with radioactivity leaks, transporting radioactive materials, and dealing with many types of hazardous wastes.

REFERENCES:
1. "Unmanned Aircraft System (UAS) Sense and Avoid (SAA) Technology Development Road map", prepared by the UAS Research and Engineering (R&E) Integrated Product Team (IPT), dated 19 January 2010.

2. FAA’s “Surveillance/Positioning Backup Strategy Alternatives Analysis”, Paper No.: 08-003 prepared by: Joint Planning and Development Office (JPDO), Air Navigation Services Working Group (2008).

3. 14 CFR Part 91: Automatic Dependent Surveillance - Broadcast (ADS–B) Out Performance
Requirements To Support Air Traffic Control (ATC) Service; Final Rule, Federal Register / Vol. 75, No. 103, p. 30160 (2010).

KEYWORDS: Automatic Dependent Surveillance-Broadcast (ADS-B); Universal Access Transceiver (UAT); Unmanned Aerial System (UAS); Sense and Avoid (SAA); self-separation; collision avoidance

N121-090 TITLE: Planar, Low Switching Loss, Gallium Nitride Devices for Power Conversion Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: Long Endurance Undersea Vehicle Propulsion FNC

OBJECTIVE: Develop a fast switching, low switching loss, 50 amp, 1KV normally-off Gallium Nitride (GaN) Transistor for efficient power conversion.

DESCRIPTION: Efficient power conversion and power conditioning devices significantly impact the mission capability and affordability of both the shipboard and airborne platforms through capacity considerations, generation cost, and size and weight-form factors. Switching devices are used to electrically drive a variety of mechanical loads. A key factor that determines the electrical-to-mechanical conversion-efficiency is the switching losses in the transistor. Fundamentally, this is a function of the switching speed and the properties of the material. Silicon is widely used for power conversion due to the technology maturity and low cost. GaN-based transistors have demonstrated significantly reduced switching losses in power conversion applications, and hence significantly improve energy efficiency. Applications such as Unmanned Undersea Vehicle (UUV) sonar transducers and propulsion are key opportunities to leverage highly efficient GaN technology to increase mission duration for power and space constrained platforms. A 1 kV blocking voltage device capability is required to begin to address this class of applications.

Current power technology for applications below 1 kV utilizes silicon-based technologies which are limited by inherently low switching speeds leading to conversion losses and inefficiency. GaN overcomes these switching losses and in many cases improves energy efficiency by several percentage points for buck converters. In load-driving applications, the improvement can be dramatic (20 percentage points). A GaN device does not currently exist at this voltage and current range.

The U.S. Navy is interested in developing a normally-off, GaN High-Electron mobility transistor (HEMT) that has a 1 kV blocking voltage and ultimately can switch 50 amps with low switching losses and at high power conversion frequencies (i.e., greater than 1 MHz). The goal is to improve overall efficiency for such applications as electroacoustic transducers and propulsion drives which will result in improved mission capability (e.g., range, endurance).

PHASE I: Provide an initial development effort that demonstrates scientific merit and feasibility of an approach to achieving normally-off device operation. The effort will demonstrate a device that provides a blocking voltage of 1000 V, a threshold voltage >1 V, with a specific on-resistance, Rsubscript(DS,ON-SP) of <20 Ohm-mm and low-gate and drain leakage of <1 µA/mm. For high efficiency switching, low output capacitance of <5 pF/mm must be achieved.

PHASE II: Demonstrate a device with 50 A continuous drain-current and an on-resistance of <50 milli-Ohm and Vsubscript(t)>1 V. Drain leakage at 1000 V not to exceed 5 mA. Gate leakage should not exceed 1 mA. Input and output capacitances must not exceed 1.5 nF and 150 pF, respectively, at 500 V drain bias. Must demonstrate > 5 MHz switching frequency in boost or buck converter test circuit with >90% conversion efficiency. In addition, the drain-current collapse, Rsubscript(AC)/Rsubscript(DC), at 600 V, will be <1.5. Device yield on-wafer should demonstrate > 50%.

PHASE III: Demonstrate manufacturability of a device with a 50 A drain-current with a blocking voltage > 1000 V, threshold voltage >1 V and reduced the on-resistance, of <40 milli-Ohm. Drain leakage at 1000V not to exceed 0.5 mA. Gate leakage should not exceed 0.1 mA over gate bias range of -10V to + 10V. Input and output capacitance must not exceed 1 nF and 100 pF, respectively, at 500 V drain bias. The drain current collapse, Rsubscript(AC)/Rsubscript(DC), at 600 V, must be reduced to <1.2. Advance on-wafer yield to > 90%.

Definitions:
Csubscript(OSS) (Output Capacitance) = Csubscript(DS) + Csubscript(GD)
Csubscript(ISS) (Input Capacitance) = Csubscript(GD) + Csubscript(GS)

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Electronic power converters and motor drive applications.

REFERENCES:
1. Yifeng Wu; Jacob-Mitos, M.; Moore, M.L.; Heikman, S.; "A 97.8% Efficient GaN HEMT Boost Converter With 300-W Output Power at 1 MHz," Electron Device Letters, IEEE, vol.29, no.8, pp.824-826, Aug. 2008.

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KEYWORDS: Power efficiency; Gallium Nitride; GaN; converter; UUV

N121-091 TITLE: Increased Capability and Interface for Computational Code for Implosion

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: EPE-FY08-06 Payload Implosion and Platform Damage Avoidance

OBJECTIVE: Develop a standard modeling procedure for implosion simulation which will be integrated into a graphical user interface (GUI) for efficient model development and increased assessment capability.

DESCRIPTION: The ONR Future Naval Capability (FNC) program on implosion will deliver a physics-based computational code at the end of FY12, which has been developed for underwater implosion modeling and simulation. Underwater implosion is a unique and complex event, such that the computational model must include strong coupling between fluid and structural solvers; the fluid model must include underwater shock propagation, and the structural model must include rapid, large deformation with material failure/fracture capability. The delivered code will be validated against deep ocean implosion experiments.

Additional research is needed to develop modeling procedures for underwater implosion. Specific areas of research include: material model and material failure criterion; shell and solid element formulation; structural element size for material fracture; relative size of fluid and structural elements with respect to fluid/structure coupling; and performance analysis of the Tillotson equation of state (EOS) for water compared to the Tait EOS. If the research listed above is not addressed, it may take longer to transition the FNC product into the NAVSEA 05P approval process for systems containing implodable volumes.

State-of-the-Art: The code is primarily a research tool, making extensive use of text input files and scripts. The available EOS within the fluid code are stiffened gas, Tait, and Jones-Wilkins-Lee (JWL). The structural code is capable of large deformation, elastic/plastic material behavior, and the extended finite element method (XFEM) for structural cracking/failure. The code will be validated against underwater explosion initiated implosion experiments.

PHASE I:
1. Identify and define the critical parameters to be included in a modeling procedure for underwater implosion.
2. Develop the concept of a GUI for underwater implosion models.
3. Determine the technical feasibility of implementing the Tillotson Equation of State for water in the fluid code.

PHASE II:
1. Develop a prototype modeling procedure and validate against underwater implosion data.
2. Build the GUI and embed the prototype modeling procedure.
3. Implement the Tillotson EOS into the physics based computational code.

PHASE III: The product will be a GUI developed specifically for underwater implosion problems of interest to the Navy. The GUI will translate user inputs into physics-based computational code input files, which adhere to the modeling procedures developed for underwater implosion. This product will transition to the Naval Warfare Centers, who are responsible for providing engineering assessments of the impact of underwater implosion close to a submarine.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The GUI and modeling procedure for implodable volumes will be available to the private sector for the design of systems that contain implodable volumes. Additionally, the modeling procedure will benefit industrial applications (e.g., aircraft, automotive, marine) which require computational analysis involving fluid structure interaction and material fracture/failure.

REFERENCES:
1. Vanzant, B.W., Russell, J.E., Schraeder, A.L., DeHart, R.C., "Near-Field Pressure Response Due To A Sphere Imploding In Water", Summary Technical Report No. 1938-1, Contract No. N00 140-66-C-0698, Southwest Research Institute, (1967).

2. Turner, S.E., "Underwater Implosion of Glass Spheres," Journal of the Acoustical Society of America, 121 (2), February 2007, p 844-852.

3. C. Farhat, A. Rallu, K. Wang, and T. Belytschko, "Robust and provably second-order explicit-explicit and implicit-explicit staggered time-integrators for highly non-linear compressible fluid-structure interaction problems," International Journal for Numerical Methods in Engineering 2010; 84:73-137.

KEYWORDS: implosion; fluid structure interaction; fracture; failure; shock; collapse; underwater

N121-092 TITLE: Rapid Crisis and Disaster Response Information Discovery

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: FNC is in development under proposed Theater Opening Enabling Capability

OBJECTIVE: Develop algorithms and processes for detecting rising crisis, partitioning information in unstructured data to separate noise from signal, and provide a means for evaluating the reliability of the information.

DESCRIPTION: Disasters and crises requiring international response and in particular, U.S. response due to strategic and national security concerns, have been made more complex and fast moving due to the technological and social changes wrought by mobile phones and information technologies. New information systems, from social media to YouTube, spread the word about rapidly evolving crisis with great speed however there exists tremendous noise, and the reliability of the information is highly variable. Information flows during crises (such as need for food, water, medical assistance or other aid) need to be monitored and information critical to the objective of the mission should be highlighted, summarized, and developed into actionable intelligence. Existing systems are slow and rely highly on human-in-the-loop for categorization and prioritization of information. There are no existing methods for trust, validation, or verification and few systems for fusing social media and existing data reservoirs to enhance the information flow so that it yields actionable intelligence.

The main objectives of this SBIR topic are developing actionable intelligence, finding the signal for a rapidly developing crisis in the "noise" of social media, and discovering and enhancing information so that it can be used in planning, monitoring, and pro-active execution of humanitarian missions. The highly desired end state is a system with the capability to fuse information from a variety of sources to create actionable intelligence, develop methods of trust and validation, with drill down, version control and capability to interact with a variety of mapping systems (e.g., Ushahidi, SAGE, ESRI) together with the ability to release some parts of the data into open-source and engage in information sharing operations in Phases II and III.

SPECIAL NOTE: THE ROLE OF SOCIAL SCIENCE. Offerors should understand that this is in part (perhaps 40-50%) a technology topic and part (50-60%) a problem of social science. The analysis of social media is about socio-technical behaviors: new behaviors that are made possible by the mobile phone and the extensions of information technology. In order to analyze information and its ramifications for social behavior, the approach taken will be most effective if social and cultural issues are delineated and addressed.

PHASE I: Design a system capable of ingesting massive amounts of unstructured data (such as more than 10,000 "tweets" per hour as an illustrative example), processing, and prioritizing information. The design should also include a good approach for the development of trust metrics for a military unit responsible for humanitarian assistance/disaster relief response. Unstructured social media information enhancement for verification, trust, and information fusion with other sources to develop actionable information pools (for example, to improve the ability to geo-locate humanitarian requests) and initial development of techniques for discerning signal from noise in social media for monitoring human-driven crisis is expected, to be elaborated in Phase II.

PHASE II: Develop a prototype of the system designed in Phase I that includes the following:
• Capability to fuse information from a variety of sources to create actionable intelligence
• New methods of trust and validation, with drill down, version control and capability to interact with a variety of mapping systems (Ushahidi, SAGE, ESRI, etc.)
• Capability to release some parts of the data into open-source and engage in information sharing operations
• Capability to allow crowdsourcing for information validation and prioritization
• Capability for micro-tasking, planning and coordination to leverage actionable intelligence generated by project using a crowdsourcing model
• Elaboration of signal discernment for detection of human-driven crisis

PHASE III: Fully deployable algorithms, methods and capabilities for:
• Aggregation, partition, and noise filtering for unstructured information from non-traditional open-sources (e.g., blogs, Ushahidi, Twitter, Facebook, possibly YOUTUBE, other social media, sms, email traffic) under lawful conditions and with ethical boundaries well defined
• Unstructured social media information enhancement for verification, trust, and information fusion with other sources to develop actionable information pools, for example, to improve the ability to geo-locate humanitarian requests
• Interaction with a variety of mapping systems (OpenStreetMap, Ushahidi, SAGE, ESRI, etc.) for improved data visualization
• Discernment of signal from noise in an incipient human-driven crisis through social media to detect emerging crisis

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector application for this technology is considerable. Social media is a rapidly developing commercial area. Spin offs from this project might include mobile "apps" for smartphones for a variety of purposes including geo-location during emergencies, emergency reporting (for example, reports of flood, tornado), and specialized apps for police (local and state), first responders of all types, and even other agencies, from FEMA to USAID. The tools themselves would be useful for homeland defense at the state and possibly National level in situations of disaster such as Katrina, floods, tornados, and earthquakes.

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KEYWORDS: humanitarian assistance; disaster relief; information fusion; crisis mapping; social media; crowdsourcing

N121-093 TITLE: Ultra-Wideband Low Power Electronic Digitizer

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: JCREW S&T, FY12 EC New Start (Dave Tremper, Code 312)

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 engineering prototypes of a power-efficient integrated digitizer with real-time multi-gigasamples per second processing capability that leverages commercial analog-to-digital converters (ADCs) while boosting their performance.

DESCRIPTION: New military communications, sensing and surveillance systems require ever-faster real-time digitization of electronic signals to achieve continuous sensing and utilization of the electromagnetic spectrum. Ultra-wideband, low-power, high-performance digitizers are needed in a wide range of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) applications. High performance ADC/Field-programmable Gate Array board digitizer products are commercially available, but are limited to a few GHz bandwidth and are primarily focused on digitization without sufficient digital signal processing capacity to perform user-specified real-time signal analysis. Hence these devices do not meet the needs of many applications where real-time monitoring of the electromagnetic spectrum and rapid response to threats are needed.

New power efficient technologies and architectures are needed to achieve next generation high-speed digitizers with high dynamic range (e.g., >8 Effective Number of Bits (ENOB), 20 GHz analog bandwidth, and <50 W total power dissipation). Achieving this real-time ultra-wideband digitizer performance at low system power consumption levels is a key challenge. Novel techniques that achieve ultra-wideband operation (20 GHz and beyond) while preserving high dynamic range with minimum power consumption are encouraged. Methods to consider may include: analog preprocessing combined with time- or frequency-interleaving of multi-channel ADCs; development of calibration methods; residual mismatch compensation in real-time hardware; development of algorithms for nonlinearity compensation; and hybrid approaches that judiciously combine the wideband capabilities of photonics with electronic quantization and digital signal processing. The technologies must be readily scalable in instantaneous bandwidth as the speed of commercial ADCs improve. Engineering prototypes of the scalable digitizers should be compatible with standard digital-interfaces for data transfer and configuration.

State-of-the-Art: Ultra-wideband digitizers may be achieved with interleaving multiple commercially available ADCs to achieve sampling rates and input bandwidths that scale with the number of ADC channels used. The performance of current time-interleaved ADCs (50 GHz analog bandwidth; 5 ENOB) suffer from channel mismatches, gain imbalances, and timing skews, all of which degrade digitizer dynamic range performance. Current ultra-wideband digitizer systems also suffer from high power dissipation (>50 W) which limit their utility in many applications even if bandwidth and dynamic range requirements are met.

PHASE I: Design the proposed new digitizer concept/architecture by analyzing its bandwidth, dynamic range and power consumption characteristics. Validate the digitizer design and performance through rigorous modeling and simulation to determine a rigorous Phase II prototype performance specification. Limited proof-of-concept demonstrations of novel aspects of the approach are encouraged but not required.

PHASE II: Develop, construct, test and demonstrate digitizer system prototype with real-time implementation of the algorithms and interfaces to a host computer. Perform a system demonstration of prototype hardware/firmware/software in a laboratory environment. Continue Phase I modeling and simulation efforts to iteratively refine and improve the digitizer hardware and software implementation.

PHASE III: Build field deployable digitizer system prototype and demonstrate in field trials. Transition the demonstrated technology to pre-production engineering prototypes for dual use markets.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Real-time digitizers developed can be used in digitizer oscilloscopes for high-speed test and measurement instrumentation, next generation optical and wireless communications, and biomedical imaging and sensing. Scaling the technology to even higher bandwidths as commercial ADC advancements are made will be useful in a number of emerging applications ranging from 40G/100G optical communications to Terahertz spectrum analysis (useful for detection of concealed weapons and illegal drugs and scanning for hazardous materials). Higher speed military uses include imaging, surveillance in the IR and Terahertz frequency bands, and high-speed imaging and processing.

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[2] Jenq, Y.C., "Digital spectra of nonuniformly sampled signals: fundamentals and high-speed waveform digitizers," IEEE Transactions on Instrumentation and Measurement, Vol. 37, No. 2, pp. 245-251 (1988).

[3] Huawen, J., Lee, E.K.F., "A digital-background calibration technique for minimizing timing-error effects in time-interleaved ADCs," IEEE Transactions on Circuits and Systems II: Analog and Digital Signal Processing, Vol. 47, Issue: 7, pp. 603 -613 (July 2000).

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KEYWORDS: Analog-to-Digital Converters; Wideband Digital Receivers; Real-time Data Acquisition and Processing; Spectrum Monitoring; Signal Intelligence; Test and Measurement

N121-094 TITLE: Additive Manufacturing for Transducer Development

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: This topic is intended to benefit future FNC projects for ASW, MIW & UUVs.

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OBJECTIVE: Leverage advances in additive manufacturing (AM) to develop, with improved reliability, a lower-cost transducer suitable for Navy underwater applications.

DESCRIPTION: AM is a fabrication process in which materials are used to construct an object by means of layering, usually in accordance with a Computer Aided Design (CAD) model. Advances in AM fabrication techniques hold the promise of novel solutions for problems in manufacturing cost and reliability for complex devices used for underwater acoustic projection and sensing. Existing known methods that are likely to benefit sonar transducer construction include inkjet printing, digital light processing, fused deposition modeling, selective laser sintering and electron beam melting. These techniques vary in the materials which can be added and the method of layering. It is believed that many of the component items in a modern sonar transducer can be produced using these methods.

The problem to be solved is to identify the portions of underwater transducer manufacturing for which additive methods might successfully be applied, and to demonstrate these in an actual device. A transducer will be designed and modeled using CAD and finite element methods, and manufactured using an AM approach for at least 50% of the device. The device proposed should be of a traditional transducer design suitable for Navy underwater applications such as anti-submarine warfare, mine-hunting or acoustic communications. The demonstration of the device should include a comparison to the equivalent transducer manufactured by traditional methods.

PHASE I: The vendor will select a transducer device currently in use for a Navy underwater warfare application and justify the selection based on the potential to achieve at least 50% of the transducer's manufacture using AM methods. Once a transducer has been selected, the vendor will develop CAD and finite element models for the device and compare modeled performance to that of the equivalent device as manufactured using traditional methods. A successful Phase I project will produce a viable design for a transducer that can potentially replace its equivalent currently in use by the Navy.

PHASE II: The vendor will use additive manufacturing approaches such as laser processing, electron beam melting, aerosol jetting, inkjet processing, or semi-solid freeform processing, etc. The transducer will be developed, tested in a tank and at the Navy's Seneca Lake sonar test facility. A successful Phase II project will produce a tested device that approximates the form, fit and function of an equivalent device currently in use by the Navy.

PHASE III: With partnership from an acquisition program, transducers will be manufactured using additive manufacturing methods and demonstrated in a Navy sonar application. Comparisons to the existing transducers will include system performance, development costs, maintenance costs, and logistics impacts.

Results from Phase III will be used as the foundation for a Future Naval Capability project proposal.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential dual use applications are in the commercial audio industry. Techniques developed under this topic may benefit the manufacture of commercial acoustic transducers such as speakers.

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1. Hopkinson, N., Hague, R., Dickens, P. editors, “Rapid Manufacturing: An Industrial Revolution for the Digital Age,” Wiley & Sons, 2006.

2. Chua, C. K., Leong, K. F., & Lim, C. S., "Rapid Prototyping: Principles and Applications (2nd ed)," World Scientific Publishing, 2003.

KEYWORDS: Additive Manufacturing; Rapid Prototyping; Underwater Acoustic Transducers; Sonar

N121-095 TITLE: Development and Processing of Dielectric Films for Application in Large Wound Capacitors

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

ACQUISITION PROGRAM: Rail Gun INP, Roger Ellis, ONR 352

OBJECTIVE: Develop and process a dielectric film that: has increased energy storage density relative to very thin Biaxially-Oriented PolyPropylene (BOPP); has low dielectric and leakage losses in a wound capacitor; exhibits graceful failure; and retains performance to 125C or higher.

DESCRIPTION: For electrical systems that require significant capacitative energy storage, polymer film capacitors, such as BOPP, are often used because the technology is scalable and they can exhibit graceful failure. BOPP is a state-of-the-art polymer dielectric film in that it has high dielectric breakdown strength, very low dielectric loss, can exhibit graceful failure when appropriately metalized, and can be processed into thin, large area films with uniform dielectric performance and minimal flaws. The weaknesses of BOPP are however, the low permittivity which limits energy storage density and a rather low maximum temperature for sustained use.

Commercial polymer dielectric films with higher operational temperature capability typically have lower energy storage density and/or show less ability for graceful failure. In academic laboratories, many approaches are being taken towards dielectric films with increased energy storage capability (i.e., Polyvinylidene Fluoride (PVDF) terpolymer, nanocomposites and nano-layered approaches (see References)). There is, however, a large hurdle in going from laboratory films prepared by spin casting or thermal pressing to films prepared by commercially viable approaches such as extrusion or reel-to-reel casting. Commercial approaches to thin films offer the possibility of improving dielectric performance by improving film quality across large areas (flaw reduction) and by providing a means for altering film morphology through annealing and orientation. However, the capability to study and pursue dielectric film development and optimization through processing does not exist in many academic laboratories.

There is a need for increased energy density and a higher thermal performance window relative to capacitors produced from the most common dielectric film currently used for larger capacitors. These improvements will allow smaller electrical components on ships and will allow components to operate without dedicated cooling systems.

PHASE I: Offerers must develop a dielectric film that outperforms BOPP on lab-prepared films and demonstrate that they can retain 80% of the energy storage density with a first step towards a commercial process such as using a laboratory extruder, doctor blading a large area, etc. At the end of Phase I, both lab-prepared films and scaled films must be presented to the Navy for testing as follows:

- At least 10 square inches of film (multiple pieces accepted) prepared in the lab and at least 40 square inches of continuous film prepared through processing that demonstrates scalability.
- Films must be less than 20 microns thick and should be free standing.
- Samples will be tested for dielectric performance (permittivity, dielectric loss, film resistance) at 1 kHz and at various temperatures between 25C and 125C.
- Samples will be tested to dielectric breakdown at room temperature.
- At least 10 measurements will be made to provide statistics.
- At room temperature, the energy storage density based on permittivity and breakdown should exceed that of BOPP and have dielectric losses below 0.3%.
- At 125C the dielectric film should retain a volume resistivity of 10^14 ohm.m or higher.

The offeror will be able to submit a reasonable number of films to the Navy for testing during Phase I and expect results in a reasonable time (less than 2 weeks).

PHASE II: The goals of Phase II are to fully develop an optimum dielectric film processed on commercial or near commercial* equipment and to demonstrate performance both on the film level and in wound capacitors. Work may include synthesis scale-up, process development runs on commercial or near commercial equipment, studies of the influence of processing variables on film morphology and dielectric properties, etc. There should be a milestone near the midpoint of this effort to finalize film work and begin work towards the wound capacitor deliverable. At this point, film samples will again be supplied to the Navy. Based on the characteristics of the optimized film, metrics for the wound capacitors will be agreed upon. Typical metrics might be for delivering several 10 joule capacitors with a 1 kHz discharge time, graceful failure, desired temperature performance, and a wound capacitor energy density above 2 J/cc.

*Near commercial equipment has capability and features such that the width of the film (amount of raw materials required) and the speed of the machine are the only major operating differences relative to commercial equipment.

PHASE III: The goal of Phase III is to deliver a number of fully packaged capacitors for potential use in a military component.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Capacitors are part of all electrical components. The focus in this solicitation is for increased energy density and a higher thermal performance window relative to capacitors produced from the most common dielectric film currently used for larger (applications besides microelectronics) capacitors. If successful, the dielectric film will likely compete against established capacitors made using BOPP, especially where volume is critical or when the electronics are housed in a hot environment.

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2. “Phosphonic Acid-Modified Barium Titanate Polymer Nanocomposites with High Permittivity and Dielectric Strength,” P. Kim, et al, Adv. Mater. 2007, 19, 1001-1005.

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KEYWORDS: wound capacitor; dielectric film; metalized film; graceful failure; polymer; processing

N121-096 TITLE: Persistent Anchorless Active Sonar Deployable Surface Buoy

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: SWMS User Operational Evaluation System (UOES) proposed by OPNAV N2/N6

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OBJECTIVE: Develop an anchorless deployable surface buoy that can provide persistent active sonar operations in excess of two weeks without recourse to mooring.

DESCRIPTION: Several autonomous active sonar processing projects have come to fruition in the last five years, primarily for short duration applications that are intended for deployment from the air. The limited efforts to develop ship-deployable systems that can operate for extended periods have produced successful systems, but persistence was achieved at the expense of deployability. The Navy needs a deployable field of active sonar systems that can be used in all depths of water and achieve tactical anti-submarine control of an area for several weeks.

The persistent anchorless active sonar system should contain a float or small craft for suspension of the sonar arrays, a low-frequency source and receiver array, and on-board processing and communications. The float or small craft must be capable of holding the system on station. The maximum size of the system must be such that two entire units, when made ready for deployment, can fit in a standard ISO shipping container (8'x20'). Achieving this form factor in a persistent station-keeping system is viewed as the primary technical challenge, as the sonar system is likely to contribute significant drag that must be compensated for in the design. The successful proposal must identify the anchorless station-keeping mechanism, provide a workable active sonar design for anti-submarine warfare, and show a notional deployment and retrieval concept for the unit.

PHASE I: The means of providing persistent power and holding station will be identified and the design justified in terms of size, endurance and power output for sonar operations. The successful Phase I project will identify the critical design elements and model all aspects of system operation to show that the design is achievable in practice and could be made suitable for deployment and retrieval from a surface ship..

PHASE II: A persistent anchorless active sonar platform will be constructed, including hotel power, thrusters, navigation and communications for remote control of the system. In this phase, use of a surrogate for the sonar, such as a dummy load and/or representative drag and weight components is acceptable. Once the platform had been developed, a test at sea or in a representative environment will be conducted. The successful Phase II project will result in a tested persistent anchorless active sonar platform that can be readily deployed and retrieved from a surface ship.

PHASE III: The prototype developed in Phase II will be integrated with a suitable active sonar system and used in a trial for detection of targets at sea. The successful Phase III project will, working with acquisition project managers, conduct a full-scale proof-of-concept test of the system including deployment, operation at sea for at least 2 weeks, and retrieval.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed under this topic will be applicable to persistent instrumentation challenges in ocean monitoring, marine fisheries and deep-sea oil exploration.

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KEYWORDS: Active sonar; persistence; anti-submarine warfare; deployable systems

N121-097 TITLE: Improved High Frequency Communications

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: MARCORSYSCOM PRC-150; and Marine Expeditionary Rifle Squad

OBJECTIVE: Improve reliability and predictability of time-of-day dependent high-frequency (HF) channels by providing high-throughput ionospheric skywave or Near-Vertical Incidence Skywave HF (e.g., 2-30 MHz frequency band) communications with a throughput of at least 100 kb/s.

DESCRIPTION: HF communications technologies have not been actively developed or improved in recent years with the exception of NATO STANAG (ref. 1) and commercial activities working with a 24-kHz channel as opposed to the standard 3-kHz channel. Recent military operations have demonstrated a shortfall in long-range tactical communications in complex terrain environments that HF communications are filling. However, due to the HF channel variations, poor signal-to-noise ratio (SNR), and interference (ref. 2, 3), attempts to improve the channel capacity, spectral efficiency, or link have met with little success using traditional approaches. If the SNR can be increased and stabilized, higher-order modulations can increase spectral efficiency (ref. 4). Local coverage (e.g., 0 to 10 miles) may also be increased by multiple-input, multiple-output (MIMO) (ref. 5, 6) and opens the possibility for an HF local area network (LAN) (ref. 7). Local to medium-range coverage (e.g., 0 to 300 miles) may be increased by exploiting the Near-Vertical Incidence Skywave (NVIS) (ref. 8). Some of the limitations in the tactical

NVIS radios may be overcome by exploiting the multipath bundles in the NVIS, the launch angles (e.g., low-angle main beam for long-haul, high angle for local and medium haul), and polarizations diversities.

Overall goals and possible approaches include the following:
1. Exceeding the performance of existing wide-channel HF radios by at least 25%
2. Using NVIS as an MIMO option (two-channel)
3. Porting the HF networking and beamforming that currently exists on ships (3kHz band) to the Marine operations
4. Designing HF networking to increase link coverage

Performance gains that can be realized through tradeoffs of HF waveforms, polarizations, and antenna design are of particular interest.

PHASE I: Develop a technical description and system design, supported by modeling, to show predicted performance gains. Include a high-level methodology for attaining Federal Communications Commission (FCC) and International Telecommunications Union (ITU) approval.

PHASE II: Complete a breadboard implementation to validate the model in laboratory and provide over-the-air demonstrations.

PHASE III: Develop a TRL7 prototype for demonstration at NVIS or skywave distances showing a data throughput of more than 100 kb/s.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Ham radio operators supporting natural disasters and governmental and non-governmental agencies performing human assistance/disaster relief missions can use infrastructure-free over-the-horizon communications capabilities that can transmit images and low-quality video.

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2. Harris, T.J.; Scholz, M.L. [2006] Characterisation of Narrowband HF Channels in the Mid- and Low- Latitude Ionosphere, Proceedings RTO-MP-IST-056, Paper 17. Neuilly-sur-Seine, France: RTO. Available from: http://www.rto.nato.int/abstracts.asp.

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KEYWORDS: High frequency; over-the-horizon; near-vertical incidence skywave (NVIS), ionospheric skywave; skywave; MIMO

N121-098 TITLE: <u>Traffic Prioritization in Tactical Networks Aligned with Commander</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Dynamic Tactical Communication Networks (FNT 09-02)

OBJECTIVE: The objective of this effort is to develop and align traffic prioritization mechanisms/techniques in tactical networks with Commander's Intent, assuring the delivery of mission-critical traffic under adverse conditions.

DESCRIPTION: The tactical environment contains a unique set of conditions including highly dynamic missions being executed in disconnected, intermittent or limited communication environment. These conditions require traffic prioritization mechanisms/techniques and the ability to orchestrate these techniques to ensure that network priorities are aligned with Commander’s Intent. Commander's Intent is a concise expression of the purpose of the operation and the desired end state. Network policies must be aligned with and support achieving the desired operational end state.

Tactical networks typically contain an admixture of critical, essential, and non-essential traffic. Criticality of the traffic depends on the types of missions that are currently being executed, and is, consequently, highly dynamic. For example, a humanitarian assistance/disaster relief operation (e.g., tsunami, earthquake) will have very different priorities than a low-intensity conflict. The situation is further complicated by the fact that geographically-dispersed, tactical forces participating in different operations, with different mission assignments, may very well be terminated at the same network operations center for their services. These operational challenges require technical solutions for identifying different types of traffic, associating each traffic type with specific platforms and functions/missions, enabling the Commander to prioritize these functions/missions, and translating the Commander’s prioritization into network policies that can be implemented across the network to ensure that mission-critical traffic is delivered before traffic of lesser importance.

The commercial sector relies primarily on fixed, terrestrial networks and can either easily procure more resources to alleviate congestion or add redundancy. For truly mission-critical traffic, the commercial sector builds dedicated networks with dedicated resources to guarantee performance; therefore, the commercial sector has not placed significant emphasis on prioritization mechanisms and how to orchestrate their employment across the network to ensure end-to-end delivery of mission-critical traffic. Military users do not have these commercial advantages and, consequently, require traffic prioritization mechanisms to assure the delivery of mission-critical traffic under adverse conditions.

PHASE I: Define traffic prioritization mechanisms/techniques that will be employed across a tactical network, outline how Commander's Intent will be articulated through policy using these approaches/techniques, explain how policy conflicts will be resolved, and provide preliminary assessment of the overall approach, to include the operational utility. A key aspect of this effort will be to define the metrics that will be used to assess the overall approach because, ultimately, the utility of the operational system will be measured on how well it is able to satisfy Commander's Intent.

PHASE II: Mature the prioritization mechanisms/techniques and demonstrate an ability to prioritize traffic, aligned with Commander's Intent, in a simulation, using off-the-shelf software (e.g., OPNET, NS3, QualNet, etc.), in a variety of environments and scales. The environments must reflect disconnected, intermittent or limited communications to understand how well the proposed approach mitigates the adverse effects of these environments. The simulation must include a sufficient number of platforms and facilities to reflect tactical operations in a theater.

PHASE III: Develop the appropriate user interface and tools that will leverage the prioritization mechanisms/techniques matured in Phase II. Implement this user interface and back-end device controls to achieve the desired prioritization in systems representative of the planned transition program(s) of record.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial sector relies primarily on fixed, terrestrial networks and can either easily procure more resources to alleviate congestion or add redundancy. However, the technology developed under this proposal could be applied to mobile computing and telecommunications applications as well as emergency response situations.

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KEYWORDS: quality of service; traffic prioritization; tactical network; Commander's Intent

N121-099 TITLE: Detecting Crack Nucleation/Damage Mechanisms In Sea-Based Aviation Environments

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

ACQUISITION PROGRAM: NAVAIR 4.3 Structures Community; PEO(A), (T) and (U&W); NAVSEA PEO(Ships)

OBJECTIVE: Design and demonstrate an innovative crack detection approach in wet (aqueous) and dry (gaseous) corrosion environments under various stress fields and gradients supported by analysis formulations for underlying damage mechanisms.

DESCRIPTION: The understanding of crack nucleation in corrosive environments through a rigorous analytical and experimental basis is required to prevent progressive damage from occurring in naval structures thereby reducing the total ownership cost of any structural asset. This fundamental understanding will not only help achieve better structural and metal alloy design for new acquisitions but will also help identify immediate remedial actions for current corrosion and stress corrosion cracking problems in the existing fleet (e.g., F-18 and P-3 aircraft). To achieve both an analytical and experimental understanding of crack nucleation in corrosive environments, there is a need for the development of nondestructive evaluation (NDE) techniques to detect the onset of crack nucleation in all types of stress fields and stress gradients present in real geometries.

Various NDE techniques and sensors that have been developed over the last decade are primarily intended for macro-crack detection in inert environments rather than in corrosive environments. There are various sensors that are capable of sensing environmental parameters like pH/Cl-, but there are only a few that are capable of measuring the onset of corrosion events. Electrochemical noise techniques have been used with some degree of success to detect onset of localized corrosion such as pitting and crevice corrosion. The detection of localized corrosion, while useful, does not capture damage mechanisms of stress corrosion cracking and corrosion fatigue in naval structures. Therefore, a systematic analytical study to understand the damage mechanisms in play and development of techniques/sensors to detect crack nucleation under various stress fields and environmental conditions is needed. Such an analytical study should capture material degradation, both at global and local levels, in corrosive environments to provide a framework of damage mechanisms considering the crack tip chemistry and chemical kinetics at the micro scale level. To support and complement analytical efforts, techniques and sensors must be developed to detect crack nucleation in both wet (aqueous) and dry (gaseous) corrosive environments that can react with the base metal [e.g., Al 7075, 7050, Ti -6-4, HY-80 and HY-130 alloys] to establish some corrosion product. The design tool should be envisioned to work within a condition-based maintenance framework to provide prognostic and diagnostic capabilities.

PHASE I: Develop an analytical approach for measuring crack nucleation for various stress fields and gradients. Demonstrate the feasibility of the approach to different environments through critical tests using novel techniques to detect crack nucleation. Outline the steps needed for improving both analysis and sensor development efforts.

PHASE II: Fully develop the approach formulated in Phase I into different material such as Al 7075, 7050, Ti -6-4 and HY-80,130 alloys. Support analysis through critical tests using the proposed crack detection technique under a variety of service loads and conditions. Provide verification of the ability of the crack nucleation measurement in differing environmental concentrations.

PHASE III: Transition the technology to a suitable platform of US Navy interest, and successfully commercialize the developed sensor system and innovative technology to designers and manufacturers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed analytical and sensor tool has the potential to transition to the commercial aircraft market and industry for the efficient design of airframe structures resulting in improved component reliability and life extension due to elimination of airframe corrosion.

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3. Vasudevan AK, Suresh S, "Influence of Corrosion deposits on near threshold fatigue growth behavior in 2xxx and 7xxx series aluminum alloys", Metallurgical and Materials Transactions 13-2, pp 2271-2280, 1982.

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KEYWORDS: Corrosion; Crack Detection; Wet/Dry; Mechanical Stress; Nucleation; NDE

N121-100 TITLE: Reconfigurable Optical Traps for use with Compact Sources of Ultracold Atoms

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace

ACQUISITION PROGRAM: PMA264 Advanced Avionics Development P-3

OBJECTIVE: Develop reconfigurable optical traps for use with compact sources of ultracold atoms.

DESCRIPTION: Reconfigurable optical traps for use with compact sources of ultracold atoms would make possible widespread exploration of methods for use of ultracold atoms for navigation, timekeeping and sensing applications. Such custom-made traps are now used in advanced research laboratories, but it is possible to envisage lower-cost manufacturable versions that can be used to implement atom interferometry, magnetometry, precision timekeeping, frequency metrology, and gravitational and inertial measurements.

Candidate devices must be designed to work with at least one of the atomic species that has been laser-cooled to temperatures below 1 millikelvin (e.g., Li, Na, K, Rb, Cs, Ca, Sr, Cr, Er, Yb), and their compatibility with such species in typical conditions of laser cooling must be specifically documented. Competitive ranking factors will include: richness and flexibility of trap functionality, such as the production of optical lattices, ring structures or other unusual spatial configurations, and differential trapping of multiple species; sufficient bandwidth to allow for reconfiguration of the trap on time scales that are short compared to characteristic ultracold atom relaxation phenomena (e.g. 1 millisecond); simplicity of design, manufacturing, and end-user maintenance; appropriate incorporation of advanced optical technologies (e.g. spatial light modulators, holographic patterns, acousto-optic modulators).

This is a rapidly-evolving research field. No general-purpose plug-and-play devices have yet been designed or manufactured. That is the goal of this SBIR topic.

PHASE I: Design a reconfigurable optical trap for ultracold atoms. The Phase I deliverable is a report containing the following mandatory elements:
1. Narrative description of the basic trap functions, operating parameters, and an example of a relevant Trial Application (e.g. production of an optical lattice, atom interferometry, etc.).
2. Description of a specific source of ultracold atoms to which the trap is to be interfaced, including identification of atomic species to be trapped and typical number density and temperature of atoms within the effective volume of the trap, when trap is on or off. Conditions similar to those reported in published literature or available at proposer's facilities will be preferred.
3. Parts list of trap components with open-market price information where available.
4. Specification of necessary optical and electrical interfaces.
5. Estimates of power consumption during operation of trap.
6. Engineering drawings sufficient for fabrication of trap components and final assembly of trap.

PHASE II: Build a prototype trap or traps as described in the Phase I deliverable. Test the trap's performance in a trial application with actual ultracold atom sources. (Optional: modify specification of trial application.) Optimize the trap with respect to performance in the trial application. Deliver a final version of the trap for validation of its performance in the trial application.

PHASE III: If the trial application has sufficient relevance to the operational Navy, the trap could become a central component of an atomic clock, frequency standard, magnetometer or other sensor. Alternatively, the trap might be developed as a general exploration platform for prototyping cold-atom applications in military and contractor laboratory environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The trap could be used as a standard component in research laboratories, much as lasers are today, increasing the convenience of ultracold atom exploration while reducing the cost of necessary experimental infrastructure.

REFERENCES:
1. "Ultracold molecules: vehicles to scalable quantum information processing," K.-A. Brickman Soderberg, N. Gemelke, C. Chin, New J. Physics 11, 055022 (2009).

2. "Species-specific optical lattices," L. J. LeBlanc and J. H. Thywissen, Phys. Rev. A 75, 053612 (2007).

3. "A Quantum Gas Microscope for detecting single atoms in a Hubbard regime optical lattice," W. S. Bakr, J.I. Gillen, A. Peng, S. Foelling and M. Greiner, Nature 462, 74-77 (2009)

4. "Single-atom-resolved fluorescence imaging of an atomic Mott insulator," Jacob F. Sherson, Christof Weitenberg, Manuel Endres, Marc Cheneau, Immanuel Bloch and Stefan Kuhr, Nature 467, 68–72 (2010)

5. "Single-particle-sensitive imaging of freely propagating ultracold atoms," R Bücker, A Perrin, S Manz, T Betz, Ch Koller, T Plisson, J Rottmann, T Schumm and J Schmiedmayer, New J. Phys. 11 103039 (2009)

KEYWORDS: ultracold; atom trap; optical trap; laser; interferometry; atomic clock

N121-101 TITLE: Absolute Localization in GPS-denied Environment for Autonomous Unmanned Ground and Micro-air Vehicle Systems

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

ACQUISITION PROGRAM: Robotic Systems Joint Project Office (RSJPO) which is an ACAT I program

OBJECTIVE: This topic seeks to develop methods for autonomous unmanned ground vehicles (AUGV) and micro-air vehicles (MAV) to determine their position in World Geodetic System 1984 (WGS 84) coordinates when Global Positioning System (GPS) is unavailable.

DESCRIPTION: In combat situations the Marine Corps utilizes a family of assets to include manned and autonomous unmanned combat and tactical vehicles to reach objective areas with speed and precision. Current AUGVs are critically dependent on GPS for much of their operation. Expensive methods are available to deal with short-term loss of GPS and methods to use odometry information obtained from electro-optical video are under research. These methods are limited in the amount of time and distance over which the AUGV can operate without GPS because of drift.

A drift-less and reliable method for an AUGV to reset its location based on non-GPS information is needed to prevent vulnerabilities of future Marine forces. A multi-prong approach is desired including:
- Development of absolute localization techniques for an AUGV employing electro-optical (EO) and LIDAR sensing augmented with the other forms of low-cost sensing in a GPS-denied scenario.
- Methods that exploit available information including, but not limited to, the local magnetic field, astronomical observations, lighting cues, local geology, odometry, near-field optical flow, or local slope information.
- Methods that exploit modification of the behavior of the autonomous vehicle to aid this localization process.

The proposed method should include an integrated architecture to create a precise drift-less absolute localization for application in both feature-rich and feature-poor environments. Of interest are methods that provide a registration of UGV-viewpoint video images with registered landmarks obtained from overhead imagery. Another area of interest is an inexpensive method to determine the localization from solar and astronomical observations employing low-cost, highly accurate clocks and sensors and which expand the availability of such observations.

Smaller tactical AUGVs and MAVs which may enter buildings or operate under GPS denial are also target platforms for such sensing and navigation capabilities, and they impose additional requirements for smaller size, weight and power packages for sensors and processors. Compact vision systems that are capable of sensing the environment and exploit stereo-based navigation, optical flow for visual odometry and obstacle proximity detection, and visual parallax are of interest.

PHASE I: Design an integrated architecture using several methods to create a precise drift-less absolute localization for application in both feature-rich and feature-poor environments. The method should provide a registration of UGV-viewpoint video images with registered landmarks possibly obtained from overhead imagery by working in conjunction with a micro-air vehicle. The architecture should also include a component that provides localization reset for regions which are poor in landmarks. Consider extensions to address tactical UGVs or MAVs moving indoors or under dense canopy. The architecture should leverage any available data and weigh its perceived utility in terms of validity and staleness.

PHASE II: Develop a prototype that can demonstrate the method from Phase I for a static (i.e. benchmark) demonstration. The prototype should be able to work in conjunction with a micro-air vehicle.

PHASE III: Transition to a program of record AUGV by development and integration of a ruggedized system onto an unmanned ground system and/or micro-air vehicle.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Numerous commercial systems use augmented GPS localization methods. Precision agriculture is one example. New commercial developments of the electromagnetic spectrum in the United States threaten the availability of these precision GPS localization methods rendering an entire industry vulnerable. A back-up localization method would find widespread application in the precision agriculture and the automobile industry as it attempts to automate many of the driver functions.

REFERENCES:

[1] M. M. Miller, A. Soloviev, M. Uijt de Haag, M. Veth, J. Raquet, T. J. Klausutis, J. E. Touma, "Navigating in Difficult Environments: Feature-Aided Inertial Systems," Proceedings of the NATO RTO Lecture Series on "Low Cost Navigation Sensors and Integration Technology," SET-116, March 2010.

[2] A. Soloviev, D. Eaton, M. Uijt de Haag, Z. Zhu, "Integration of Ladar Vision and Inertial Data for GNSS Denied Navigation," Proceedings of the ION GNSS 2009, Savannah, GA, September 2009, pp. 818-825.

KEYWORDS: GPS-denied; navigation; ground vehicles; autonomy; localization; positioning

N121-102 TITLE: Survivable Electronics for Control of Hypersonic Projectiles under Extreme Acceleration

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: Office of Naval Research EM Railgun Innovative Naval Prototype (INP)

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 electronics package or hardening techniques for existing electronics to support guidance, navigation, and control functions along with diagnostics and communications for use in hypersonic electromagnetic railgun projectiles.

DESCRIPTION: The Electromagnetic Railgun Innovative Naval Prototype (INP) program is developing a novel weapon system that can launch projectiles at speeds in excess of Mach 7 without the use of traditional propellants. These launchers are intended for a variety of applications, including long-range fire support, and therefore require on-board electronic guidance, control, and communication capabilities. Existing high-speed projectiles, such as missiles and artillery rounds, utilize electronics packages that have been designed to tolerate high accelerations that occur during launch. These technologies have been developed to survive short-pulse shock events characteristic of existing guns and missiles but have not been designed for the combination of extended extreme acceleration, high temperatures, and large electromagnetic fields that are present in the railgun application. Therefore there is a need to develop new electronics packages that are compatible with the harsh launch environment that is characteristic of electromagnetic railguns.

The on-board electronics must provide for guidance, navigation, and control functions (including Inertial Navigation System (INS)/GPS with anti-jamming and commands to control surfaces) and should also provide diagnostic data and communications back to the launch site (at ranges of 100-200 NM) to meet mid-course adjustment, reconnaissance, and flight termination requirements. The capability developed under this topic should provide high precision GPS positions with accuracy better than +/- 5 meters, 6DOF projectile orientation, and diagnostic/reconnaissance data via a communications link operating at a data rate of 5 Mbps (threshold) / 10 Mbps (objective) over a 110 NM (threshold) / 200 NM (objective) flight path at speeds in excess of Mach 8. The communications link must be bi-directional in order to support flight termination and retargeting requirements. The GPS receiver must utilize military codes and must be compatible with M-code signals. Where possible, the package should also incorporate deeply integrated functions such as anti-jamming, GPS up-finding, safe/arm functionality, and height of burst sensors.

The package must fit within the mass (< 2 kg), diameter (< 40 mm outer diameter), and volume (200 cm3) constraints of the projectile and do so without altering the center of gravity. It should also be able to survive accelerations of at least 20,000 g (threshold) / 40,000 g (objective) in all axes, high electromagnetic fields (E > 5,000

V/m, B > 2 T), and surface temperatures of > 800 deg C. The package should be able to operate in the presence of any plasma that may form in the bore or at the muzzle exit and must also be radiation hardened due to exo-atmospheric flight. Total power consumption must be less than 8 watts (threshold) / 5 watts (objective) and the battery life must be at least 5 minutes (from initial launch) to enable operation during the entire engagement. In order to be affordable, the production cost per projectile must be as low as possible, with a goal of less than $1,000 per unit.

Innovative research and development is needed to investigate electronic architectures and hardening techniques that can provide these capabilities within the environmental constraints of electromagnetic railguns described above. Since it is unlikely that all of the survivability requirements can be addressed within the scope of a single project, the emphasis for this topic should be on designs that provide acceleration/shock hardening with efficient packaging, space, volume, power requirements. The Navy will accept proposals that address the entire system, sub-components (i.e. crystal oscillator), or packaging manufacturing techniques. Potential solutions can include the use of microelectromechanical systems (MEMS) or solid-state components for accelerometers and inertial measurement units, hardening techniques for crystal oscillators, and novel materials and packaging techniques. Shock hardening of components (especially GNC & crystal oscillators) is of particular interest.

PHASE I: Refine and determine the feasibility of the proposed approach to meeting railgun projectile electronics requirements for both performance and survivability. As the concept is developed, feasibility will be shown through proof-of-concept demonstrations using a combination of laboratory testing, modeling and simulation, and live-fire testing using either gas guns or electromagnetic launchers as appropriate. Successfully demonstrating feasibility will be the criteria for Phase II projects.

PHASE II: Scale up the concept developed during Phase I to create a prototype electronics package that can be installed in a prototype railgun projectile furnished by the Navy for testing purposes. This prototype will demonstrate at least some of the functionality (e.g. position tracking, diagnostics, communications) required in the package as well as compliance with all of the environmental survivability requirements. Testing will be performed using either gas guns or electromagnetic launchers to demonstrate survivability under realistic operational conditions. The results of testing may be classified.

PHASE III: Apply the knowledge gained during Phase II to build a complete projectile electronics package that provides all required functionality while surviving the environmental conditions present during railgun launches and projectile fly-out. This package will be installed in an actual railgun projectile furnished by the Navy and tested in a full-scale electromagnetic launcher to demonstrate suitability for transition to the acquisition program. The results of testing may be classified.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of survivable control electronic packages can be applied to all forms of precision navigation applications, including other guided munitions, aircraft, spacecraft, and vehicles. Electronics that can survive high g-forces and shocks can also be applied to a variety of dual-use applications, including cell phones and other consumer electronics that require durability against accidental damage. They can also be used in data recorders (such as “black boxes”) and other devices that are designed to operate under extreme environmental conditions.

REFERENCES:
1. http://www.empf.org/programs/packaging.htm

2. B. Flyash, et al, “High-g Telemetry System for Tank Munitions”, 23rd International Symposium on Ballistics, April 16-20, 2007.

3. M. Berman, “Electronic Components for High-g Hardened Packaging”, ARL Technical Report ARL-TR-3705, January 2006.

4. http://www.empf.org/empfasis/june05/g0605.htm

KEYWORDS: High-G Electronics; Guidance; Navigation; Control; Telemetry; Survivable Electronics

N121-103 TITLE: Simple Profiler for Official Information Exchange

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: Navy Messaging System, ACT IVM

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 proposal is to develop software that would accept military messages in standard formats, such as ACP-123, ACP-128, or USMTF, via SMTP or as an XML or plain text file (.txt), and apply a set of profiles to the messages so as to make informed choices about how to forward disseminate each message to those who want to receive that type of information. Profiles must be configurable and must afford selection based on criteria such as message precedence, classification and other specific attributes in addition to conducting a keyword search of the message body, originator and destination addressees and subject.

DESCRIPTION: Navy activities receive thousands of Organizational messages daily. The administrative burden of human intervention to review that quantity of messages manually and make decisions about who needs to see which type of message based on content or other message attributes is not practical. Consequently this process must be automated, and profiling software is able to provide this function. The profiler software must be designed using an open standard architecture concept to accommodate multiple Operating Systems, with the ultimate goal of platform independence. Also the software should have no dependency on other commercially licensed software, but instead must be self-contained and run independently. The software must provide the administrator with the capability of tailoring the profiles based on such factors as organizational size, volume of incoming/outgoing messages, and military missions. The profiler software must afford users the flexibility to create new profiles based on current situation and ability to modify existing profiles as needed.

PHASE I: Develop an innovative profiler software architecture that leads to initial development of a profiler prototype that can be integrated into the Navy Messaging System (NMS). Consideration should be given to automated routing and distribution mechanism, the Department of Defense and Navy message standardization, commercial e-mail profile standardization, and the ability to load and run on various Operating Systems. The prototype should be able to be integrated into the Navy Messaging System and can optimally/automatically route and distribute messages with no human intervention during run-time. System Administration, as well as user tasks of creating, editing and removing profiles pertinent to their organization, should be the only human intervention required. The demonstration should include ability to successful route and distribute messages as desired based on the criteria configured in the profiles. The technology will be integrated as Navy's enterprise solution and be a component of business operation to support unique military messaging applications.

PHASE II: The Profiler prototype will be expanded to provide user interface and system administration capability as web-services that allow users to access these services from anywhere. The automation capability includes warnings and alerts of status of critical messages - delivery success, delivery failure, receipts and/or non-receipts. Desired capability would include providing such notices via SMTP e-mail, or through web-based user or SysAdmin interfaces, in addition to the local user interface. . Technology should support the Navy's enterprise environment and should be documented in the integration planning.

PHASE III: Upon successful completion of Phase I/II, the Profiler software will be integrated into the Navy Messaging Systems and evaluate the performance for transition. The technology transition plan will be updated and necessary resourcing will be coordinated to ensure sustainment and maintenance will be afforded.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology promotes greater competition for e-mail profiling capability that is currently dominated by limited commercial vendors at high cost. It also provides ability to tailor the profile based on mission criticality as well as to support unique messaging standards.

REFERENCES:

1. https://www.portal.navy.mil/oix/default.aspx, ALCOM 061/11, Organizational Global Address List.

2. http://www.navy.mil/search/display.asp?story_id=55467

3. Sample Navy message re safety related functions, uploaded in SITIS 12/19/11.

4. Sample Navy message re NAVADMIN, uploaded in SITIS 12/19/11.

5. Intelligence Community Information Transport Service Organizational Messaging Interface Control Document Appendix A IC Messaging Service (ICMS) XML Schema (Version 1.9) Document Version 1.1, 18 April 2011.

6. Intelligence Community Information Transport Service Organizational Messaging Interface Control Document Appendix B IC Organizational Messaging (ICOM) XML Version 1.4 Document Version 1.2, 25 August 2011.

KEYWORDS: ACP, Navy Messaging, Defense Message Distribution Systems, DMDS, profile, e-mail

N121-104 TITLE: Low Cost Electronically Steered Multi-Beam Transmit Array

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: PMW-120 - Ships Signal Exploitation Equipment, various ACAT III PORs

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 Low Cost Electronically Steered Multi-Beam Transmit Array.

DESCRIPTION: Modern US Navy ships have various requirements for high gain antennas that can transmit multiple high power signals to anywhere in the hemisphere of the ships field-of-view. Modern USN ships are also required to have a low radar cross-section, and utilize antennas for more than one function. This task is to develop a Low Cost Electronically Steered Multi-Beam Transmit Array that can operate over a very broad frequency band and transmit high power so that it can be used for multiple functions while maintaining a low radar cross-section. Only a transmit capability is required. Proposals are not limited to phased arrays, but must be capable of transmitting multiple beams that are electronically steerable. The array must be affordable, and conform to the specifications outlined below. The development is innovative due to the broadband high power required, small size, low weight, and multiple electronically steered beams. The following are specifications for this antenna. Refer to reference 1 and 2 for definitions of these parameters.

Low Cost Electronically Steered Multi-Beam Transmit Array Specification: The intent of this specification is to provide a high powered transmit array for shipboard use. All antenna types will be considered.

Freq range: Threshold: 1-21 GHz
Objective: 1-50 GHz

Azimuth/Elevation: 360 deg/ 0-90 deg

Simultaneous beams: Threshold: 2 (per quadrant)
Objective: 8 (per quadrant)

Beamwidth: 14 deg @ 1 GHz narrowing proportionately to Threshold: 5 deg @ 18 GHz;
Objective: 1 deg @ 21 GHz

Modulation bandwidth: Threshold: 1 GHz ;
Objective: 4 GHz

Beam Pointing/Steering accuracy: No worse than 0.7 deg RMS (triaxially stabilized against NAVSEA class standard ship motion specs) and able to maintain the beam on target within the 3 dB Beam width

Slew Rate: Azimuth (deg/sec): Threshold: 6   Objective: 10
Elevation (deg/sec): Threshold: 6   Objective: 10

EIRP: Threshold: 75 dbW (1-6 GHz), 60 dbW (6-18 GHz)
Objective: 80 dbW (1-6 GHz), 65 dbW (6-18 GHz)

Duty Cycle: @ 80 dBW with threshold 5% objective 10%
@ 40 dBW with threshold 50% objective 100%

Cost: Threshold: $1M per shipset
Objective: $250K per shipset

Size: Threshold: Diameter not greater than 96 inches
Objective: Diameter not greater than 72 inches

Weight: Threshold: Under 250 lbs; Objective: Less than 100 lbs

Environmental Requirements: USN ship Shock, vibration, temperature, salt air and other environmental requirements per reference MIL-HDBK-2036

PHASE I: Develop the approach for implementing the Low Cost Electronically Steered Multi-Beam Transmit Array that meets threshold specifications. Accomplish modeling to identify the expected efficiency of the application. Provide a paper documenting the design approach and modeling results.

PHASE II: Complete antenna development and design that meets the requirements using computer modeling and by prototyping and testing. Fabricate an engineering development model antenna (EDM). Test this antenna for compliance with the electrical and mechanical specifications. Provide a report outlining the antenna performance in relation to the above specification. Develop a plan to develop the EDM antenna into a production antenna. Provide the EDM antenna to the US Government for evaluation and testing.

PHASE III: Refine the antenna design and fabricate and test production model antennas. Qualify these antennas for USN Ship installation. Develop an antenna production line and provide antennas for USN Shipboard installations.

REFERENCES:
(1) Antennas, second edition, John D. Kraus; ISBN 0-07-035422-7, McGraw Hill, copy write 1988, 1950.

(2) Antenna Theory and Design, 2nd Edition, Warren L. Stuzman and Gary A. Thiele; ISBN-10: 0471025909; ISBN-13: 978-0471025900; 1997

(3) MIL-HDBK-2036

KEYWORDS: low RCS; multi beam; Antenna; broadband; shipboard; stabilized

N121-105 TITLE: Lines of Operations Automated Decision Support System

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO C4I/PMW150

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 Lines of Operations Automated Decision Support System to evaluate Lines of Operations identifying deviations from planned Lines of Operations (to cue re-planning), formulate branch plan and sequel recommendations, and feedback plan changes to the master operational plan repository.

DESCRIPTION: The Operational Planning Processes of NWP 5-01 (Navy Planning) results in a selected Course of Action composed of a set of logical Lines of Operations. As defined by Joint Publication 3-0 (Joint Operations), Lines of Operations are logical lines that connect actions on nodes and/or decisive points related in time and purpose with objectives. Lines of Operations developed in the planning phase are based on a set of assumptions about the expected execution phase operational situation. The dynamic nature of warfare nearly guarantees that the actual operational situation will deviate from the assumed operational situation utilized in planning. Resulting deviations necessitate branch plans and sequel actions to accommodate emergent operational events. Human C2 operators regularly spend more time heads-down in their C2 systems assessing incoming situational awareness data, leaving them little time to engage in the important task of evaluating the operational situation with respect to the selected Course of Action and stated operational goals/objectives. Evaluation is critical, as identification of Lines of Operations deviations precedes vital branch planning and sequel action activities. What is needed is an automated system that evaluates incoming situational awareness data and has the capability to alert human C2 operators when deviations from planned Lines of Operations are detected. Furthermore, the automated system should provide initial branching plan and sequel action recommendations. This enables the human C2 operator to shift focus from building the C2 picture to making C2 decisions!

PHASE I: Assess the feasibility of developing a Lines of Operations Automated Decision Support System. Determine if a Lines of Operations evaluation data model can be developed such that incoming C2 data can be aggregated and analyzed in a manner that enables system understanding of Line of Operations progress and deviation. Determine what kinds of operational re-planning could be conducted by such a system when deviations from current Lines of Operations are detected. Define a high-level architecture for the system and provide a roadmap for development of Phase II prototype of the system.

PHASE II: Develop a prototype Lines of Operations Automated Decision Support System. Demonstrate that the prototype is able to aggregate and analyze incoming C2 data and provide C2 operator with Lines of Operations progress updates and deviation alerts. Demonstrate how the system would assist in operational re-planning when deviations from planned Lines of Operations are identified. Determine what additional capabilities are required to provide a fully developed Lines of Operations Automated Decision Support System for the fleet.

PHASE III: Work with the Navy C2 Program of Record sponsor – PMW-150 GCCS-M Program Office - to expand prototype and prepare for transition of the Lines of Operations Automated Decision Support System into the Navy C2 architecture for eventual fielding at ashore and afloat locations. Analyze and address Information Assurance Certification & Accreditation requirements. Demonstrate the Line of Operations Automated Decision Support

System in a Sea Trial experiment and evaluate for military utility. The experiment shall be deployed on a US Navy Secret network, with at least one ashore instance, one command ship, and two or more subordinate afloat units.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A successful implementation of a Lines of Operations Automated Decision Support System should yield a technology foundation that can be similarly applied to other distributed enterprises. Navy processes are unique only in their application domain. The technology should be adaptable to corporate environments, other Government agencies, or any other organization that implements operational plans. The technology and know-how developed by the provider will support a private sector business model if desired.

REFERENCES:
1. Willard, Robert F. Rediscover the Art of Command and Control, Proceedings of the U.S. Naval Institute, October 2002

2. Naval Warfare Publication NWP 5-01 Navy Planning, Office of the Chief of Naval Operations, January 2007

3. Joint Publication 3-0 Joint Operations, Joint Chiefs of Staff, 17 September 2006 Change 2 (22 March 2010)

4. On Lines of Operations : A Framework for Campaign Design Coxwell, Charles W. 01 November 1995

KEYWORDS: Lines of Operation; OLW; Command and Control; C2; Planning; Decision

N121-106 TITLE: Technologies/Methods for enabling Transactional Interfaces

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Command and Control Processor (C2P) ACAT II

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OBJECTIVE: To define a set of technologies and or methods that will enable transactionally based data links yet decouple the internal interfaces to the maximum extent possible in a way that can be leveraged across many different systems.

DESCRIPTION: Combat systems exchange tactical information over data links which prescribe unique sequences of events known as transactions that must occur for an information exchange to take place. Historically the transactional nature of these data links has led to equally closed and transactionally based internal interfaces between the combat system Computer Software Configuration Item (CSCI) and the data link processing CSCIs. This tight coupling between internal interfaces and the data links has precluded the DoD's ability to easily leverage modern communication technologies to provide rapid insertion of capability to the end users. This also precludes our ability to migrate tactical data link functionality into the cloud-based architecture to support "APP Store" capability to hand held devices for applying "Power to the Edge" command and control doctrine. Additionally, over time each system has developed unique and frequently proprietary methods to interface internal components that leads to the DoD repetitively procuring the essentially the same capability across each different system employing data links.

PHASE I: Assess the feasibility of developing a method to enable transactionally based data links. Determine if a data/architecture model can be developed such that incoming C2 data can be aggregated and analyzed in a manner that enables system understanding of multiple systems. Determine what kinds of interfaces can be decoupled and provide a analysis to what extent the decoupling will impact development. Determine how to evolve technology to support Tactical Data Link functionality to hand held devices using an APP Store approach. Define a high-level architecture for the system and provide a roadmap for development of Phase II prototype of the system.

PHASE II: Develop a prototype system to provide Technologies and Methods for enabling Transactional Interfaces. Demonstrate that the prototype is able to aggregate and analyze incoming CSCI data and provide C2 operator with modern communications technologies to interact with combat systems with greater ease. Develop an APP prototype to provide initial Tactical Data Link capability. Demonstrate how the system would interact with combat systems utilizing decoupled and non-proprietary technologies to allow for eventual rapid insertion for fleet use. Determine what additional capabilities are required to provide a fully developed methodology to provide decoupled and easily developed transactional interfaces for data link integration to multiple systems for the fleet. Work being done under Phase II will be classified Secret.

PHASE III: Work with the Navy C2 Program of Record sponsor – PMW-150 GCCS-M Program Office - to expand prototype and prepare for transition of the Transactional Interfaces into the Navy C2 architecture for eventual fielding at ashore and afloat locations. Analyze and address Information Assurance Certification & Accreditation requirements. Demonstrate the Transactional Interfaces in a Sea Trial experiment and evaluate for military utility. The experiment shall be deployed on a US Navy Secret network, with at least one ashore instance, one command ship, and two or more subordinate afloat units. Work being done under Phase III will be classified Secret.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A successful implementation of the Transactional Interfaces should yield a technology foundation that can be similarly applied to other distributed enterprises. Navy processes are unique only in their application domain. The technology should be adaptable to other environments and other systems involving data links. The technology and know-how developed by the provider will support a private sector business model if desired.

REFERENCES:

1. INTRODUCTION TO TACTICAL DIGITAL INFORMATION LINK J AND QUICK REFERENCE GUIDE FM 6-24.8, MCWP 3-25C, NWP 6-02.5, AFTTP(I) 3-2.27

2. AIR LAND SEA APPLICATION CENTER, JUNE 2000

3. "Understanding Link 16, A Guidelines for United States Navy and United States Marine Corps Operators", September 2004.

KEYWORDS: data links; combat systems, interfaces; command and control; link 16; tactical information