NAVY
SBIR FY07.1 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, williajr@onr.navy.mil. For general inquiries or problems with electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST). 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 on the website before **6 December 2006.** Beginning 6 December, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in section 1.5c of the program solicitation must be used for any technical inquiry.

TABLE 1: NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT

Topic Numbers	Point of Contact	Activity	Email
N07-001 thru N07-005	Mr. Paul Lambert	MARCOR	paul.a.lambert@usmc.mil
N07-006 thru N07-051	Mrs. Janet McGovern	NAVAIR	janet.mcgovern@navy.mil
N07-052 thru N07-067	Ms. Janet Jaensch	NAVSEA	janet.l.jaensch@navy.mil
N07-068	Ms. Bree Hartlage	NAVSUP	bree.hartlage@navy.mil
N07-069 thru N07-102	Mrs. Cathy Nodgaard	ONR	nodgaac@onr.navy.mil
N07-103 thru N07-113	Ms. Linda Whittington	SPAWAR	linda.whittington@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 activity's facility for one day of meetings are recommended for all proposals and required for proposals submitted to MARCOR, NAVSEA, and SPAWAR. 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. For NAVAIR topics N07-006 thru N07-051 the base amount should not exceed $80,000 and 6 months; the option should not exceed $70,000 and 6 months. For all other Navy topics the base effort should not exceed $70,000 and 6 months; the option should not exceed $30,000 and 3 months. **PROPOSALS THAT HAVE A HIGHER DOLLAR AMOUNT THAN ALLOWED FOR THAT TOPIC WILL BE CONSIDERED NON-RESPONSIVE**.

The Navy will evaluate and select Phase I proposals using the evaluation criteria in section 4.2 of the DoD solicitation in descending order of importance with technical merit being most important, followed by the qualifications, and followed by commercialization potential. 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, email 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

In addition to the final report required in the funding agreement, all awardees must electronically submit a non-proprietary summary of that report through the Navy SBIR website. Following the template provided on the site, submit the summary at: **http://www.onr.navy.mil/sbir**, click on "Submission", and then click on "Submit a Phase I or II Summary Report". This summary will be publicly accessible via the Navy's Search Database.

NAVY FAST TRACK DATES AND REQUIREMENTS

The Fast Track application must be received by the Navy 150 days from the Phase I award start date. Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates may be declined. All Fast Track applications and required information must be sent to the Technical Point of Contact for the contract and to the appropriate Navy Activity SBIR Program Manager listed in Table 1 above. The information required by the Navy, is the same as the information required under the DoD Fast Track described in section 4.5 of this solicitation.

PHASE II GUIDELINES

Phase II proposal submission, other than Fast Track, is by invitation only. If you have been invited, follow the instructions in the invitation. **Each of the Navy Activities 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 solicitation in descending order of importance with technical merit being most important, followed by the qualifications, and followed by commercialization potential. 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.

Under the new OSD (AT&L) directed Commercialization Pilot Program (CPP), the Navy SBIR program will be structuring more of our Phase II contracts in a way that allows for increased funding levels based on the projects transition potential. This will be done through either multiple options that may range from $250K to $1M each, substantial expansions to the existing contract, or a second phase II award. For currently existing phase II contracts, the goals of the CPP will primarily be attained through contract expansions, some of which may significantly exceed the $750K recommended limits for Phase II awards not identified as a CPP project. All projects in the CPP will include notice of such status in their Phase II contract modifications.

All awardees, during the second year of the Phase II, must attend a one-day Transition Assistance Program (TAP) meeting. This meeting is typically held 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.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary through the Navy SBIR website at the end of their Phase II.

A Navy Activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award have been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

The Navy typically awards a cost plus fixed fee contract or an Other Transaction Agreement 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 the Law (PL102-564) permits Phase III awards during Phase II work, the Navy 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. If you have questions, please contact the Navy Activity SBIR Program Manager.

PHASE III

Public Law 106-554 provided for protection of SBIR data rights under SBIR Phase III awards. A Phase III SBIR award is 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. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description. 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

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

Any contractor proposing research that requires human, animal and recombinant DNA use is advised to view requirements at website http://www.onr.navy.mil/sci_tech/ahd_usage.asp. This website provides guidance and notes approvals that may be required before contract/work may begin.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria must be met or your proposal will be REJECTED.

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

____2. Your technical proposal has been uploaded and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 a.m. EST 10 January 2007.

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

____4. For NAVAIR topics N07-006 thru N06-051, the base effort does not exceed $80,000 and 6 months and the option does not exceed $70,000 and 6 months. For all other proposals, the Phase I proposed cost for the base effort does not exceed $70,000 and 6 months and for the option $30,000 and 3 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.

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Navy SBIR 07.1 Topic Descriptions

N07-001 TITLE: Ballistic Exhaust Grille

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: DRPM Advanced Amphibious Assault (DRPM AAA) ACAT I

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

OBJECTIVE: Research, design and build a high flow rate ballistic exhaust grille that allows directional output control.

DESCRIPTION: The Marine Corps EFV is a 76,000 lb armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. The current cooling outlet armor grilles are grilles affixed to the hull that are used to protect the heat exchangers from ballistic damage. The current design is limited due to competing requirements: 1) The design must maintain ballistic performance, 2) must allow for airflow, and 3) must also reduce vehicle infrared signature. Material selection has been difficult due to the extreme operating environment which ranges from -25F to 200F, hot dessert blowing sand to full salt water immersion. The EFV is looking to create a cooling outlet armor grille or simple design that allows for increased air flow and directional flow control capabilities while maintaining ballistic protection against 14.5mm API B32 at 0 degrees elevation and the 99th percentile 155mm fragment simulated using the 20mm FSP.

PHASE I: The contractor shall conduct research into lightweight ballistic materials for use on the EFV, keeping in mind the environment in which those materials will be used. Based on their research, the contractor shall create a conceptual design including estimated weight, cost and performance characteristics (i.e. air flow, temperature extremes, estimated life, functionality, etc.)

PHASE II: The contractor shall manufacture a prototype and conduct ballistic and airflow testing to validate their design meets EFV required performance levels.

PHASE III: The contractor shall manufacture ballistic cooling exhaust grilles for use on the EFV. This technology is directly applicable to large military vehicles such as the Army's FCS and facilities that require ballistic protection and must still maintain exhaust air flow.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology may be used in the commercial sector to maintain airflow in harsh environments that may include high speed fragments and high pressure explosions.

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

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

3. MIL-STD-889B Dissimilar Metals

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

KEYWORDS: Ballistic; Grille; Airflow; lightweight; exhaust; cooling; all-weather

N07-002 TITLE: Single Aperture Passive Rangefinding

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Family of Individual Optics ICD, PM Optics & Non-Lethal, ACAT IV

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

OBJECTIVE: This topic seeks technology to determine the range of objects without the use of active emitters or separated apertures for trigonometry measurements. The system shall be compatible with current electro-optical imaging technology to allow a single sensor to perform both imaging and ranging functions. The system shall be capable of quickly building a three dimensional map of all objects within the field of view. Measured distance accuracy may be inversely proportional to the distance measured.

DESCRIPTION: The increasing use of warning receivers and electro-optical devices capable of detecting radar or laser rangefinders employed by Marines alerts enemy forces to friendly presence and may provide sufficient time to evade direct fire or precision guided weapons that rely on accurate target location information. Optical rangefinding devices are by necessity cumbersome due to the separation required between optical elements to make angular measurements. Focused and unfocused light arriving through a single aperture may provide enough information for range determination by electronic image processing techniques. The ability to covertly map objects in three dimensions would also improve the use of automatic target detection and recognition techniques to enhance situational awareness.

PHASE I: Determine, insofar as possible, the scientific and technical requirements for completing the following tasks:
1. Determine distance of objects in the field of view of an electro-optical imaging device without the use of active emitters or multiple apertures. Provide an analysis of rangefinding accuracy as a function of target distance and sensor geometry.
2. Construct near real-time three dimensional maps of objects using the techniques developed for the previous task.

PHASE II: Develop proof-of-concept demonstrators of systems to conduct each task separately or simultaneously.

PHASE III: Integrate proof-of-concept demonstrators with existing fielded optical systems and demonstrate.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Machine vision systems for industrial and consumer use would benefit from the ability to perform distance measurements and three dimensional perception of objects without the cost of high-resolution laser/radar systems. Physical space requirements for optical rangefinders also limit employment.

REFERENCES:
1. Initial Capabilities Document for the Marine Handheld/Head Mounted Optic

2. Initial Capabilities Document for the Infantry Marine Individual Weapon Sight

KEYWORDS: Passive Rangefinding, Sensor Fusion, Target Profiling, Automatic Target Recognition, Machine Vision, 3-D Mapping

N07-003 TITLE: Improved Compact High Pressure Hydraulic And Pneumatic Actuation System

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: DRPM Advanced Amphibious Assault (DRPM AAA) ACAT I

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

OBJECTIVE: Significantly improve performance of Expeditionary Fighting Vehicle (EFV) hydraulic/pneumatic retractable actuators through development of ultra-high capacity actuator technology utilizing innovative high pressure sealing systems, bearings, spring/damping/position control, and material technologies. These actuators will be highly compact in size and capable of withstanding higher dynamic gas and hydraulic pressures (20,000 – 30,000 psi), wide temperature range operation (-65F – 140F), and increased bearing loads for longer periods of time and greater distances (3,000+ miles) than current technology provides.

DESCRIPTION: The Marine Corps EFV is a 78,000 lb. armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. The EFV has a significant number of hydraulic and pneumatic actuator controlled appendages. For some of its actuators, the EFV is near the limits of seal and bearing technology and this will have a negative effect on reliability and lifecycle cost. A second issue is the expectation that as EFV weight increases in future years, due to added equipment or armor, additional stress will be placed on many of the vehicle's actuators. Due to space constraints and weight limitations, the actuators' physical size cannot be increased. This requires that innovative sealing systems, bearings, linkage mechanisms, internal hydraulics, materials and other technologies be used to increase actuator load capacity and durability within an already very compact actuator space claim. Other armored vehicles, including FCS (Future Combat Systems), and many commercial applications would benefit from the improved actuator load carrying capacity over what is traditionally available in a compact actuator. If successful, actuator life cycle costs and the vehicle's maintenance burden would decrease while reliability and mission availability would increase.

PHASE I: Investigate new and innovative mechanical linkage, gas & hydraulic layout concepts, robust & non_temp sensitive sealing and bearing materials, and other material technologies that have the potential to increase EFV actuator durability and capacity without increasing the external size. Down-select a candidate for and perform limited lab testing to confirm performance expectations.

PHASE II: Continue research and make final selections for innovative designs, materials, sealing systems, bearings, and hydraulic control. Conduct lab testing to refine material, component shape, and/or system configuration in order to meet or exceed performance requirements. Fabricate and test a limited number of prototype actuator solutions. Perform simulated (laboratory) 3,000 mile durability tests.

PHASE III: Purchase and install one vehicle set of improved hardware. Perform field testing. Begin procurement planning for technology insertion into production vehicles.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Improving the capacity and durability of hydraulic and pneumatic actuators while maintaining a compact size will find a wide range of applications in commercial markets. Although cost may be higher, the reduced size and capacity coupled with reasonable durability will provide an improved solution for many applications.

REFERENCES:
1. Engineering Design Handbook, Automotive Series Automotive
Suspensions, 14 April, 1967, published by United States Army Material Command, pg. 1-22

2. Fundamentals of Vehicle Dynamics, Gillespie, T. D., Copyright 1992, published by Society of Automotive Engineers, pg.147-189
KEYWORDS: Elastomer, rubber, polyurethane, durability, suspension, track, roadwheel

N07-004 TITLE: Replacement of Red Phosphorus in smoke producing munitions

TECHNOLOGY AREAS: Materials/Processes, Battlespace

ACQUISITION PROGRAM: Marine Corps Systems Command, Program Manager for Ammunition (PMM204)

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

OBJECTIVE: The objective of this effort is to develop a replacement material that can be used in all, or most, obsurant smoke cartridges currently in the USMC inventory.

DESCRIPTION: Find a material or combination of materials that, is capable of generating large quantities of obscuring smoke, while limiting the user to harmful and hazardous chemicals, both during opearation and storage.

PHASE I: Find potential candidate materials to replace red phosphorus in smoke producing, obscurance, munitions. Define the mechanism of operation, and perform small scale tests to demonstrate its potential effectiveness and to justify larger scale testing.

PHASE II: Using the best candidate(s) from Phase I, perform larger scale testing on prototype hardware, that demonstrates the material's smoke producing capabilities. Perform chemical analyses during operation and storage to demonstrate it does not subject the user to harmful or hazardous chemicals. Define the manufacturability of the material.

PHASE III: The USMC has requirements for obscuring smoke producing cartridges is all mortar and artillery systems 60MM and larger. The candidate fill material has potential applications in the USMC 60MM, 81MM, and 120MM mortars; the 155MM artillery smoke cartridges; and floating smoke pot, as well as the US Army 105MM artillery cartridge.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Non-toxic smoke generation for potential use in firefighter training and entertainment, such as stage plays and celebrations.

REFERENCES:
1. Toxicity of Military Smokes and Obscurants, Vol 2; National Academy Press; ISBN 0309063299
Field Manual FM71-123, Appendix G: Tactics and Technicques for Combined Arms Heavy Forces: Armored Brigades, Battalion Task Forces, and Company Teams, Appendix G - Smoke Obscurants.

KEYWORDS: Obscurants; Smoke; Red Phosphorus

N07-005 TITLE: <u>Advanced Equipment Maintenance Using Revolutionary Augmented Reality Technology</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Human Systems, Weapons

ACQUISITION PROGRAM: Program Management Test, Measurement, and Diagnostic Equipment (PMTMDE)

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

OBJECTIVE: Develop an advanced equipment maintenance capability, based upon revolutionary Augmented Reality (AR) technology, that is designed to provide Marine Corps equipment maintainers with rapid and intuitive access to complete weapon systems data.

DESCRIPTION: For many years, the Marine Corps and DoD have been using paper technical manuals and a variety of Interactive Electronic Technical Manuals (IETM) to guide equipment maintainers through a variety of complex maintenance procedures. These have been utilized on equipment such as land vehicles, radar systems, radio communications systems, and ground based weapon systems. These technical manuals require the maintainer to often flip, scroll, or hyperlink though a long series of pages full of text, drawings, and computer programs in order to locate the information that he needs to debug maintenance issues. The use of these types of technical manuals can tend to be time consuming, tedious, and limited to either desktop or laptop computer viewing methods. Extracting the appropriate data can require much time and searching in many cases.

In light of this, there is currently a need in the Marine Corps to provide its equipment maintainers with a cutting edge, graphic intensive, interactive, and highly intuitive Augmented Reality (AR) based equipment maintenance capability that provides Marine Corps equipment maintainers with rapid and intuitive access to complete weapon systems data. It must equip them with the intelligence and data pertaining to any given Marine Corps weapon system for the purpose of quickly and accurately assessing its true condition, and restoring that system to full operation. This includes maximal automation and auto-documentation. The end state of this particular capability will allow an average maintainer to be equipped with all of the technical knowledge that he needs to perform maintenance on any given piece of Marine Corps equipment; even while he is being trained in the field (post schoolhouse). This capability, when used by the maintainer, will allow him access to the exact data that he needs at the time that he needs it.

Such technology can be used to rapidly expand a Marine Corps maintainer's awareness by providing timely and valuable information and instructions to him as he attempts to repair a malfunctioning piece of equipment. As the maintainer nears the asset, a small display system would generate augmented reality overlays on his visual field thru what appear to be low profile, safety-like eyewear. Using the latest visual processing methods, microminiaturized, high resolution cameras embedded within the frame of the glasses would use the true visual field as the maintainer moves about the asset as a relative reference for any visual augmentation to the field of view. The augmented information would be clear and stark, would not present any safety hazard, and would be viewable in any lighting or dust conditions.

The low profile, safety glasses would also come equipped with integral earpieces that provide noise reduction circuitry as well as audio to the maintainer. The AR based system will even know if the maintainer is performing the wrong action, as the same visual capability that provides/drives the augmented reality will be able to derive the position and placement of the maintainer as he moves upon/within the asset. The key here is that the detailed physical layouts and topology of the weapons systems themselves rarely change except within a certain range of motion. (i.e., Line Replaceable Unit (LRU), chassis and cabinet modifications, cable removals etc.).   Therefore, the potential for the AR based system to detect incorrect actions is enhanced.

For example, consider a situation where a maintainer approaches a Light Armored Vehicle (LAV)-25 to perform diagnostics. As he approaches the vehicle, augmented visual overlays driven by validated, data-based prior maintenance actions and remote sensoring, with behavioral input indicate to him that the LAV-25 is not currently due for any planned maintenance. However, sensor data and behavioral trending indicate that unusual electrical noise had been detected on several analog and digital data lines within the hull during the last mission. As the maintainer enters the powered down LAV-25, he sees three-dimensional renditions of the suspected noise signal locations and is able to view exact signal routing layouts and measurement points without opening a single module.

At this point he is ready to energize the LAV-25. He is not a seasoned veteran, but a young Marine who is still acquiring experience, and the AR based system knows the skill level of the actual maintainer using it (the system would 'rate' his skill level based on training, and behavior tracking each time the maintainer 'logs in'). The AR based system prompts if he is ready to start up the LAV, and as the maintainer indicates, he is well instructed (audibly) by the system as if a seasoned maintainer were standing next to him. The system, equipped with AR technology, shows the Marine exactly where to go and what to do for a safe startup. The instructions are seamlessly overlaid upon the actual areas on which the maintainer must interact.

There is currently no Augmented Reality (AR) based system in existence today that offers all of these capabilities. Most AR based maintenance aids simply utilize predefined procedures to guide an equipment maintainer through maintenance tasks with very few smarts in the system (see reference #2 below).   A tremendous amount of research and development would be needed to make an AR based capability with the all of the smarts that this SBIR topic describes. In light of this, a great deal of risk would be involved in the development of this capability.

PHASE I: Design a cutting edge, graphic intensive, interactive, and highly intuitive Augmented Reality (AR) based equipment maintenance capability. This would provide Marine Corps equipment maintainers with rapid and intuitive hands free access to complete weapon systems data while fully viewing the area or platform in need of maintenance.

This includes detailed, fully functional, three dimensional, mechanical, electrical signal level, and block diagrammatic information that can be accurately overlaid or manipulated in context within the maintainer area of visual interest while working on a weapons system. This information must be available upon need, as the situation may require, in an intuitive fashion, but not as to distract the maintainer. This system must be capable of data integration with external test equipment to verify displayed parametric signal data with AR represented signal data and show matching or mismatching of data within the same field of view. The system must be capable of interaction and recognition of both seasoned maintainers who require little intervention and less experienced technicians who will require more enriched data. Active learning and auto-documentation of completed and verified work taskings can also occur within this environment. The capability must be designed to augment a Marine Corps maintainer's view of the maintenance environment by providing timely and valuable information and instructions to him as he attempts to repair a malfunctioning piece of equipment. The AR system must be capable of overlaying information within the maintainers' normal field of view in real time. The overlaid, full color data must adjust for lighting, and track correctly to the equipment of interest even as the maintainer moves about. All methods to eliminate vertigo, eye strain or disorientation must be utilized to maximize utility and ensure safety. Interaction between the user and the system must be as intuitive and seamless as possible. It must also be designed to know if the maintainer is performing a wrong action via real time detection of the position and placement of the maintainer as he moves upon/within the test asset. Upon proper identification and verification of a failed part, the ability to order the item automatically with full auto documentation will help maximize work throughput. The additional use of integral noise-canceling, audio interfacing (listening and speaking) technology will accelerate data transfer. This type of interfacing will provide an unparalleled training and data transfer capability that currently does not exist within the DoD.

PHASE II: Develop a lightweight, hands free prototype AR based equipment maintenance capability that fully implements the capabilities developed in Phase I.

PHASE III: Develop the AR based equipment maintenance capability prototype for field demonstration of equipment maintenance for specific DoD platform applications. Transition the capability to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS:
The proposed novel technology would have broad civilian impact for equipment maintainers in diagnosing and repairing problems associated with a variety of electronic systems in numerous commercial applications.

REFERENCES:
1. Feiner, S., MacIntyre, B., and Seligmann, D., "Knowledge-Based Augmented Reality"; Communications of the ACM – July 1993, Vol. 36, No. 7, p. 53.

2. Boeing website – http://www.boeing.com/defense-space/support/training/instruct/augmented.htm

3. Columbia University Computer Graphics and User Interface Lab's website – http://www1.cs.columbia.edu/graphics/top.html - June 2005

4. Flexwork website – http://www.flexwork.eu.com/members/iststor/starmate.pdf

KEYWORDS: Maintenance; training; automation; augmented reality; equipment; data overlay

N07-006		TITLE: Non-Line-of-Sight Coating Of Turbine Airfoils

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: F35 Joint Strike Fighter Program

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

OBJECTIVE: Develop and demonstrate an affordable method of coating complex-shaped turbine airfoils with controllable thickness distributions and with microstructure that is sufficiently strain-tolerant and will survive in the turbine environment.

DESCRIPTION: Current state-of-the-art techniques used to coat turbine airfoils with ceramic thermal barrier coatings (TBCs) are typically line-of-sight. These coating techniques offer limited throwing power to coat hidden and deeply concave surfaces. As a result, the achievable coating thickness distributions on complex-shaped parts are limited and inconsistent. Furthermore, suboptimal coatings are developed on surfaces with limited line-of-sight to the coating source, reducing the life of the coatings in a turbine environment.

The need exists for an innovative manufacturing technology that can produce coatings capable of withstanding the harsh turbine environment, and offers an improved degree of control to produce a somewhat tailorable thickness distribution, regardless of the complexity of the shape of the part. An additional significant constraint is the need to retain a microstructure that is strain tolerant for the ceramic TBC. Finally, a capital and/or recurring cost advantage relative to current state-of-the-art TBC processing technologies is required for commercialization.

PHASE I: Design an improved manufacturing process and demonstrate its feasibility in a laboratory environment. Compare the new coating process with the current industry standard process. Include the standard process as the baseline when comparative testing is performed. Ensure durability of coatings has not been degraded when compared to the baseline.

PHASE II: Develop and test a prototype system or process that is capable of producing engine quality hardware at a deposition rate that would produce an acceptable low-cost solution for producing these coatings.

PHASE III: Develop a production quality, low-cost, low-maintenance machine or process that can survive in a production environment. Produce production quality coatings at a cycle time and cost required to meet production quantities and cost requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Such a process would have wide ranging applicability in both the public and private sector. The geometry of turbine airfoils for commercial jet engines is getting more complex with each design. Thus several current and future airfoil designs would benefit from this technology. Indeed, this capability might enable more complex designs. In general, any complex-shaped part that requires a refractory metal or refractory ceramic coating would benefit from this envisioned technology.

REFERENCES:
1. Tamarin, Y., “Protective Coatings for Turbine Blades.” ASM International 2002.

2. Donachie, Matthew J., “Super Alloys,” ASM International 2002 page 319.

3. http://www.msm.cam.ac.uk/phase-trans/2003/Superalloys/coatings/index.html.

4. http://www.freepatentsonline.com/6572933.html.

5. http://www.freshpatents.com/Non-line-of-sight-process-for-coating-complexed-shaped-structures-dt20060209ptan20060029733.php.

6. http://www.er.doe.gov/sbir/awards_abstracts/sbirsttr/cycle23/phase1/083.htm.

7. http://www.people.virginia.edu/~jfg6e/groves/PhD/chp12.pdf.

8. http://www.netl.doe.gov/publications/proceedings/03/materials/manuscripts/Besmann_m.pdf.

KEYWORDS: Non-Line-of-Sight (NLOS); Thermal Barrier Coatings; Bond Coats; Zirconia; Oxidation Resistance; Turbine Airfoils

N07-007 TITLE: Solid-State High-Efficiency Radar Transmit Module

TECHNOLOGY AREAS: Air Platform, Electronics, Battlespace

ACQUISITION PROGRAM: PMA 263 Unmanned Air Vecihles Program Office

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

OBJECTIVE: Develop innovative technology with a solid-state high module (or building block) power output that has the necessary characteristics to operate in a Class E or F radar transmit module.

DESCRIPTION: The efficiency of current radar transmitters for airborne surveillance systems is in the 20 percent to 30 percent range. The remaining 70 percent to 80 percent of the electrical energy that is generated to drive these devices must be removed as heat energy. The weight and fuel consumption associated with the generation of this unused electrical energy, and its removal as heat energy results in increased airborne system costs and/or reduced aircraft performance. These impacts are exacerbated by the reduced size and increased altitudes associated with high-altitude, long-endurance unmanned air vehicles (UAVs), where propulsion and power generation are principal cost drivers. Further, the increased demand for greater surveillance capability in the form of long-range detection of low-observable air targets continues to drive power requirements to higher and higher levels.

The conventional approach to achieving kilowatts of peak power is to combine lower power devices, typically in a parallel corporate feed, to achieve the desired transmit power levels. There is a significant penalty associated with configurations of this nature, due to the RF losses inherent with the combining networks. The higher power requirements necessitate more combining networks with commensurately higher power losses. One approaches a point where the dissipation in the combining networks must be addressed as part of the overall system thermal design, impacting the capacity of the cooling system. Consequently, a comprehensive approach to both improving high-power amplifier efficiency, and developing the highest module (or building block) power output is required to reduce the number of combining networks required to achieve the ultimate transmitter peak power.

The silicon bipolar devices that have been the mainstay for high-power short-pulse amplifiers do not possess the characteristics for use in Class E or F high-power amplifiers (HPAs). Whereas, these high-voltage lateral diffused metal oxide semiconductors (LDMOS) are improving, their high capacitance limits their performance in a switched mode Class E amplifier. Silicon carbide (SiC) and Gallium Nitride (GaN) devices show promise to deliver high power and high efficiency. These devices are becoming commercially available. These devices have the ability to sustain very high heat densities, in excess of 10 watts per sq mm. Both SiC and GaN have breakdown voltages on the order of 50 volts, a significant improvement over silicon LDMOS devices with a 28-volt capability.

Because these newer solid-state, SiC and GaN device designs offer higher efficiencies, it is anticipated that forced-air or conduction cooling will be utilized to achieve the thermal design. Another factor in the device selection process is to evaluate the tolerable heat dissipation of the devices. SiC appears to be particularly tolerant of high-power dissipations, with the ability to handle 3-10 watts/mm2 with junction temperatures of 200 C. These factors along with the plenum design and judicious use of heat pipes should be considered to provide a reliable long life environment for the HPAs. The focus of this development effort is on SiC or GaN Class E or F HPAs at the UHF frequency (405-450 MHz).

PHASE I: Demonstrate feasibility of proposed technology in a laboratory breadboard experiment and evaluate with respect to stated performance objectives.

PHASE II: Develop and demonstrate a solid-state prototype HPA circuit module that addresses the electrical objectives stated above and the thermal requirements that will satisfy reliable long-term operation within operational flight environments of next generation UAVs. Efficient packaging for multiple module integration should implement combiner networks to minimize RF losses, which will subsequently impact total efficiency of the HPA multi-module configuration.

PHASE III: Refine design as necessary and incorporate into a solid-state high-power amplifier module design. Integrate and demonstrate modules to implement an operating UHF high-power radar transmitter. Transition this technology into an operational radar transmitter.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The high-efficiency transmit modules should have application to all commercial avionics manufacturers, all commercial radar applications, and all marine radar applications.

REFERENCES:
1. T.B. Mader and Z.B. Popovic, "The Transmission-Line High-Efficiency Class-E Amplifier," IEEE M&GWL, Vol.5, N0.9, pp.290-292, Sept. 1995.

2. R. Tayrani, "A Monolithic X-band Class-E Amplifier," IEEE GaAs IC Symposium Digest 2001, pp.205-208.

3. T. Quach et al., "Broadband Class-E Power Amplifier for Space Radar Application," IEEE GaAs IC Symposium Digest 2001, pp.209-212.

4. Agilent Advanced
Design Systems (ADS), V.1.7, & Agilent ICCAP, V.5.4.

KEYWORDS: Radar; Efficiency; Power Amplifier; Solid-State; Silicon Carbide; Transmitter

N07-008 TITLE: Fast And Accurate Radar Signal Processing In Non-Gaussian Stable Environments

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMA-263 BAMS-UAV, PMA-231 Advanced Hawkeye, PMA-265 F-18 AESA, Joint Strike

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OBJECTIVE: Develop innovative advanced radar algorithms that are numerically fast and give near optimal performance in non-Gaussian stable environments.

DESCRIPTION: Univariate and multivariate stable distributions have significant advantages for more accurately modeling the interfering clutter and noise associated with radio frequency (RF)/optical sensors. Although their modeling flexibility is significant, their density and distribution functions are not in closed form, which militates against their usability in practice. The numerical representations of these distributions are notoriously difficult, and this topic has been a significant area of research during the past decade. Nearly 80 years after their derivation, efficient numerical methods are starting to yield to the persistence of researchers and reliable commercial-quality "stable processing" packages, first thought of as a utopia, are now available.

When used in radar systems, stable processing algorithms can introduce tremendous performance gains when compared against traditional estimation methods based on the Gaussian assumption. Stable processing can greatly improve detection, tracking, and imaging quality of radar systems in practical non-Gaussian environments, and can also be very powerful in detecting asymmetric threats.

Besides the inherent difficulties associated with the computation of the stable laws, the development of fast and accurate stable processing algorithms in radar systems presents additional computational challenges that arise from the non-convexity of the log-likelihood functions and the lack of known statistically sufficient estimators for the stable framework that can play the role traditionally played by the matched filter in the Gaussian framework. This topic seeks innovative stable processing algorithms that address these issues and advance the state of the art in the field of non-Gaussian radar signal processing. The algorithms developed should be numerically fast and give near optimal performance along the whole family of stable distributions, including the Gaussian distribution. They should perform as well as traditional Gaussian-based algorithms when the environment is Gaussian, but also should outperform Gaussian algorithms in the presence of heavy-tailed clutter and noise. Applications of interest include but are not limited to target tracking processing (Kalman filtering), space time adaptive processing (STAP), and synthetic aperture radar (SAR) imaging.

PHASE I: Determine the feasibility of developing advanced radar algorithms that are numerically fast and give near optimal performance in non-Gaussian stable environments. Identify how the new methods will attack the problems of computational complexity, non-convexity of the optimization space, and non-sufficiency of the statistical estimators.

PHASE II: Demonstrate that stable radar processing can provide real-time accurate estimation and image creation along with the sensors operating in their natural environment. Implement these new methods in an industrial quality commercial software package for radar systems engineering.

PHASE III: Transition the technology to one of the major Navy radar development programs. Demonstrate, real-time with hardware-in-the-loop, the improvements of the new algorithms in real environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The algorithms and methods arising from this research will be of interest to private radar and remote sensing companies. Commercial applications may include acoustic and RF sensors, as well as imaging for geological exploration, forest management, and law enforcement.

REFERENCES:
1. C. Nikias and M. Shao, Signal Processing with Alpha-Stable Distributions and Applications. John Wiley, NY, 1995.

2. G. Arce, Nonlinear Signal Processing. John Wiley, NY, 2005.

3. G. Samorodnitsky and M. Taqqu, Stable Non-Gaussian Random Processes, Stochastic Models with Infinite Variance. Chapman Hall, 1994.

4. R. Adler, R. Feldman, and M. Taqqu, Editors, A Practical Guide to Heavy Tails. Birkhauser, Boston, 1998.

KEYWORDS: Stable Distributions; Numerical Algorithms; Non-Gaussian Estimation and Detection; Robust Signal Processing; Heavy Tails; Impulsive Clutter and Noise

N07-009 TITLE: Modeling Algorithms for Unmanned Aircraft/Weapons Management Systems

TECHNOLOGY AREAS: Information Systems, Sensors, Weapons

ACQUISITION PROGRAM: Firescout/ACAT I

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

OBJECTIVE: Research and demonstrate innovative modeling algorithms for the embedded real-time and safety critical processes of an aircraft/weapons control system to enable more rapid and less expensive integration of new systems or components.

DESCRIPTION: Emerging modeling languages such as the Architecture Analysis and Design Language (AADL) offer the promise of being able to accomplish accurate modeling of hardware and software components and their interaction as a system. Unmanned Air Systems (UASs) are being increasingly looked upon not just as remote sensors, but also as weapons platforms. Weapons control from unmanned air platforms requires an extreme degree of confidence in the aircraft weapons control systems when prosecuting targets with strict rules of engagement and when returning with weapons to the ship. Warfighters will not engage targets nor allow the return of weapons to the ship unless the weapons control system is highly reliable and effective. Therefore real-time, safety critical systems are required to be highly reliable, and this must be effectively demonstrated during the early stages of development to engender warfighter confidence that the system will not introduce errors and risks. These demonstrations add significantly to the costs of development and integration of additional payloads. Payload intensive platforms that include sensors, weapons and communications, such as UASs, should benefit significantly from demonstration that the modeling algorithms are effective in a system of systems that includes hardware and software, modeling algorithms and real-time communications. Technical challenges to over come will be scheduling and timing issues, which cause processor freezes and shutdowns. The timing issues are especially important given the latency associated with command and control of UASs.

Using these emerging technologies to develop modeling algorithms that optimize and manage the real-time and safety critical systems on board an aircraft will increased warfighter confidence and reduce acquisition and integration costs. As a result UASs will gain acceptance when strict rules of engagement (ROE) are employed, the integration and acquisition times will be more controllable, and the UASs will be more adaptable to meeting changing threats and ROE.

PHASE I: Research and determine the feasibility of using the emerging modeling languages such as AADL for developing modeling algorithms of real-time and safety critical systems in manned or unmanned aircraft. Determine the baseline requirements for these algorithms and the potential confidence level of repeatable results.

PHASE II: Develop a prototype of an executable system architecture model of the real-time and safety critical systems. Using the algorithms, demonstrate the impact on the real-time systems due to the integration of a candidate weapons system and demonstrate how the model can be modified for other systems. Demonstrate the models in a system of systems environment using air platform, communications and weapons control models.

PHASE III: Develop an executable system architecture model to include all of the real-time and safety critical systems found on a Fire Scout. Characterize the performance and extensibility of the model. Develop an application program interface for the architecture to ensure that third party vendors could easily integrate new subsystems into the Fire Scout because the model would describe all the necessary characteristics. Demonstrate the effectiveness in flight test operations.

PRIVATE SECTOR COMMERCIAL POTENTIAL: UASs are increasingly being used in commercial applications. The ability to model new components being integrated onto the UAS would save a considerable amount of development time and qualification time with the FAA or CAA. If taken to its conclusion, this SBIR will provide validation to commercial manufacturers of the capability of this modeling technique. The benefits to a commercial company include enabling a highly reliable, timelier and cheaper integration period for modifying processors with repeatable results. Impacts on scheduling and latency issues can be assessed with these models as equipment is modified to account for obsolescence, technology insertions, and capability upgrades on unmanned and manned commercial aircraft.

REFERENCES:

1. Society of Automotive Engineers (SAE) Aerospace Standard (AS) 5506, Architecture Analysis and Design Language (AADL), November 2004 available at http://www.sae.org/.

2. Tutorials, Open Source AADL Tool Environment, and other relevant information available at: http://la.sei.cmu.edu/aadlinfosite/

KEYWORDS: Weapon System; Targeting Sensors; Software Integration; Modeling and Simulation; Real-Time Avionics, Architecture Analysis Description Languages

N07-010 TITLE: Advanced Prognostic and Health Management (PHM) and Model Based Prognostic Useful Life Remaining Capabilities for Aircraft Tactical Information and Communication Systems

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: JSF

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OBJECTIVE: Develop and demonstrate new and advanced prognostic models for communication, navigation and identification (CNI) systems and their components.

DESCRIPTION: In order to fully enable the predictive part of any PHM concept, there must be some capability to relate detected incipient fault conditions to accurate remaining useful life predictions for any point in time. Key to accomplishing this is being able to understand incipient fault-to-failure progression characteristics for the component and/or subsystem of interest and having verifiable prognostic models. This may be accomplished through the merging of an understanding of the component’s physics of failure, analytical models, physical models, statistical techniques, and actual failure data. It is desirable that the models be supported and driven by existing parameters and measurands.

This effort will develop, demonstrate, and apply these advanced prognostic and remaining useful life models in support of the predictive part of PHM on aircraft CNI systems and their subsystem components. Subsystems include aircraft global positioning systems (GPS), inertial navigation systems (INS) including landing aids, identification friend or foe (IFF) systems, radar altimeter, and voice and data communications systems. With the criticality of radar systems to complete

aircraft missions, it is important that the user be able to accurately diagnose faults and predict failures and remaining life of these components. Because of the large amount and variety of components and devices used in CNI systems, new and innovative approaches, models, and methodologies will be required.

PHASE I: Define the techniques and processes needed to relate remaining useful life (RUL) predictions to detectable conditions in one or more aircraft CNI subsystems and their components. Determine the feasibility of developing advanced prognostic models, statistical techniques and other programs required for a specific CNI subsystem application and/or its components. Determine the required inputs to the models; outline a method of extracting them from an installed CNI subsystem and/or specific component; and define required user interfaces.

PHASE II: Assess the application boundaries, accuracy, and limitations for these modeling techniques. Demonstrate the prototype prognostics models, techniques and supporting programs for a specific CNI subsystem and its components.

PHASE III: Finalize these prognostics models with specific JSF CNI system applications. Develop, validate, and deliver a complete set of application modeling programs and techniques to be used on JSF CNI subsystems, circuits and components. Provide software programs, tools, and procedures for integrating these capabilities within the JSF PHM system and transition some or all of these modeling programs and capabilities into the F-35 JSF program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: CNI systems have applications in both commercial and military applications. These advanced models would be applicable in the private sector to many CNI applications that will be applying diagnostic, prognostic, and health management capabilities. Any results and understanding gained from applying these failure progression rate models to particular CNI subsystems will provide a significant crossover benefit to other similar applications, commercial or military.

REFERENCES:
1. Henley, Simon, Currer, Ross, Sheuren, Bill, Hess, Andy, and Goodman, Geoffrey. “Autonomic Logistics—The Support Concept for the 21st Century,” IEEE Proceedings, Track 11, paper zf11_0701.

2. Byer, Bob, Hess, Andy, and Fila, Leo. “Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics,” Aerospace Conference 2001, IEEE Proceedings, Vol. 6, pp. 3095, 3103.

3. IEEE Aerospace Conference Proceedings for 2001 and 2002 Track 11 PHM.

KEYWORDS: Diagnostics; Prognostics; Modeling; Remaining Useful Life; Remaining Predictions; Failure Prediction

N07-011 TITLE: Compact Magnetic Detection Set (CMDS) for Air Antisubmarine Warfare (ASW) and Land-Based Use

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: SH-60 (B, R), Fire Scout, P-8A, P-3C

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OBJECTIVE: Develop a compact total field magnetometer for use on UAVs (vertical take-off and fixed wing) employed for shallow water ASW and land-based target detection such as buried weapons caches and IEDs. This system must be a scalar total field device able to operate in all magnetic latitudes (magnetic dip angles) and aircraft attitudes without operator intervention, i.e. manually aligning a cell to the local dip angle. A vector magnetometer device is not acceptable except as an ancillary sensor to reduce noise.

DESCRIPTION: The CMDS is intended for use with small UAV and VTUAV platforms, manned ASW platforms, as well as land and airborne platforms for ground sensing. The Fire Scout and the SH-60 are candidate platforms for airborne ASW. The requirement consists of packaging a total field magnetometer sensor, ancillary sensors as required for noise reduction, and the signal processing technology for noise reduction and detection to fit within an ultra-light package that is compatible with the constraints of small UAV/VTUAVs, that is, light weight, compact, and low power.

The noise floor of the CMDS should be equivalent to the current military airborne Magnetic Anomaly Detection (MAD) systems; namely the Polatomic AN/ASQ-233 laser magnetometer and the CAE AN/ASQ-508 which are on the order of 0.3 pT/vHz or less over the frequency band of 0.01 Hz to 100 Hz. The goal for CMDS volume, weight, and power, including all sensor cells, electronics, ancillary sensors, and processors, should be less than half of the AN/ASQ-233. The ASQ-233 form factor is approximately 2300 cubic inches (7” diameter cylinder 60” long), weighs 21 lbs and uses 28 Watts. The CMDS concept should be compatible with ASW platforms including small UAVs and VTUAVs, Fire Scout VTUAV, current rotary-wing and fixed-wing ASW aircraft.

Currently in there are two manufacturers of military airborne MAD systems and two known commercial manufactures plus some ongoing university research which all use different earth's field alignment techniques, optical pumping techniques, gasses, and signal processing and vary enormously in size, power, weight, noise level, bandwidth, and ruggedness. The requirement is to have a MAD system that operates at all magnetic latitudes either through the use of multiple cells or a single cell with automatic alignment. The complete system, except for any operator displays, must fit within the current P-3C detecting head canister of 7" diameter and 60" long with the goal to reduce that volume by half.

PHASE I: Develop the detailed specifications for the proposed CMDS technology that will achieve the weight, size, power, and performance requirements. Evaluate its applicability to small UAV/VTUAVs and manned ASW platforms. Develop a detailed design and to meet the requirements and establish the feasibility of designing and fabricating the CMDS breadboard in Phase II.

PHASE II: Fabricate a CMDS laboratory breadboard based on the Phase 1 design. Demonstrate the integration of all of the ancillary sensors into the system. Demonstrate the specified noise floor in a laboratory environment.

PHASE III: Design, fabricate and demonstrate a CMDS flyable breadboard in the laboratory. Install the CMDS into one of the candidate platforms or a surrogate and flight test.

PRIVATE SECTOR COMMERCIAL USE: Miniature high-performance magnetometers will find application in UAVs for geologic applications including mineral and petroleum exploration.

REFERENCES:
1. F. D. Colegrove and P. A. Franken, "Optical Pumping of Helium," Physical Review 119, 680 (1960).

2. W. Happer, Reviews of Modern Physics 44, 169 (1972).

3. N. Bloembergen, E. M. Purcell and R. V. Pound, Physical Review 73, 679 (1948).

4. E. B. Alexandrov and V. A. Bonch-Bruevich, "Optically Pumping Atomic Magnetometers", Op
tical Engineering 31, 711 (1992).

KEYWORDS: Magnetometers; Magnetic Anomaly Detection; Airborne ASW; Unmanned Air Vehicles (UAVs); Vertical Takeoff UAVs (VTUAV); Improvised Explosive Devices (IEDs)

N07-012 TITLE: <u>Antenna to Antenna Coupling and Electromagnetic Interference (EMI) Tool for Air Platforms.</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: TBD

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

OBJECTIVE: Develop a physics-based simulation tool that incorporates sophisticated coupling models as well as transmitter and receiver models for predicting EMI among multiple radio frequency (RF) systems on an airborne platform.

DESCRIPTION: It is not unusual for modern aircraft to utilize over one hundred antennas systems. These systems often interfere with one another thus requiring elaborate frequency management schemes. Advanced full-wave and asymptotic solvers exist for predicting coupling between antennas located on a common platform. These tools can very accurately predict the power received at a receiving antenna due to a transmitting antenna. Test engineers, however, often need to predict the fre-quency and level of the signal that will be seen at the intermediate frequency (IF) filter of the receiver. A strong signal seen at the antenna port of the receiver does not necessarily equate to an interference problem. Additionally, low level out-of-band signals can produce interference through intermodulation products generated in the mixer of the receiver that pass through the IF filter and disrupt the performance of the system. A tool is required that allows analysts to accurately predict RF system level performance with respect to EMI and to mitigate any problems discovered during the analysis process. The resulting tool should employ advanced computational solvers for both full-wave and asymptotic regimes to compute coupling between antennas across a very large frequency range (2MHz – 40GHz). Models for transmitter emissions and receiver response should be developed. The user should be able to specify transmitter and receiver charac-teristics through very simple (e.g., piecewise linear descriptions) or more complex (e.g., circuit level) models to facilitate various types of users, from novice to expert. Additionally, the tool should incorporate visualization capabilities that assist the user in problem setup, analysis, and post processing of results.

PHASE I: Demonstrate proof of concept prototype algorithms for simple transmitter/receiver models and identify full-wave and asymptotic solvers for the coupling component of the analysis tool. Develop a plan for integrating the coupling and transmitter/receiver models into a single tool as well as layout a graphical user interface (GUI) for this tool.

PHASE II: Develop and implement circuit level transmitter/receiver models. Perform integration of solvers and transmitter/receiver models. Design and implement GUI.

PHASE III: Conduct EMI/electromagnectic compatibility (EMC) analyses and measurements to assess the actual performance of antenna systems on board actual airborne vehicles in support of existing and future programs. Develop commercial strength version of tool.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The EMI problems encountered on military aircraft are also a serious problem for commercial airliners. Commercial aircraft manufacturers currently use very crude codes (e.g. spreadsheets) or "back of the envelope" calculations to study EMI problems associated with antenna to antenna coupling. A sophisticated tool such as the one proposed would allow for much greater accuracy and efficiency in this process, which will in turn provide significant time and cost savings.

REFERENCES:
1. Kodali, W.P., Electromagnetic Compatibility. New York: Wiley-IEEE, 2001.

2. Paul, C.R., Introduction to Electromagnetic Compatibility. Hoboken: Wiley-Interscience, 2006.

3. Weston, D., Electromagnetic Compatibility, 2nd ed. New York: Marcel Dekker, 2001.

KEYWORDS: Broadband Antennas; Phased Arrays; EMI Coupling; Design Parameters; Optimization Algorithms; RF Systems

N07-013 TITLE: Dynamic Color Ratio Infrared Simulator Source

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: Air 5.0C, PMA-272, W0602

OBJECTIVE: Develop a dynamic color ratio infrared (IR) simulator source for open-air test and evaluation (T&E) of missile warning and countermeasures systems.

DESCRIPTION: Infrared (IR) missile warning systems currently under development use two-color processing to discriminate missile threat signatures from non-threat signatures, e.g., fires on the ground. Two-color processing entails examining the signature irradiance in two mid-IR bands and forming a ratio to declare a threat or non-threat. Typical threat missile signatures have a definitive characteristic color ratio signature. Open-air test and evaluation

(T&E) of missile warning and Directional Infrared Countermeasures (DIRCM) is currently being performed with sources having a constant color ratio. In general it is necessary to have a dynamic color ratio capability to more realistically simulate various threat missile signatures. Currently no capability exists that can provide dynamic color ratio signatures. Research and development of a robust dynamic color ratio IR simulator source will provide this needed key capability, and allow realistic and comprehensive T&E of missile warning systems for all missile threats of interest.

Current technology is inadequate for development of a robust dynamic color ratio IR simulator source. Consequently the high degree of technical risk associated with its development would be mitigated through development of the needed technology.

The dynamic color ratio source should be capable of functioning in a standalone mode but must also be capable of adaptation for operation with existing open-air surface-to-air missile plume simulators. Open-air environmental operating conditions include extreme temperatures (20 deg F – 120 deg F), wind, sand, and dust and represent a significant risk and design challenge.

PHASE I: Develop a conceptual design for the dynamic color ratio IR simulator source. Perform system analyses and tradeoff studies to demonstrate feasibility of the concept. Develop a cost-effective approach for fabrication and testing of the source.

PHASE II: Develop detailed designs for the dynamic color ratio simulator source. Fabricate and demonstrate a standalone prototype system that meets the performance and environmental requirements. Support initial integration of the source into an open-air surface-to-air missile simulator system.

PHASE III: Upgrade the prototype dynamic color ratio source as required to a fully operational production system. Present the source design and performance to interested military open-air test ranges.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology can be used for test and evaluation of commercial airliner missile protection systems currently under development, and it has potential for application to commercial airline maintenance facilities for test and evaluation of installed missile protection systems. It can also be used in conjunction with commercial flight simulators for training of commercial airline pilots in tactics and procedures when under a missile attack.

REFERENCES:

1. Infrared Simulator / Target Array (ISTAR) System, Presentation at the 2005 ATEDS (Advanced Technology Electronics Demonstration System) Conference, San Diego, CA, Dr. Randy van Daalen Wetters, Technology Service Corporation.

2. Infrared Stimulator and Target Array Phase III Final Report, TM8457, November 2004, Naval Air Warfare Center, Weapons Division, China Lake.

KEYWORDS: Dynamic Color Ratio; Infrared; DIRCM; Simulator; Open-Air; Surface-to-Air Missile (SAM)

N07-014 TITLE: Time Reversal Sonobuoy System

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA 264 Multistatic Anti Submarine Warefare (ASW) Systems

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

OBJECTIVE: Improve the detection capability of airborne ASW missions using short low-power pulses.

DESCRIPTION: A requirement exists for improved detection capability for the airborne ASW mission. Current airborne multistatic detection systems utilize high power impulsive sources. Recent advances in multistatic search systems, such as time-reversal processing (TRP) refocus acoustic energy both spatially and temporally. They also have the advantage of alleviating or mitigating environmental concerns associated with high power and/or long pulse sonar by generating short low-power pulses. Critical parameters to be considered in improving the detection capability include determining the optimum operating frequency, motion sensitivity of probe sources and the time reversal mirror (vertical source - receiver array), system performance, processing techniques, methods of searching the whole water column, tactics, applicability to shallow and deep water, and acoustic medium stability.to shallow and deep water, and acoustic medium stability.

PHASE I: Determine the feasibility of improving the detection capability of airborne ASW missions using short low-power pulses.

PHASE II: Develop a prototype of the system design and field test the critical design parameters.

PHASE III: Perform over-the-side (OTS) testing of the proposed system design

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications of TRP include pollution monitoring and remote control of remotely operated ocean vehicles.

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1. H. Song et al, "Demonstration of a High Frequency Acoustic Barrier with a Time-Reversal Mirror," IEEE Journal of Oceanic Engineering, Volume 28, Number 2, April 2003, page 246.

2. Kim Seongil et al, "Robust Time-Reversal Focusing," Journal of the Acoustical Society of America, Volume 114, Number 1, July 2003, page 145.

3. Kevin B. Smith et al, "Time-Reversal Acoustics in Shallow Water," Journal of the Acoustical Society of America, Volume 113, Number 6, June 2003, page 3095.

4. M. Heinemann et al, "Experiments in Time-Reversal Acoustics," Journal of the Acoustical Society of America, Volume 113, Number 6, June 2003, page 3111.

5. "Temporal Resolutions of Time Reversal and Passive Phase Conjugation for Moderator Acoustic Communication," IEEE Journal of Oceanic Engineering, Volume 28, Number 2, April 2003, page 229.

KEYWORDS: Time-Reversal; Time-Reversal Mirror; Refocusing; Sonobuoy; ASW; Search System

N07-015 TITLE: Improved Catapult Performance Monitoring Through Advanced Cylinder Elongation Measurement Techniques

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA 251 Aircraft Launch and Recovery Equipment

OBJECTIVE: Develop an innovative means of monitoring the average catapult cylinder temperature through indirect measurement techniques.

DESCRIPTION: When launching aircraft from the flight deck of a carrier, several variables are involved in calculating the energy required to set the catapult prior to launch. One variable is the temperature of the catapult cylinders. This is currently derived from the cylinder elongation reading, which is an indirect way of measuring the temperature of the power cylinders. The cylinder elongation is currently determined by reading the through-deck pointers mounted on the power cylinders. These pointers move relative to scales mounted in the deck plates and the scales are calibrated in inches.

The catapult should be elongated to a pre-determined range before the aircraft can be launched. This window of elongation is to be maintained during operations. Elongation of the catapult is brought about by steam preheat (a set of finned steam pipes located in the trough) and maintained through aircraft launches and the steam preheat system. This system has an inherent flaw in that the scales used for measuring the cylinder elongation also grow (to a smaller degree) with the increasing temperatures during operation. Currently, the bow safety observer leaves the catwalk and goes out onto the flight deck to read the elongation when requested during operations (periodicity can vary).

This topic seeks to provide the Fleet with real-time (deck temperature corrected) elongation readings of the catapult for every launch. This will remove the bow safety observer from the dangers associated with taking readings during flight operations, improve catapult performance monitoring, and allow for more accurate catapult settings that will yield more consistent catapult performance. The system will provide a readout of the elongation in a location other than on the flight deck.

The current C13-2 catapult has a nominal power stroke of 309.7 feet. Power cylinder material is MPR2 steel. The length can grow up to 10 inches due to temperature expansion during normal operations, so a sensor will need to indicate a range of 0- to 10-inch expansion at a resolution of 5/100th of an inch. Any sensor will need to survive the harsh environment: steam temperatures up to 550 degrees F, humidity approximately 100 percent, shock loads up to 1000 Gs, salt spray/water and exposure to various lubricants.

Proposals that will investigate multiple solutions (both contact and non-contact) in order to determine an optimum solution will be given more consideration.

PHASE I: Determine the feasibility of the concept(s) by developing a conceptual design and addressing all technical issues either through analysis or limited lab demonstrations. Develop a concept of operations, and provide defendable estimates for cost and reliability and maintainability.

PHASE II: Develop a prototype and demonstrate. The final demonstration will be in an environment representative of a shipboard catapult (such as a NAVAIR Lakehurst test catapult). During a final demonstration, the system should provide system health monitoring, fault detection/isolation, and a method of visual verification of elongation position (in the event the system fails). The system will be tested for a number of catapult shots (precise number to be determined) with and without intentional faults injected.

PHASE III: Further develop a prototype for robustness, shock, vibration, environmental and electromagnetic interference (EMI) testing (as applicable). Produce units for delivery to carrier Fleet and shore sites.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed system will have commercialization potential with the Foreign Military Service (such as the French and potentially the British). The technology used to develop the sensor for this application will have potential industrial commercialization in applications that require high precision measurement with tight tolerances in harsh environments.

KEYWORDS: Non-Contact Sensors; Health Monitoring; Fault Isolation; Catapults; Elongation; Indirect Measurement

N07-016 TITLE: <u>Reactive Missile Plume Simulator for Open-Air Testing</u>

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: Air 5.0C, PMA-272, W0602

OBJECTIVE: Develop a realistic reactive missile plume simulator for open-air test and evaluation (T&E) of infrared (IR) missile warning and countermeasures systems.

DESCRIPTION: Open-air test and evaluation of missile warning and Directional Infrared (IR) Countermeasures (DIRCM) systems require realistic spectral, temporal, and spatial simulations of the missile plume. The missile IR plume signatures must be properly simulated to the IR tracker associated with guiding the countermeasures onto the missile. Adequate evaluation of the DIRCM requires that the missile plume signatures be simulated under both jammed (when the missile is being effectively countered) and non-jammed missile conditions. Because of the high IR tracker resolution, a continuous spatial simulation is needed. Current IR and ultraviolet (UV) spatial simulators are not capable of generating continuous spatial simulations. This severely limits the flexibility required for proper testing and evaluation of the performance of the DIRCM system with jammed-missile scenarios. Current technology is not capable of the simulation of jammed missile plumes. Enabling technology must therefore be developed, or existing technology adapted, so as to provide a new and innovative approach for continuous spatial plume signature simulation at the time that DIRCM is detected. The reactive missile plume simulator will provide this needed capability, and allow end-to-end testing of the missile warning and countermeasures systems, specifically under jammed-missile scenarios.

The simulator must be capable of functioning in a standalone mode but should also be capable of adaptation for operation with existing open-air surface-to-air missile plume simulators. Open-air environmental operating conditions include extreme temperatures (20 deg F – 120 deg F), wind, sand, and dust and represent a significant risk and design challenge.

PHASE I: Investigate enabling technologies and develop a conceptual design for the reactive missile plume simulator. Perform system analyses and tradeoff studies to demonstrate feasibility of the concept. Develop a cost-effective approach for fabrication and testing of the simulator.

PHASE II: Develop detailed designs for the reactive missile plume simulator. Fabricate and demonstrate a standalone prototype system that meets the performance and environmental requirements. Support initial integration of the simulator into an open-air surface-to-air missile simulator system.

PHASE III: Upgrade the prototype reactive missile plume simulator as required to a fully operational production system. Present the simulator design and performance to interested military open-air test ranges.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology can be used for test and evaluation of commercial airliner missile protection systems currently under development, and it has potential for application to commercial airline maintenance facilities for test and evaluation of installed missile protection systems. It can also be used in conjunction with commercial flight simulators for training of commercial airline pilots in tactics and procedures when under a missile attack.

REFERENCES:
1.Infrared Simulator / Target Array (ISTAR) System, Presentation at the 2005 ATEDS (Advanced Technology Electronics Demonstration System) Conference, San Diego, CA, Dr. Randy van Daalen Wetters, Technology Service Corporation.

2.Infrared Stimulator and Target Array Phase III Final Report, TM8457, November 2004, Naval Air Warfare Center, Weapons Division, China Lake

KEYWORDS: Missile; Simulator; Reactive; Spatial; Open-Air; Surface-to-Air Missile (SAM)

N07-017 TITLE: Recognition of High-Range-Resolution (HRR) Profile Signatures of Moving Ground Targets for Combat Identification (CID)

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-265 F/A-18 E/F

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of

foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a hierarchical aided target recognition (AiTR) algorithm to provide robust real-time automatic recognition of High Range Resolution (HRR) profiles of moving ground targets over tactical depression and aspect angles.

DESCRIPTION: Stationary relocatable ground targets can employ a variety of camouflage, hide, and signature altering processes to defeat fire control systems. A moving target, while sacrificing many of its deception options, is more difficult to detect and recognize. Radar HRR profiles—one-dimensional (range) representation of target scatterers—provides a standoff all-weather capability for recognition of moving targets. The major drawback of HRR recognition—high pilot workload required for manual recognition—can be reduced by a factor of 100 using AiTR. Based on guidance from Navy pilots, AiTR, to be most effective, must provide a high-confidence decision at some level of recognition (combatant, tank, T-72) within a few seconds. However, current HRR AiTR approaches with heavy reliance on statistical algorithms, measured HRR profiles, and identification level (T-72) decisions have not shown the consistent high confidence decision necessary to realize this reduction in pilot workload for small tank-size ground targets. The hierarchical algorithm sought in this SBIR must provide a methodical search of the target recognition space as well as utilization of the HRR time series for "find x" and general recognition problems for target sets of 20 to 30 ground combatants. Although a top-down divisive approach from detection to classification to recognition to identification is sought, agglomerative techniques that roll up the decision from identification to more general recognition levels will also be considered. Critical to success will be a measure of confidence/uncertainty that will allow the AiTR to decide not only at what recognition level to output the target decision to the pilot, but at what point in the HRR time series it has a high confidence decision. The algorithm must utilize synthetic HRR profiles for template generation or feature sets for statistical classifiers and allow for rapid insertion of new target classes in operational applications. Because of the limited pilot time available, the algorithm must have a high correct decision rate, low false alarm rate, and an "other class" capability that rejects private and commercial vehicles. It must operate against forward-looking tactical radars over as great an aspect and depression angle range as possible. Finally, real-time processing in tactical aircraft processors is required.

PHASE I: Develop and demonstrate the feasibility of a hierarchical approach to recognize measured HRR signatures of moving ground mobile target signatures. Show performance for different encounter geometries. Include estimates of the CPU and memory requirements for the approach.

PHASE II: Demonstrate automatic recognition of measured moving and ground target HRR signatures, and provide for unambiguous extrapolation to operational data sets. Present final CPU and memory requirements. Demonstrate:
- Robust correct recognition/ID (80%) for
  - o Combatant similar confuser false alarm rate of 20% or less
  - o Other class leakage rate of less than 1%
  - o All encounter geometries
  - o Full signatures of 20 range cells on a tank-size target at aspects of 45 degrees on either side of front or back aspects of the target.

PHASE III: Develop and complete automatic aided target recognition (AiTR) software system or a set of software modules/tools and incorporate into existing/legacy systems and platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: HRR recognition can provide a reduction by a factor of 100 and greater in the manual tasking required for monitoring of security facilities and areas of interest for detection of moving targets that might be used for terrorist purposes. This will provide benefits to the commercial security sector and Homeland Security as well as force protection in hostile areas.

REFERENCES:
1. HRR profile and general radar technology

2. Donald R. Wehner, High Resolution Radar. Norwood, MA: Artech House., 1987.

3. Jerry L Eaves, Edward K. Reedy, Principles of Modern Radar. New York, NY: Van Nostrand Reinhold Company Inc., 1987.
AiTR technology

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5. Keinosuke Fukunaga, Introduction to Statistical Pattern Recognition Second Edition. San Diego, CA: Academic Press Inc., 1990
Confidence and uncertainty measures

6. Glen Shafer, A Mathematical Theory of Evidence. Princeton, NJ: Princeton University Press, 1976.

7. Judea Pearl, Probabilistic Reasoning in Intelligent System: Networks of Plausible Inference. San Mateo, CA: Morgan Stanley Publishers, Inc., 1988

8. George J. Flir, Tina A. Folger, Fuzzy Sets, Uncertainty, and Information. Englewood Cliffs, NJ: Prentice Hall, 1988

KEYWORDS: Real-Time Image Processing; Object/Target Recognition and Identification; Combat Identification (CID); High-Range Resolution (HRR) Automatic Target Recognition (ATR); Template Based Target Identification; Profile Signatures

N07-018 TITLE: Variable Remapping of Airborne Imagery

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors

ACQUISITION PROGRAM: PEO(T), PMA-265

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

OBJECTIVE: Develop, in real time, a predicted target image based on imagery from one or more different sensors, taken at different times and from different perspectives.

DESCRIPTION: Unmanned air vehicles (UAVs) are rapidly emerging as an important adjunct source of targeting information. They can be employed close to the target in harm's way to provide targeting quality imagery to other strike platforms carrying weapons. However, there needs to be a positive handoff to the strike platform. In this case, the positive identification (ID) is made by positively associating the ID quality imagery obtained by the unmanned aircraft system (UAS) with the imagery being obtained by the strike platform’s imaging sensor. Often, geopositional confirmation is not possible or cannot disambiguate the target vehicle from others in the immediate vicinity. In these cases a visual correlation must be made. To effect this correlation with high confidence, it is important to present the targeting imagery as if it were being viewed from the weapon platform, which may be observing the target from a significantly different perspective. In recent years there has been an extraordinary amount of research in computer vision to render images from a moving camera, or an array of cameras, to create a predicted or synthetic image from another perspective with high fidelity. The technical innovation required is how to use a combination of image warping techniques, sensor modeling, atmospheric modeling, and physics-based synthetic signature modeling to develop in real-time a predicted target image based on imagery sensed by another sensor viewing, or having recently viewed, the same target. It is expected that the real-time algorithms will be integrated with the DARPA video verification of identity (VIVID) into a man-portable “transit case” processor.

PHASE I: Determine the feasibility of proposed techniques for matching target and background imagery acquired from two different sensors of similar type e.g., both color TV cameras or both infrared. Investigate issues of range, perspective, differences in lighting (e.g., shadow effects), and atmospheric effects. It should be assumed that the perspective views of the targets are known from both the UAV and the manned aircraft. For example, assume it is known what the range and angles are relative to the reference frame of the vehicle being viewed. The following issues need to be addressed:

1. Effect of uncertainty in the range and perspective angle knowledge.
2. When and to what degree warping can be used to bring images of different perspective into correspondence without producing artifacts that will significantly degrade human visual correlation.
3. Use of synthetic target image generation techniques such as SPIRITS or ASGARD
4. Potential differences in sensor spectral bands. For example, the UAS sensor is uncooled long wave infrared and the manned aircraft sensor is medium wave infrared.
5. Atmospheric effects such as spectral transmission.
6. Latency between UAV imagery and weapon platform imagery when viewing moving targets.
7. Advantage of attempting to correct for visual correspondence.
8. Evaluate the confirmatory ID (CID) algorithms of DARPA Video Verification of Identity (VIVID) processing vis-à-vis providing the UAS reference imagery.

PHASE II: Develop real-time algorithms for remapping or rendering imagery from a UAS to correlate to that projected to be observed from a targeting pod such as the Advanced Targeting FLIR (ATFLIR) or the Litening II pod. Integrate the algorithms with the DARPA VIVID algorithms into a man-portable “transit case” processor.

PHASE III: Demonstrate the transit case Variable Remapping Of Airborne Imagery (VRAI)/VIVID processor with an appropriate UAS and F-18 with ATFLIR.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Most any unmanned or manned airborne system working to coordinate visual imagery with ground personnel or other manned aircraft will benefit from image remapping. Applications such as law enforcement, fire rescue, boarder patrol, agricultural, fish and wildlife tracking, high tension line tracing, and geological survey all have obvious needs for oriented visual signal interfaces.

REFERENCES:
1. Strat, Thomas M. and Hollan, Lois C., eds., Video Verification of Identity (VIVID): Automated Video Processing for Unmanned Aircraft – A compilation of scientific papers and technical reports that summarizes the accomplishments of the DARPA VIVID program, Phase 1, Approved for Public Release

2. Merchant, John, "Exact area registration of different views of a common object scene", Optical Engineering, 20(3), pp. 424-436 (May/June 1981)

3. Sali, E. and Ullman, S., “Recognizing novel 3-D objects under new illumination and viewing position using a small number of example views or even a single view,” Computer Vision, 1998. Sixth International Conference on, 4-7 Jan. 1998 Page(s): 153 - 161

KEYWORDS: Image Processing; Model-Based Rendering; Image-Based Rendering; Target Recognition; Target Identification; Video Correlation

N07-019 TITLE: Whale Search Radar

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA 264 - Marine Mammal Mitigation Program - ACAT IV

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

OBJECTIVE: Develop innovative technologies to accurately identify the presence of whales in an anti-submarine warfare (ASW) test range

DESCRIPTION: Open ocean training and testing activities are often suspended or curtailed due to the possibility of harm to marine species in reference to the Marine Mammal Protection Act. Maritime patrol aircraft need all-weather, all-light sensors that can detect and track whales as they breach the ocean surface at extended collection ranges. Commercial maritime search radars have been demonstrated to be able to detect whale breaches in low sea states (<3). However, there is no data on how well these radars can detect whale breachings in higher sea states (>3). Additionally, innovative automatic target recognition algorithms (ATRs) are needed to automatically detect whale breaches.

The end goal of this SBIR is to develop whale tracking systems that will allow the use of automated techniques that make the affordable radar a cueing sensor for high-resolution systems such as electro-optic(EO)/infrared (IR) cameras; development of automated techniques to use affordable radar systems to detect and track a variety of maritime objects; and the development of a multi-sensor approach that performs range clearance with a minimum set of sensors.

PHASE I: Determine the feasibility of using a search radar with innovative ATR algorithms to detect whale breaches in higher sea states and demonstrate a proof of concept.

PHASE II: Develop and test a prototype ATR algorithm to automatically detect and track whales as they breach the ocean surface at extended ranges. The algorithm's effectiveness should be defined by the analysis of receiver operating curves (ROC) and false alarm rates (FAR) for various sea states and weather conditions.

PHASE III: Transition the technology to the Marine Mammal Mitigation Program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Companies engaged in commercial undersea exploration and Allied nations would be well served by this technology.

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1. D.R. Statter, Jr., "Maritime Search Radar Analysis - Second Report," unpub, NAVAIR 4.5.5, 28Nov06

2. D. DeProspo et al. "Project Humpback - Experiment Quicklook Briefing," PowerPoint Presentation, Arete Associates, 4Nov03.

3. D. DeProspo et al. "Using Ship-mounted Radar to Detect and Track Cetaceans - Results of the CEDAR Experiment," presented at the 16th Biennial Marine Mammal Conference, 12 Dec 05.

KEYWORDS: Marine; Mammals; Radar; Automated; Tracking; Detection

N07-020 TITLE: <u>Deployable Intelligent Projection Systems for Training</u>

TECHNOLOGY AREAS: Air Platform, Information Systems, Human Systems

ACQUISITION PROGRAM: PMA-205 Aviation Training Systems

OBJECTIVE: Develop innovative computer algorithms and associated technologies (as appropriate) to support automatic and continuous estimation and correction of geometric and photometric errors arising from the use of a small set of cooperating "intelligent" projectors (integrated projection and sensing) to create a single seamless wide-area (panoramic) image as part of a deployable visual training system for multiple viewers.

DESCRIPTION: Recent advances in projector technologies, off-line display calibration, and rendering algorithms have made possible the use of multiple overlapping projectors to create a visually seamless wide-area image on many every-day (unprepared) surfaces. Such systems and methods could be an integral part of deployable visual training systems. One key to the success of such applications is the method used to calibrate (estimate) the relative geometric and photometric parameters of the projectors and imagery to facilitate the necessary warping and blending. Researchers have had initial success through the use of embedded sensors [1] and off-line passive approaches [2]. For deployable multi-projector visual training systems to be practical the projections must be robust to physical and electrical perturbations over time, adjusting automatically and continuously during use [3]. Through an application of multiple polarized projected images, it is further possible to provide individual viewpoints for two or more users immersed in the same simulation. [4]

PHASE I: Demonstrate the feasibility of proposed innovative solutions to provide automatic and continuous estimation and correction of projected imagery from a small overlapping set of casually configured conventional or intelligent projectors. Identify corresponding algorithm and device possibilities and tradeoffs related to complexity of use and implementation, robustness, and reliability.

PHASE II: Develop a prototype multi-projector deployable display system using the chosen intelligent projectors (technologies). Adapt/modify an example of an existing visual training application (software) to function with the prototype, and demonstrate the automatic and continuous geometric and photometric calibration capabilities.

PHASE III: Install and test prototype multi-projector display system (with automatic and continuous calibration) within a system providing shipboard training capability.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The simulation based training and entertainment industries will benefit as the need for expensive wall-mounted (or head-mounted) visual image generators will no longer be required. Projectors that could correct screen distance, screen angles, curves and dimensions, and that in addition automatically adjust to properly overlap images for immersive surround-screen imaging would enable simulations to be conducted in any room. With the addition of corrections for multiple viewpoints, several trainees could participate in a two-dimensional or three-dimensional simulation simultaneously.

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1. Lee, J. C., Dietz, P. H., Maynes-Aminzade, D., Raskar, R., and Hudson, S. E., “Automatic Projector Calibration With Embedded Light Sensors,” in Proceedings of the 17th Annual ACM Symposium on User Interface Software and Technology (Santa Fe, NM, USA, October 24 - 27, 2004). UIST '04. ACM Press, New York, NY, 123-126.

2. Raskar, R., Brown, M., Yang, R., Chen, W., Welch, G., Towles, H., Seales, B., and Fuchs, H., “Multi-Projector Displays Using Camera-Based Registration,: in Proceedings of the Conference on Visualization 99: Celebrating Ten Years (San Francisco, CA, USA, October 24 – 29, 1999): pp. 161-168.

3. Yang, R. and Welch, G., “Automatic and Continuous Projector Display Surface Estimation Using Every-Day Imagery,” presented by Herman Towles at the 9th International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision (Plzen, Czech Republic, 2001).

4. Hendriks, E. A. andRedert, “A. Real-Time Synthesis Of Digital Multiple-Viewpoint Stereoscopic Images,” SPIE Proceedings Vol. 3639 pp.266-276.

KEYWORDS: Projection; Simulation; Intelligent; Visual Display; Training; Multiple-viewpoint

N07-021 TITLE: Alternative/Replacement Wire Stripper

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: JSF (Joint Strike Fighter); PMA-260 (Aircraft Ground Support Equipment)

OBJECTIVE: Develop a portable electrical wire stripper that: is adaptable to all wire insulation constructions, insulation types, cable types (round, twisted, square) and wire gauge sizes; eliminates damage to the conductor; operates in an aircraft flight line environment (including fueled aircraft and electromagnetic controlled (EMC) environments); is sized for on-aircraft operation; and is lightweight and battery operated (does not require input power other than for recharging).

DESCRIPTION: Wiring system problems are one of the two leading causes of aircraft downtime or non-mission readiness. Stripping of wire is done on a daily basis to facilitate wiring repair and inspections and to perform qualification of related interface components (i.e., contacts, terminals, etc.).

Available stripper blades do not cover all gauge sizes of all wire types used in the Fleet. Nevertheless, improper sized blades and unapproved tools (such as razor blades) are used to obtain the best strip available, frequently resulting in nicked conductors, incomplete removal of insulation, and a considerable increase in maintenance man-hours in the Fleet. Problems related to wire stripping tools and blades reported from the depot level show that tools and blades are usually not the proper size, part numbers indicating size and cable type are not visible, and there are no calibration procedures in place. In addition, replacement of worn blades occurs only after strippers are found to be functioning improperly, risking damage to aircraft electrical wiring.

Laser technology is a new approach for wire stripping that uses a directed electromagnetic beam at a set power and frequency. Any conductive material (such as wiring) will reflect the beam. Without absorption, heat cannot be generated and, therefore, damage cannot occur to the wire. Benefits of this laser technology include no damage to conductors even if plated with another metal; the ability to process flat, round, twisted or shielded cable with little or no tooling changes; precise removal of only selected insulation material; removal of insulation from any location along the wire length in any required programmed pattern; precise control of cut location, size and depth; and adaptability to any of the currently available wire insulation constructions. This desk top approach is not available in hand-held units.

Innovative wire stripper technology is needed to replace today's mechanical tools and blades. Solutions may involve but are not limited to laser technology. The next generation of small, lightweight, portable wire strippers must be adaptable to all wire insulation constructions; automatically adjust or be easily adjustable to varying insulation types, cable types, and wire gauge sizes; eliminate damage to the conductor during insulation stripping; be operable in aircraft flight line environments (including fueled aircraft and EMC environments), and not require input power (other than for recharging).

PHASE I: Assess the feasibility of developing the described wire stripping technology. Validate approach analytically or provide test data that would validate approach.

PHASE II: Design, develop, and demonstrate prototype wire stripper technology. Conduct testing to demonstrate capabilities.

PHASE III: Prepare wire stripper samples for qualification testing and submit to qualifying activity.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The currently available wire strippers are used both in commercial and military aviation. The issues of improper wire stripping; large number of strippers, dependence of blades and gripper sets on wire size and type; and calibration issues are common to both the commercial and military sectors. In addition, ships, submarines, and other applications using aerospace type quality wiring insulation constructions have the same issue wire stripping issues.

REFERENCES:
1. GAO Report GAO-02-77, "AVIATION SAFETY FAA and DOD Response to Similar Safety Concerns", Jan. 2002

2. Project on Government Oversight (POGO), "Fact Sheet on Aircraft Wiring Problems", 19 Nov. 2002

3. Aircraft Wire Degradation Study, FAA Contract DTFA03-02-C-00040

KEYWORDS: Wiring; Insulation; Strippers; Support Equipment; Aircraft Electrical

N07-022 TITLE: Omni-Directional Capability for Shared Reconnaissance Pod (SHARP) Data Link

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-265 SHARED Reconnaissance Pod System, ACAT-III

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OBJECTIVE: Develop an omni-directional capability for transmitting tactical imagery and data to improve the SHARP data link field of view

DESCRIPTION: New technologies, including transmission control protocol/internet protocol (TCP/IP) can improve omni-directional transmissions in a tactical environment. Omni-directional capability will increase the amount of operational time that SHARP data can be transferred to ship/shore/ground active sites. Currently, the data link beam is directional, and the data link is not operational during some aircraft maneuvers and flight profiles. Adding an omni-directional capability will enable data exchange to continue even during most aircraft maneuvers and will improve data transmission time to the greatest number of weapons platforms, both airborne and on the ground. It will also provide a capability for near real time sensor to shooter data transfer in a tactical (hot) environment by improving the data link's field of view and transmission range compared to an existing directional data link.

PHASE I: Determine the feasibility of improving the omni-directional transmission of tactical imagery data and the SHARP data link field of view.

PHASE II: Develop a prototype of the omni-directional antenna and incorporate the proposed transmission technology into the SHARP data link system. Demonstrate improvements in the data link's transmission range and field of view.

PHASE III: Integrate the omni-directional antenna and associated transmission technology into the SHARP pod. Perform flight tests to demonstrate improvements in data link connectivity during all aircraft maneuvers and environmental conditions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Rapid air to ground wide area coverage is needed for search and rescue in different types of environments from remote areas to urban applications. It can be used in disaster relief to coordinate the rapid response teams to the most critical sites. It can also be used in border protection and security by coordinating wide area ground surveillance and with mobile border patrol teams. The same application can be used by DEA for drug traffic interdictions.

REFERENCES:
1. "FORCEnet Architecture and Standards Volume II Technical View", Office of the Chief Engineer (SPAWAR 05), 31 December 2004

2. SHARP Operational Requirements ACAT III dated 07 March 2003 N780C10

KEYWORDS: data link; omni-directional antenna; omni-directional transmission; sensor; SHARP; tactical imagery

N07-023 TITLE: RF Sensor Performance in Electrically Large, Complex Environments

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: TBD

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OBJECTIVE: Develop an electromagnetic (EM) computational tool that can be used to predict RF sensor performance in electrically large, complex environments. The capability to compute the influence of one antenna on others is a must while the ability to compute near-field quantities is desirable.

DESCRIPTION: The free-space characteristics of an antenna can be changed drastically by the platform on which the antenna is mounted and by the presence of other antennas on the same platform. Thus, not only antenna properties (e.g., volume coverage) may be affected but, also, the performance of signal processing algorithms that rely on an assumed behavior of the antenna. It is imperative then to be able to predict the behavior of an antenna on its installation platform rather than just in free space. If the platform is electrically small, this can be accomplished using an exact-physics computational electromagnetic (CEM) code. Such an approach, however, is totally impractical for electrically large platforms. For this reason we are seeking approximate electromagnetic methods that can provide usable information for an antenna that is mounted on a large platform and in the presence of other antennas. These methods should result in tools that approximate physics well, provide good accuracy in the far field, are quite fast, and do not require enormous computational resources.

PHASE I: Determine the feasibility of developing a tool to predict the behavior of antennas on large platforms using approximate EM methods. These methods should accurately compute the on-platform radiation pattern using either the free-space pattern or equivalent antenna currents and should also be able to predict the interaction (coupling) of the antenna with any other antenna present. These methods should apply to very general geometries and should not require canonical shapes. Materials that can be described in terms of an impedance boundary condition should be included.

PHASE II: Fully develop the methodology selected in Phase I and incorporate into a prototype EM tool which includes a suitable graphical user interface (GUI). Provide interfaces for reading common CAD formats. Demonstrate the accuracy, robustness and speed of the tool.

PHASE III: Fully develop and refine the EM tool developed in Phase II to meet the needs of the scientific/engineering community, either alone or in partnership with another company.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The tool developed in this project will find applications among commercial airframe builders, pleasure boat designers, wireless communications, etc.

REFERENCES:
1. Knott, E.F., Shaeffer, J.F. and M.T. Tuley, Radar Cross Section, Chapter 5. Boston: Artech House, 1985.

2. M. I. Sancer, "Physically interpretable alternative to Green's dyadics, resulting representation theorems, and integral equations", IEEE Trans. Antennas Propagat., Vol. 38, No. 4, pp. 564-568, 1990.

3. Bhattacharyya, A.K. and D.L. Sengupta, Radar Cross Section Analysis and Control, Chapter 2. Boston: Artech House, 1991.

4. J.-M. Jin, S. S. Ni and S.-W. Lee, "Hybridization of SBR and FEM for Scattering by Large Bodies with Cracks and Cavities", IEEE Trans. Antennas Propagat., Vol. 43, No. 10, pp. 1130-1139, 1995.

5. Ufitsev, P.Ya., Theory of Edge Diffraction in Electromagnetics. Encino: Tech Science, 2003.

6. Janpugdee, P., Pathak, P. H., Kindt, R. W., Marhefka, R. J. and J. L. Volakis, “A Hybrid Numerical – UTD Analysis of Large Arrays on a Large Platform,” International Conference on Electromagnetics in Advanced Applications, Torino, Italy, September 12 – 16, 2005.

KEYWORDS: Antenna-Platform Coupling; Antenna-to-Antenna Coupling; Large Platforms; Approximate Electromagnetic Solvers; Antenna Arrays; Signal Processing

N07-024 TITLE: Interactive Marine Mammal Communications

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-264 - Marine Mammal Mitigation Program

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OBJECTIVE: Develop an eco-friendly method for alerting whales to leave an area so that Anti-Submarine Warfare (ASW) training exercises may be conducted without harming the whales.

DESCRIPTION: The Navy is currently severely constrained in its ability to use active sonar systems during ASW training exercises, due to the potential harmful effects these systems could have on the whales in the test range. Innovative acoustic techniques that would alert the whales to leave a test area are being sought. Options may include analyzing the spectrum of various whale songs to determine the frequencies and decibel levels that are used by the whales, as well as the rough meaning of the various songs. Beluga whales of Alaska and Canada are likely to be selected as these mammals use that portion of the sound spectrum that most closely resembles the spectrum used by humans. The proposed system should be able to receive sound from the whales, process and analyze the sound, transmit sounds back to the whales and process and analyze the response. The ability to easily clear a test range of whales will dramatically improve the Navy's anti-submarine warfare (ASW) training opportunities.

PHASE I: Determine the feasibility of developing new acoustic techniques to alert whales to leave an area and demonstrate proof of concept.

PHASE II: Develop a prototype under water sound transmission/reception system that can be used to effectively communicate with a selected group of whales of Alaska or Canada, with predictable results.

PHASE III: Demonstrate that the underwater sound transmission/reception system developed in Phase II can be used to clear a test area of whales, without harming them, so that ASW training exercises can be performed.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Academia and companies engaged in commercial undersea exploration would be well served by this technology.

REFERENCES:
1. http://www.interspecies.com/pages/beluga%20game.html (Jim Nollman, Interspecies.com)

2. http://csiwhalesalive.org/csi03303.html (William Rossiter, Cetacean Society International)

KEYWORDS: Marine; Mammals; Communications; Interactive; Beluga; Research

N07-025 TITLE: Next Generation Aircraft Wiring Insulation

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter (JSF); PMA-275 (V-22 Program); PMA-261 (H-53)

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foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop the next generation electrical wire insulation that will have the following properties: light weight; low flammability; low smoke toxicity; low smoke density; high cut through; low wire-to-wire and wire-to-frame abrasion; no hydrolysis, >260ºC temperature rating, low cost, high flex life, high dielectric properties, good strip ability, and good marking contrast.

DESCRIPTION: Wiring failures result in both tangible and intangible costs to the Navy. The tangible cost is the NMC (not mission capable) and AVDLR (aviation depot level repairable) costs due to wiring repair. The intangible costs are the costs associated with removal and troubleshooting of equipment with no fault found. Advancements in wiring technology would increase the life and reduce the hazards related to aircraft wiring.

Currently used wire technology was first introduced in 1991 and although there have been some improvements, there has been no significant advancement in performance. The current composite insulation technology is based on a tape wrapped construction consisting of one layer of fluropolymer-polyimide-fluropolymer and a second layer of polytetraflouroethylene (PTFE). This construction is commonly referred to as TKT (Teflon-KAPTON-Teflon). The primary wire insulation characteristics of this construction are similar to those of aromatic polyimides. H film aromatic polyimide (DuPont ™KAPTON) has well documented issues with hydrolysis, which result in the break down of the material leading to cracking of the insulation and arc tracking. T film aromatic polyimide (DuPont ™OASIS) used in current composite insulation technology has improved hydrolysis properties, but the long-term effects of hydrolysis are still unknown. In addition, composite insulation has raised concerns related to: unwrapping of the tape, shrinkage, poor strip ability, abrasion, poor laser marking, flex endurance, and likelihood of damage to outer layer of PTFE during installation and maintenance.

New materials are sought to develop innovative electrical wire insulation, which will exceed the capabilities of current wire insulation and address the concerns raised with current composite insulation. This next generation of electrical wire insulation should meet or exceed the requirements of MIL-DTL-22759 and exhibit the following properties: light weight; low flammability; low smoke toxicity; low smoke density; high cut through, low wire-to-wire and wire-to-frame abrasion; no hydrolysis; >260ºC temperature rating; low case; high flex life; high dielectric properties; good strip ability and good marking contrast.

PHASE I: Determine the feasibility of developing new wire insulation described above. Proposed approaches should address concerns relating to unwrapping of the tape (if tape wrapped construction used), shrinkage, poor strip ability, abrasion, poor laser marking, flex endurance, and damage to insulation during installation and maintenance. Validate approach analytically or provide test data that would validate approach.

PHASE II: Design, develop, and demonstrate a prototype wire insulation technology. Conduct testing in accordance with AS22759 specification to demonstrate capabilities.

PHASE III: Prepare wire insulation samples for qualification testing and submit to qualifying activity.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The currently available wiring insulations are used both in commercial and military aviation. The issues of aging wiring due to insulation break down are common to both the commercial and military sectors. In addition, any densely wired system such as ships, submarines, subways, nuclear power plants, etc. all have the issue of aging wiring and insulation breakdown.

REFERENCES:
1. GAO Report GAO-02-77, “AVIATION SAFETY FAA and DOD Response to Similar Safety Concerns”, Jan. 2002

2. Project on Government Oversight (POGO), “Fact Sheet on Aircraft Wiring Problems”, 19 Nov. 2002

3. Aircraft Wire Degradation Study, FAA Contract DTFA03-02-C-00040

KEYWORDS: Wiring; Insulation; KAPTON; Composite; Hydrolysis; Electrical

N07-026 TITLE: Autonomous Aircraft Securing

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMA 251 Aircraft Launch and Recovery Equipment

OBJECTIVE: Develop an innovative concept or technology that would enable aircraft to be secured on the flight deck autonomously, without the need of personnel to manually secure the aircraft using chocks and tiedown chains.

DESCRIPTION: Because of ship motion and potentially wet decks, aircraft aboard aircraft carriers are required to be secured to the deck to prevent them from moving and sustaining or causing damage. The process of securing aircraft is currently a manual process that requires numerous flight deck personnel to accomplish it. Personnel are required to place chocks on the wheels and multiple chain tiedowns that hook onto aircraft hookpoints and "pad eyes" in the deck.

The best approaches are those that minimize the impact to flight deck operations, aircraft and ship. For example, operational flexibility – the ability to park aircraft anywhere on the deck in any orientation – is important. Aircraft securing time should be minimized so that the tempo of operations is not impacted negatively. Approaches that add appreciable weight to the aircraft or complex ship-installed equipment have less of a chance of ultimately being accepted into the Fleet. Aircraft can be densely packed on the flight deck, with no more than a few inches clearance between adjacent aircraft, and they can be parked on the deck edge with the tires abutting the deck edge combing. Aircraft can typically weigh 60,000 lbs. Wind over deck can be up to 50 kts. By means of bounding the problem, assume that automatic sensing of aircraft location and orientation already exists and need not be part of the solution.

PHASE I: Prove the feasibility of the approach for securing aircraft through experiments, analysis and modeling/simulation if applicable. Produce a conceptual design. Provide a list of technical issues related to the approach and the approach's application to the environment, and conduct experiments that address each technical issue. Provide an assessment of impact to operations, aircraft and ship.

PHASE II: Build a prototype system and demonstrate in a laboratory environment.

PHASE III: Continue any development required to successfully demonstrate in an environment that closely mimics the shipboard environment. Produce systems that can be integrated into future carriers (CVN-79 and beyond), and retrofit them aboard existing carriers if applicable.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: If a concept could be proven, this would certainly advance the state-of-the-art in robotics, which would benefit non-government areas such as manufacturing.

REFERENCES:
1. Pattison, J.H. and Bushway, R.R., "Deck Motion Criteria for Carrier Aircraft Operations," Advisory Group for Aerospace Research & Development (AGARD), AGARD Conference Proceeding 509, November 1991

KEYWORDS: Autonomous Operations; Aircraft Securing; Tiedowns; Robotics; Flight Deck

N07-027 TITLE: Innovative Approaches to the Fabrication of Composite Helicopter Tail Booms

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA 261; H-53 Heavy Lift Helicopter Program

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foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate low-cost effective fabrication methods for low-rate production of high-performance composite tail booms for Navy and Marine Corps rotary-wing aircraft.

DESCRIPTION: Advances in composites have been beneficial to the United States Navy rotary-wing community by offering improved fatigue performance and significant weight reductions with equivalent or improved strength capabilities as compared to metallic structure. However, composite aircraft components are expensive to fabricate, especially for low-rate production. Much of this cost is associated with tooling and the lack of automation for low-rate production components. These high costs, and a perceived reduction in composite component durability and survivability, often prevent the transition of composite technology.

NAVAIR is interested in pursuing low-cost fabrication methods for low-rate production of high-performance composite aircraft components. In this application, the maintenance of static strength is critical, but so is an improvement in durability, survivability, and weight. For tail boom components with diameters ranging from four inches to 36 inches, a target of 20 percent of in-plane properties in out-of-plane would provide a significant improvement in the value of large composite components. To this end, improvements in ballistic survivability and the tolerance of low-velocity impact damage (LVID) are critical to the use of composites for tail boom structures.

Composite braiding and three-dimensional composite weaving are examples of technologies that could be used to fabricate tail booms. The z-directional reinforcement and inherent structural rigidity of these processing methods allow for both stiffness in the cured state and conformability of the preform to a wide variety of shapes. In addition, both of these reinforcement technologies could allow for long-range integration of skin and stiffener, further increasing performance while decreasing weight. By combining this technology with innovative curing mechanisms and tooling, it would be possible to fabricate large, complex shapes with little initial investment in tooling. This could reduce the production cost for low-rate items.

The use of carbon fiber reinforcement with long-range architecture, in the form of braiding and weaving, has shown significant improvement over traditional prepeg composites in components with cylindrical geometries. The addition of fibers in the z-direction has been shown to have direct benefit to both damage tolerance and ballistic survivability. However, as with any new technology, it is critical that the development of innovative composite tail booms follow a building block approach, and use sound design methods that are coupled with analytical predictions and test data to validate the use of new materials and structural concepts.

PHASE I: Develop a low-cost composite reinforcement fabrication method for low-rate production of high-performance Navy helicopter components. Demonstrate the ability to make a representative component that is at least 24 inches in diameter and 8 feet in length.

PHASE II: Implement and validate the proposed methods. This should include representative evaluations of building block mechanical testing, manufacturing demonstration of a boom of representative size and structural configuration, and a demonstration of marked improvement in out-of-plane properties.

PHASE III: Demonstrate capability through production, fatigue testing, and static testing of full-size prototype aircraft components.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This composite fabrication method could be used by commercial vendors to provide low-cost low-rate production to the aerospace community.

REFERENCES:

1. http://www.albint.com

2. http://www.ballyribbon.com

3. https://www.dodmantech.com/successes/AirForce/04-08/Vertical%20Tail.pdf

4. https://www.dodmantech.com/successes/AirForce/C-17MLGDoors.pdf

5. https://www.dodmantech.com/successes/AirForce/03-07/FiberPlace.pdf

6. https://www.dodmantech.com/successes/AirForce/04-08/CAI_T2_Wing.pdf

7. https://www.dodmantech.com/successes/Joint/03-07/Fuselage.pdf

KEYWORDS: Tail Boom; Cost Reduction; high-Performance Composite; low-Rate Production; Innovative Fabrication; Tooling

N07-028 TITLE: High Performance/Reliability Display Backlighting

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PMA-209 Air Combat Electronics. [Non-ACAT]

OBJECTIVE: Enhance the performance/reliability of cockpit sized active matrix liquid crystal displays (AMLCDs) for aircraft, using an advanced modular light emitting diode (LED) backlight assembly.

DESCRIPTION: Current AMLCDs employ inefficient backlight technology, which introduces significant power, heat and reliability penalties that reduce mission effectiveness for airborne applications. Innovative LED illumination and control technologies, which synchronize the backlight with the displayed image, greatly enhance the optical performance of the AMCLD by providing extremely high-contrast ratios and enhanced image clarity.

PHASE I: Provide a design concept and determine the feasibility of developing an LED backlight assembly to enhance performance/reliability of an AMCLD for airborne applications. Develop performance specifications based upon available data and preliminary concept designs.

PHASE II: Develop a night vision (NVIS) compatible display head assembly prototype capable of being installed in an existing flight display. Perform optical and preliminary environmental tests (thermal, vibration and electromagnetic interference (EMI)) in a laboratory environment. Refine factors that affect performance and identify limitations.

PHASE III: Incorporate the NVIS compatible display head assembly into ongoing Air Combat Electronics display programs. Perform full system development and demonstration (SD&D) of the technology for aircraft integration and production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High-performance computer monitors, medical imaging systems, and high-definition televisions would all benefit from this technology.

REFERENCES:
1. MIL-L-85762A, Lighting Requirements of Night Vision Compatible Display Systems

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

3. MIL-STD-810F, DoD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, dated 01 Jan 2000

4. RTCA/DO-160D, Environmental Conditions and Test Procedures for Airborne Equipment, dated 29 July 1997.

5. VESA FPDM 2.0, Flat Panel Display Measurement Standard Version 2.0.

KEYWORDS: AMLCD; Displays; LED; Ultra High Contrast; NVIS; Avionics

N07-029 TITLE: Low-Cost, Eye Limiting Resolution, Immersive Display

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop innovative eye limited resolution immersive display technology suitable for real-time training.

DESCRIPTION: Real-time training simulators can not afford to provide 20/20 resolution throughout the full immersive field of view (FOV). The 20/20 Snellen eye chart letter “E” appears as 1 arc minute thick bars with 1 arc minute spaces between the bars. In order to display the 20/20 Snellen eye chart under best case conditions, the display must provide resolution of 2 arc minutes per Optical Line Pair (OLP) or at least 1 pixel per arc minute. Typically, immersive display systems provide one half to one fourth this resolution or 20/40 to 20/80 resolution. The result is training pilots in an immersive training experience as if the pilot needed glasses.

Training environments are sometimes artificially distorted in order to provide necessary training visual cues on displays with limited resolution. For example the virtual size of a carrier visual landing aid may be greatly increased to be as large as the carrier itself. Some visual cues can not be effectively provided due to limited display system resolution such as the wing orientation of a distant aircraft or some terrain surface objects.

The cost per pixel of immersive display systems precludes 20/20 resolution throughout a large immersive FOV. However, new commercial-off-the-shelf (COTS) displays with a large number of pixels and low cost per pixel are becoming available. For example a COTS 56 inch LCD monitor with 3840 by 2160 pixels retailing for $10,000 will be available in 2006. By using such displays channels, a cost-effective immersive 20/20 display system is feasible if some technical issues are solved.

Foremost is the need to develop a solution that eliminates gaps between channels when using low-cost flat panel displays. Other issues include channel matching, alignment, controlling contrast degradation due to cross illumination, as well as other characteristics beneficial to immersive training simulators. At the same time, if a cost-effective method of providing high-resolution immersive stereoscopic or collimated displays can be found, then this would be very useful. Stereoscopic immersive displays would allow more effective training of air refueling, formation flight, and confined area landings as well as integrating pilot helmet mounted displays into the training device. Collimated displays provide realistic motion parallax cues and are mandated by FAA for level D certified trainers. Flat panel displays also provide bright imagery compared to current immersive display systems based on projectors. A bright high-resolution immersive display system would obviate the need for expensive calligraphic display system technology. The advanced technology developed will be incorporated into a display system for use in real-time training simulation.

PHASE I: Develop the advanced technology preliminary design approach to enable low-cost, gapless immersive display systems. Address issues of production cost, technical risk, weight, and performance factors important to training simulation.

PHASE II: Develop a prototype and demonstrate in a display appropriate for real-time training simulation. Measure the performance.

PHASE III: Integrate the new technology into training simulator programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial flight simulator training devices and visualization for research, engineering, and marketing would benefit from advances in immersive display technology.

REFERENCES:
1. http://news.zdnet.co.uk/hardware/emergingtech/0,39020357,39255860,00.htm,

2. http://www.tedmontgomery.com/the_eye/acuity.html,

3. http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/5B7322950DD10F6B862569BA006F60AA?OpenDocument (FAA Advisory Circular AC 120-40B dated 7/29/91 "Airplane Simulator Qualification")

KEYWORDS: Simulation; Training; Immersive; Display; Virtual Reality; 20/20

N07-030 TITLE: Advanced Magnetic Signal Processing for Littoral Antisubmarine Warfare (ASW) Using an Inboard Magnetometer System

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: SH-60, Fire Scout, P-3C, P-8

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OBJECTIVE: Develop advanced signal-processing algorithms for magnetic-noise mitigation, magnetic target detection, and magnetic target tracking using the outputs of a high-sensitivity scalar magnetometer plus ancillary sensors such as vector magnetometers, accelerometers, current monitors, position/attitude sensors, high-resolution GPS receivers, and other sensors as required.

DESCRIPTION: Advanced magnetic anomaly detection (MAD) signal-processing algorithms have the potential to increase detection range in a high platform noise and a high littoral noise environment while extracting precise target signatures that optimize detection and tracking. The algorithms must address all the known airborne MAD noise sources for inboard MAD installations including aircraft maneuver, control surface noise, airframe flexing, onboard equipment interference, and buffeting as well as external noise sources such as geomagnetic, geology, and wave noise. Platforms of particular interest are those supporting littoral ASW missions. These include vertical takeoff unmanned aerial vehicles (VTUAVs) such as Fire Scout, as well as the P-3C, P-8A, and SH-60 aircraft. Incorporation of advanced MAD signal-processing algorithms will enable ASW aircraft to search, localize, and detect submerged targets more effectively.

PHASE I: Develop a conceptual design and demonstrate the feasibility of using inboard littoral MAD signal processing algorithms to achieve the desired range and performance requirements.

PHASE II: Develop the candidate MAD signal-processing algorithms using a high-level language such as MatLab or equivalent and perform testing and performance validation using simulated and actual data.

PHASE III: Integrate these algorithms into a magnetic detection system for real-time operation. Demonstrate performance during a flight test program using Navy ASW platforms or representative commercial surrogate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High-performance magnetometer systems will find additional applications in geology surveys including mineral and petroleum exploration, subsurface fault detection, and underwater wreck detection.

REFERENCES:
1. S. Kay, Fundamentals of Signal Processing - Volume II, Detection Theory. Prentice-Hall (1998).

2. S. Kay, Modern Spectral Estimation: Theory and Application. Prentice-Hall (1988).

3. A. V. Oppenheim and R. W. Schafer, Digital Signal Processing. Prentice-Hall (1977).

KEYWORDS: Magnetometers; Magnetic Anomaly Detection; Signal Processing; Airborne Antisubmarine Warfare (ASW); Target Detection; Unmanned Air Vehicles (UAVs)

N07-031 TITLE: Innovative Rotorcraft Flight Control Systems Options to Enhance Shipboard Operations

TECHNOLOGY AREAS: Air Platform, Information Systems

ACQUISITION PROGRAM: PMA-275; V-22 Program

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OBJECTIVE: Develop innovative rotorcraft flight control system options that account for ship airwake and ship motion effects. Show how the innovative flight control system options affect rotorcraft handling qualities, performance, loads, and ground effects in the shipboard environment.

DESCRIPTION: The aviation capable ship mission includes providing a sustainable forward presence in both peacetime and in time of crisis. Aircraft provide the aviation capable ship power projection and it is important to use future analytic options to help enhance aircraft ship-based operations. Enhancement is needed in terms of allowing the aviation asset the widest latitude of ship and environmental conditions in which to launch and recover. This will allow the aviation asset to be employed a greater percentage of the time, and allow the ship commander the greatest flexibility in operating the ship. Future close-in at-sea scenarios will require a mixture of rotorcraft types, including tilt rotor aircraft operating from a variety of ship classes. The effects of ship airwake and ship motion are not considered in the rotorcraft flight control system design process. Rotorcraft flight control systems are usually designed for steady flight and specified maneuvers in a land-based environment. These land-based designs may not be adequate for the disturbances and resulting loads that can be encountered in shipboard operations. The design of flight control systems for land operations over shipboard operations can result in flight control systems that actually limit the aircraft ability to operate in the near proximity of ships. Flight control systems that provide decreased pilot workload in a land base operations, might provide increased pilot workload, or even uncontrolled flight conditions, in the shipboard environment when it attempts to provide corrections when control authority has already been exceeded due to a ships airwake for example.

In addition, the Navy rotorcraft flight control system specifications date back to the 1950's. These specifications do not address the advanced technology flight control systems of modern aircraft, or modern aircraft ship-based missions. These specifications also do not address the coupling between modern aircraft structures, performance, handling qualities, flight controls, ship configuration, and ship airwake/motion. The outdated flight control system specifications also provide little or no insight into modern rotorcraft flight control design enhancement for the shipboard environment. It is important to develop innovative control system algorithms that consider ship airwake and motion. Ship airwake data may be obtained from full-scale measurement, from wind tunnel data, and from computational fluid dynamics analysis. Ship motion information may be obtained from full-scale measurements or from linear and non-linear strip theory programs. The turbulence created by the interaction of the ship airwake and ship motion can have a pronounced affect the rotorcraft flight control system requirements.

PHASE I: Demonstrate the feasibility of defining innovative rotorcraft flight control system algorithms as a function of ship airwake turbulence and ship motion. Conduct initial sensitivity studies showing the effects of ship airwake turbulence and ship motion on basic rotorcraft performance parameters.

PHASE II: Develop innovative rotorcraft flight control system options that account for ship airwake and motion effects. Show how the innovative flight control system options affect rotorcraft handling qualities, performance, loads, and ground effects in the shipboard environment. Conduct non-real and real time pilot-in-the-loop analysis and simulation to validate the proposed algorithms for a tilt rotor aircraft.

PHASE III: Apply the developed technology to specific future military ship programs like LHA(R) and CVN 21, and to aircraft acquisition programs like tilt rotor UAV aircraft and to VTOL aircraft. Apply the developed technology to future commercial aircraft certification in clear air turbulent environments, and to commercial offshore oilrig and rooftop rotorcraft applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: New advanced ship-based flight control system algorithms would benefit all commercial rotorcraft builders, testers, and operators. The new control system would be useful for rotorcraft and VTOL operations for off shore operations (oil rigs for example) and inner city transportation (skyscraper to skyscraper operations).

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6. MIL-C-18244A, Control and Stabilization Systems: Automatic , Piloted Aircraft, General Specification for

7. MIL-F-18372 (Aer), Flight Control Systems, Design, Installation and Test of Aircraft (General Specification for)

8. MIL-F-83300, Flying Qualities of Piloted V/STOL Aircraft

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KEYWORDS: Flight Controls; Ship Air Wake; Ship Motion; Rotorcraft; Flight Loads; Simulation

N07-032 TITLE: Innovative Material for Enhancing Landing Gear Life

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA 274; Presidential Helicopters Program

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

OBJECTIVE: Develop and demonstrate innovative low-cost, high-strength, high-fracture-tough, corrosion-resistant metal alloys.

DESCRIPTION: Aircraft landing gear components are subjected to some of the highest stresses on an air vehicle. Common materials used today by the United States Navy (USN) are 4340 steel, 300M, and AerMet 100. AerMet

100 has superior material properties to 4340 and 300M. These landing gear materials are chosen because of their material properties and the austere environment in which USN aircraft operate. The USN air vehicle environment facilitates this need for a high-strength, high fracture toughness, corrosion-resistant metal alloys.

Landing gear components made from AerMet 100 has had success within the USN. However this is an expensive, limited supply material. The USN is interested in pursuing an alternative to AerMet 100 with the development of a high-strength, fracture-tough, corrosion resistant, lower cost metal alloy. The nominal material property values for AerMet 100 are 250-ksi 0.2 percent yield strength, 285-ksi ultimate strength, and 100 ksivin. Modeling and simulation (M & S) technology could be used to develop this material for the USN.

Traditional methods of trial and error to develop new materials are very costly and time consuming. M & S techniques would allow for the creation of a material to fit the specific needs of the USN. Previous projects along these lines have been unsuccessful in providing the corrosion resistance necessary for the USN aircraft. Once the material composition has been refined, a coupon could be produced and tested to verify the M& S conclusions. An alternative landing gear material would reduce life-cycle maintenance and cost for USN aircraft.

Landing gear components produced from these innovative metal alloys could have increased capabilities. With corrosion resistance, plating of the components would not be necessary. Plating involves coating components with expensive toxic materials to prevent damage and/or failure due to corrosion. Corrosion causes rust, cracks, and breaks that can cause failure of landing gear components. Thinner dimensions and lower weight components could be fabricated with these materials. With the increased fracture toughness and strength, fatigue cracks that occurred would have a slower growth rate, thus lengthening the period for detection before critical crack length is reached. In addition, the inspection interval would be decreased.

PHASE I: Develop low-cost, corrosion-resistant, high-strength, high-fracture toughness materials suitable for USN landing gear components. Design the selected alloy using modeling and simulation. Establish feasibility through limited coupon testing.

PHASE II: Optimize the properties of the alloy through an iterative approach that includes modeling, fabrication, and testing. Initiate the development of the material design allowable database for the optimized design,through a coupon fabrication and testing program.. Mechanical property testing should include fracture toughness, ultimate strength, yield strength, and elongation at room temperature. Corrosion resistance testing should include resistance to general corrosion, stress corrosion cracking, and corrosion fatigue in 3.5% NaCl solution.

PHASE III: Fully develop the design allowable database for the material. Demonstrate and validate the performance of the new material through component testing in a service environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A high-strength, high-fracture toughness, corrosion-resistant metal alloy has the potential for transition to the commercial aircraft market for cost reduction and enhanced landing gear life expectancy.

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KEYWORDS: Landing Gear Components; High Strength; High Fracture Toughness; Corrosion Resistance; Cost Reduction; Modeling & Simulation

N07-033 TITLE: Advanced Aircraft Simulator Flight Fidelity Evaluation Measures

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PMA 205, Aviation Training Systems

OBJECTIVE: Develop advanced aircraft simulator flight fidelity measures to help better quantify the criteria required for Navy/Marine Corps operational flight trainer acceptance. Demonstrate how factors like aircraft type, flight test maneuver, maneuver aggressiveness, control strategy, visual scene, simulator component, time and/or frequency domain analysis options, plus risk and cost factors affect trainer flight fidelity evaluations. Also demonstrate how the advanced flight fidelity measures relate to the military flight operations quality assurance (MFOQA) process for simulators.

DESCRIPTION: Pilots have used simulators for learning to fly and for proficiency training ever since Ed Link's "Blue Box" flight trainer was introduced in the mid 1930's. It was not until the 1970's that operational flight trainers (OFT) and weapon systems trainers (WST) were evaluated quantitatively by developmental flight test teams using standard aircraft evaluation techniques taught at the US Naval Test Pilot School. This process involved comparing aircraft data for a specified flight test condition to the simulator data for the same test conditions. The simulator data are required to match flight test data for each specified maneuver within a certain specified percentage. Automatic flight fidelity evaluation options are built into most flight trainers, but the automatic options are based on matching flight test data within an arbitrary specified percentage or margin. The FAA evaluates their flight simulators in terms of levels A-D as a function of training requirements, where the model data are also compared to test data. Advanced aircraft simulator flight fidelity measures are needed to help better quantify the criteria required for Navy/Marine Corps operational flight trainer acceptance. It is important to show how factors like aircraft type, flight test maneuver, maneuver aggressiveness, control strategy, visual scene, simulator component, and time and/or frequency domain analysis options affect simulator flight fidelity evaluations. What can be done to minimize the risk and cost associated with trainer flight fidelity evaluations for both land and shipbased mission applications? What advanced measures are available to analyze flight trainer mission data for trend analysis?

PHASE I: Demonstrate proof-of-concept of proposed operational flight trainer and/or weapons system trainer flight fidelity measures for rotorcraft, vertical takeoff and landing (VTOL), and fixed-wing aircraft.   Review available aircrew performance measures including visualization, event detection, and trend analysis. Commence evaluating simulator components for different aircraft types and different land and ship based mission maneuvers.   Commence developing the advanced simulator flight fidelity measures of effectiveness.

PHASE II: Develop a prototype of the advanced aircraft simulator flight fidelity measures.   Show how factors like aircraft type, flight test maneuver, maneuver aggressiveness, control strategy, visual scene, simulator component, and time and/or frequency domain analysis options affect trainer flight fidelity evaluations. Also show how the risk and cost associated with simulator flight fidelity evaluations for both land and ship based mission applications can be minimized. Use the advanced simulator measures to demonstrate full MFOQA capability to provide simulator data and trend analysis. Apply the advanced aircraft simulator flight fidelity measures to a specified rotorcraft or VTOL flight trainer evaluation program.

PHASE III: Apply the advanced aircraft simulator flight fidelity measures to help support new aircraft training programs for rotorcraft like VXX and HLR and VTOL aircraft like JSF.   Apply the advanced aircraft simulator flight fidelity measures to future commercial aircraft certification. Extend the full MFOQA capability to available flight simulators.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Use the advanced aircraft simulator flight fidelity measures to improve the acceptance procedures for FAA and commercial flight trainer developers.   The improved simulator data analysis and trending technology could be applied to commercial trainers.

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2. Hewett, M. D., Galloway, R. T., and Murray, J. C., Improving the Flight Fidelity of Operational Flight Trainers/Weapons Systems Trainers, 7th NTEC/Industry Conference, Nov 1974

3. Woomer, C. and Carico D., A Program for Increased Flight Fidelity in Helicopter Simulation, 33rd AHS Annual Forum, Washington D.C., May 1977

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11. Muessig, Paul R., et. al, Optimizing the Selection of VV&A Activities – A Risk/Benefit Approach, Winter Simulation Conference, 1997, also see the DMSO www page VV&A

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13. DoD MFOQA Process Implementation Memorandum of 11 Oct 2005

14. Joint Aviation Requirements JAR-29 – Large Rotorcraft, Amendment 3, Joint Aviation Authorities, The Netherlands, 2002

15. Joint Aviation Requirements JAR-29 – Large Aeroplanes, Joint Aviation Authorities, The Netherlands, 2000

KEYWORDS: Simulation; Math Model; Fidelity; Visual System; Time Domain; Frequency Domain

N07-034 TITLE: Military Training Systems Acceptance Test & Evaluation

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Extend and apply new technologies and methodologies of automated acceptance testing to the wide variety of complex Navy flight and maintenance training simulators.

DESCRIPTION: Today acceptance tests of computer-based simulations are labor intensive, requiring systematic identification, classification and manipulation of a large number of variables, against a diverse set of criteria and associated ratings. An innovative approach is needed to more systematically address the complexity and variation of training simulator acceptance testing. Moreover, new methodologies should enable automated, simultaneous testing of multiple critical performance variables each time a trainer is upgraded. Inefficiencies, errors, and oversights caused by today's poorly devised testing processes presently inflate the time and expense of government acceptance testing. Training system deficiencies that are not identified and corrected during testing have resulted in reduced performance and training effectiveness. Latent (undetected) defects have also proven to be expensive to correct after the training system has been accepted for military use in terms of contractor fees, government effort, and trainer downtime.

PHASE I: Propose an innovative methodology for standardized and automated acceptance testing - based upon the wide range of complex training systems planned for use in the Navy over the next five to ten years. It should allow referencing of documents related to the test process, such as the simulator specification, Requirements Traceability Matrix (RTM) and test procedures. Identify the variables involved, common problems encountered, and projected cost avoidances if successful.

PHASE II: Develop, integrate, and demonstrate a prototype acceptance test system on a Navy training simulator.

PHASE III: Commercialize the test system and apply to other DoD and commercial simulators.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The developed technology and methodology can be applied by any business that performs independent acceptance testing of simulators or systems of like complexity. It could also be used for joint contractor/government test and development, and private sector developer/customer simulator test & evaluation.

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3. M. George, et. al., The Lean Six Sigma Pocket Toolbook, McGraw Hill (2005).

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KEYWORDS: Systems Testing, Quality Control/Engineering, Test and Evaluation, Defect/Issue Tracking, Training Systems; Simulation Training; Lean; Six Sigma

N07-035 TITLE: Development of Cost-Effective Rapid Turn-Around Mask Making Systems and Low-Volume Military Integrated Circuit (IC) Manufacture

TECHNOLOGY AREAS: Materials/Processes, Electronics

ACQUISITION PROGRAM: ACAT I

OBJECTIVE: Provide a cost-effective commercial source of rapid turn-around mask supply for small-volume military IC production and prototyping. Reduce the time and costs for patterning masks.

DESCRIPTION: Military systems achieve “force multiplier” capabilities through the use of application-specific IC (ASIC) chips. These components are generally used in very small volume.(Less than a total of 1,000 components would satisfy the total system requirement including spares). Despite the small production requirement, military chip acquisition is a challenge. Components must be “cutting-edge” in performance and design turn around must be rapid. While major system insertion times are longer than a decade, important system modification and/or mission specific technology insertion is considerably more rapid. A given conflict may require turn-around times (from design to component) of less than a year.

One of the major bottlenecks in ASIC production (in terms of cost and turn-around time) is photomask making. Photomasks are the “negatives,” or blueprints from which IC chips are built. To make a cutting edge mask set today requires over a month of direct labor and a cost that may approach a million dollars. Many new mask systems that make use of writing tool parallelism (multi-beam approaches) are currently in development. These novel tools could supply the necessary masks rapidly and cheaply at costs an order of magnitude less than commercial IC mask makers. It is the aim of this solicitation to bring one of these novel systems up to production standard for use in military chip supply.

PHASE I: Demonstrate the scientific merit and capabilities of the proposed novel small-volume mask or wafer production tool. Provide prototype masks or wafers to ascertain the level of system maturity and to point the way to reliable manufacture of the finished tool.

PHASE II: Fabricate and characterize a beta-tool for evaluation and field-testing. Depending on the specific tool concept, alpha-tools may be substituted in lieu of beta-tools should the Government agree with the offeror that such tools would satisfy establishing the business case for small lot fabrication.

PHASE III: Develop the necessary manufacturing base to supply the completed tool to military system and component vendors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of this mask-making tool will provide a small business with a long-term product that will be of enormous use to military design engineers. In addition, many commercial electronics suppliers require such small-volume production for prototyping and production. Not all commercial electronics systems require tens of millions of parts to be successful in the business market. Many large (and expensive) systems, like mainframe computers, are not sold in volume. But they do require cutting-edge technology to gain customer advantage. The ASIC market world-wide has supported such requirements.

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2. Principles of Lithography, Second Edition (SPIE Press Monograph Vol. PM146), Harry J. Levinson, SPIE Press, 2005.

3. Mask Industry Cooperative Working Group (MICWG) Briefing to DUSD(S&T) dtd. 3/18/2005. (attached to electronic mail sent to the NAVAIR SBIR/STTR Office)

4. A general description of multibeam approaches is found for sale at:
http://informationnet.ecnext.com/coms2/summary_0243-826_ITM

KEYWORDS: IC Production; ASIC production; Chip Production; Photomasks

N07-036 TITLE: Modulated Pulsed Laser Sources for Imaging Lidars

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-264 ACAT IV

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

OBJECTIVE: Develop high-frequency modulated pulsed laser sources that can improve target recognition and identification capabilities in turbid media.

DESCRIPTION: As ongoing research in underwater lidar progresses, it has been proposed that high-frequency modulated pulsed laser sources will improve target recognition and identification capabilities in turbid media. In order to investigate potential gains in this area, modulated pulsed blue-green (400 - 550 nm) laser sources must be developed. The requirement is for high energy (1 - 100 mJ) low repetition rate (0.1 - 10 KHz), and low energy (0.01

- 1 mJ) high repetition (10 - 500 KHz). The pulse widths should be from 10 - 30 ns with very little pulse-to-pulse variation (less than 5 percent or best effort). Furthermore, each of the pulses should envelop a tunable high-frequency (0.5 - 2 GHz) modulation that can be phase locked to an external source with very low jitter. The resultant source must be small, compact, low weight, and ruggedized for use in the field.

PHASE I: Determine the feasibility of developing laser sources that meet the required specifications and then perform preliminary bench-top tests to explore potential designs.

PHASE II: Demonstrate a working bench-top system and then develop and test a fully functioning prototype to ensure stability.

PHASE III: Ruggedize the protype and package it for use in the field.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications that would benefit from these modulated sources include biomedical optical imaging and imaging through clouds, smoke and flame.

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3. D. Kao, T. Kane, and L. Mullen, "Development Of An Amplitude-Modulated Nd:YAG Pulsed Laser With Modulation Frequency Tunability up to 60 GHz by Dual Seed Injection," Opt. Lett. 29, 1203-1205, 2004.

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KEYWORDS: Laser; Modulation; Pulse; Image; Contrast; Communication

N07-037 TITLE: <u>Accelerated Assimilation of Flight Deck Wind, Pitch, Weather and Roll Limitations</u>

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA 205; Aviation Training Systens

OBJECTIVE: Develop a prototype simulation environment for rotary-wing aircraft that models dynamic wind, rotor-wash, and weather effects across varied ship decks, landscapes, and man-made structures, together with the combined effects of rotor wash on operations.

DESCRIPTION: Recent developments in the modeling and simulation industry have made it possible to create affordable PC-based simulators supporting helicopter operations in a Navy, Marine Corps, Army, or Coast Guard helicopter environment. While today's simulated environments can generate a variety of weather states, times of day, and other visual and audio effects, the impact of these variables on simulated objects within these simulated environments has yet to be integrated. Today's environmental models do not show the combined impact of weather, wind, and rotor wash on even basic simulated tasks such as enemy engagements, vertical replenishments, or search and rescue operations. Consequently, training new personnel to understand and visualize the effects of wind, pitch, and roll on aircraft during movement on deck and during launches and recoveries is a complex and largely abstract process. The catastrophic effects of exceeding these limits all too often remain just that, an abstract idea, until one witnesses the unforgiving laws of nature at work. Recent developments in the modeling and simulation industry have made it possible to create massive multi-player online "game like" environments that allow networked, PC-based training simulations. However, these simulated environments do not use realistic, dynamic wind models.

A virtual environment is sought that not only visually displays the weather, but also accurately displays the impact of airflow around solid objects such as a ship superstructure across the deck of a small ship's landing area, or correctly models the behavior of search and rescue equipment at high sea states. The simulated objects should accurately model pitch, yaw, roll, and shaking or vibrations that would occur in the real world under actual conditions. Additionally, the rotor wash should accurately model a variety of airframes, including the TH-57, H-60, CH-53, and the V/22 tilt-rotor aircraft – in both hover and forward flight modes of operation. It is proposed that an innovative training environment be developed that necessitates multiple trainees to enact and coordinate the roles of all personnel involved in aircraft launch and recovery). The instructor or the trainees can control the weather effects and wind models or they can be set to randomly vary during the game. Proper coordination within limits will result in a safe landing, recovery, or stowage, while exceeding safe limits may not. After each evolution, provide the trainees with the option of trading positions, trying a different weather condition, etc. The system should include an innovative visible winds feature that enables beginners to "see" the wind, wind gusts, and speed, as well as rotor wash, as the air moves around the ship, past the aircraft, and over the deck during flight operations. As the winds approach the trainee's limits, the coordination required of the trainees should also intensify

PHASE I: Identify critical tasks performed by helicopter and tilt-rotor crews that are directly impacted by weather, rotor wash, and/or sea state. Rank the tasks by how they are impacted by the effects of weather, airspeed, and rotor wash. Develop concepts for environmental wind and weather algorithms. Develop concepts for animation of critical physical objects responding to winds, weather, and rotor wash. Project the cost of integrating such models into existing simulated environments. Develop and demonstrate an innovative concept of visually depicting the wind direction, intensity, gusts, etc. Create a training strategy that will involve and motivate trainees to master each role, and to coordinate effectively.

PHASE II: Develop, evaluate, and refine the algorithms and object models outlined in Phase I. Test the integration of these models into existing simulated databases. Develop, test, and evaluate the systems effectiveness for training personnel in understanding of, and ability to coordinate for, safe flight operations under varied weather and sea state conditions.

PHASE III: Transition weather, wind and rotor wash models, and models of identified key objects that respond appropriately to these environmental cues to Navy, Marine Corps, Army, and Coast Guard training facilities throughout the world. Adapt training scenarios to be used for entertainment purposes, market the product to the gaming industry.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These models could be incorporated into commercial pilot and aircrew training systems for mission rehearsal under a variety of conditions. The models would also provide those who may not be experienced helicopter pilots, an opportunity to observe the predicted effects of environmental conditions, buildings, terrain, rotor wash, etc. on planned operations in a gaming environment. Additionally, NASA, DHS, Army, Marine Corps, Air Force, Air National Guard, Coast Guard, Forestry, Intelligence Agencies, and Law Enforcement organizations around the world could use the system to train personnel who interact with or pilot helicopters as part of their duties.

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KEYWORDS: Helicopter; Weather; Hoist Operations; Wind Envelope; Simulation; Modeling

N07-038 TITLE: Techniques, Processes, And Tools For Implementing An Integrated Corrosion Detection System

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: ACAT ID: Multi-Mission Maritime Aircraft

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

OBJECTIVE: Develop an integrated health management system (IHMS) for corrosion detection in large military aircraft.

DESCRIPTION: Current methods of detecting corrosion in large military aircraft involve careful manual inspection of aircraft surfaces by maintainers in the field and at the depot level. These schedule-based detection methods are time consuming and quality of inspection is limited to detection by the human eye. Furthermore inspection in non line-of-sight and tight spaces is not possible without a bore scope or other item of non-destructive inspection (NDI)equipment.

In order to increase the availability of the aircraft and minimize the amount of inspections required, an IHMS is needed to identify early signs of corrosion and alert maintainers when and where inspection is necessary. This will be a very difficult task because of the large amount of hidden corrosion areas and the advanced aerospace materials found in modern aircraft. In order to fully enable the detection part of any IHMS corrosion concept, there must be some capability to relate detected incipient corrosion fault conditions to accurately detect when an area needs to be inspected. This may be accomplished through the merging of an understanding of the particular physics of failure, analytical models, physical models, statistical techniques, and actual failure experience data. It is desirable that the models be supported and driven by existing parameters and measurands. These advanced corrosion detection models should be applied in support of the detection part of IHMS on aircraft structures. New and innovative approaches, models, and methodologies will be required.

PHASE I: Demonstrate feasibility of technology to "self -assess" corrosion detection capability and its ability to accurately determine when it is necessary to inspect impacted areas.

PHASE II: Develop the necessary system architecture, models, processes, and management tool sets. Develop system prototype to demonstrate system capabilities.

PHASE III: Incorporate these techniques, processes, software, models, and/or tools into the Multi-Mission Aircraft (MMA) IHMS.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial aerospace industry where corrosion is possible.

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KEYWORDS: Corrosion; Diagnostics; Health; Total Ownership Cost; Sensors; Inspections

N07-039 TITLE: Three-axis Low Airspeed, Low-Cost Air Data Sensor for Rotorcraft

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA-261

OBJECTIVE: To develop an accurate low airspeed three-axis air data sensor for enhanced safety of flight during low speed maneuvers, automatic flight control support, and weapons delivery.

DESCRIPTION: An accurate low air speed rotorcraft air data sensor is needed for enhanced safety of flight during low speed maneuvers, automatic flight control support, and weapons delivery. The low air speed regime is important in terms of safety and safely expending the maneuvering envelope during low speed maneuvers such as approach, rapid descent, hover, sideward, and rearward flight. At present, there are many challenges towards developing low cost, low weight sensors that work reliably at low air speeds for rotorcraft. This results in higher total ownership cost, limited automatic flight control authority, and costly systems for delivering weapons on target. Standard pitot systems degrade in capability below 40 knots due to sensitivity issues and the effect of rotor downwash. Although some specialized sensors can provide improvements over standard pitot systems, they are often complex, hard to calibrate, expensive, and/or significantly heavier than the standard systems. Optical Air Data Systems are one potential solution, but they currently can be expensive, complicated, and have substantial weight penalties. Other potential approaches involve separating the effect of rotor downwash from airspeed. There is a need for low cost, low weight, low maintenance, robust technology that can be easily introduced and integrated with existing avionics for rotorcraft such as the UH-1N, AH-1W, UH-1Y, AH-1Z, V-22, and rotary-wing UAVs.

The desired capability would provide accurate airspeed down to a few knots despite rotor downwash. This capability should simultaneously provide measurement of airspeed and flow angularity in all three directions (forward, vertical, and lateral). Specifically, the low airspeed sensor of interest should have the following characteristics: (1) it should provide accurate speed measurements along the longitudinal, vertical, and lateral axes; (2) it should be easy to maintain with minimum calibration requirements; (3) it should be possible to easily retrofit the sensor with existing avionics systems without extensive structural changes to the vehicle. Small size, weight, low cost, and low power consumption are also highly desirable.

PHASE I: Provide an initial feasability study that demonstrates scientific merit and capabilities of the proposed three-axis low airspeed sensor. If possible, this should incorporate limited laboratory scale experiments to support the analysis of the feasibility of the proposed concept. Conduct preliminary design studies to develop concepts for sensor protection from harsh environmental effects. Provide evidence via design studies, analysis, and limited laboratory testing that the proposed system can meet acceptable requirements in terms of accuracy below 40 kts airspeed (with a particular focus on airspeeds below 30 kts) and in different environmental conditions, calibration requirements, retrofit requirements, cost, weight, size, and power consumption.

PHASE II: Design, fabricate and demonstrate a breadboard and/or limited prototype three-axis airspeed sensor. Conduct analysis supported by wind tunnel and relevant environmental testing of system. Conduct helicopter flight-tests on a naval or surrogate system to fully document the system's performance. Provide evidence via design studies, analysis, wind tunnel, environmental, and flight testing that the proposed system can meet acceptable requirements in terms of accuracy below 40 kts airspeed (and with a particular focus on airspeeds below 30 kts.) in different environmental conditions, calibration requirements, retrofit requirements, cost, weight, size, and power consumption.

PHASE III: Develop a proptotype sensor, integrate the airspeed sensor and conduct final flight-testing using a naval production rotary-wing aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of low airspeed sensor should enhance safety and performance features of civilian helicopters. It will also assist in enhancing safety of search and rescue operations, fire-fighting, homeland defense, and in efficient transportation of loads such as lumber. Accurate low airspeed sensors will provide important data for closed-loop flight control for ‘hover and stare” operations required in reconnaissance and aerial survey.

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KEYWORDS: Airspeed; Sensor; Air Data; Rotorcraft; Helicopter; Low Speed

N07-040 TITLE: Novel Flame Holder Design Providing Enhanced Stability in Gas Turbine Augmentors

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: Joint Strike Fighter

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

OBJECTIVE: Identify, test, and verify uniquely shaped flame holding concept(s) that reduce the fuel-air ratio at lean blowout for high-altitude, low-Mach-number flight conditions.

DESCRIPTION: Gas turbine augmentors employ bluff body flame holders to anchor and stabilize the flame. Legacy augmentors have utilized spray bars/spray rings and v-gutter flame holders. To avoid potential auto ignition due to high-inlet air temperatures, modern augmentors employ close-coupled fuel injector/flame holder designs.

There are difficult challenges in static stability, especially in the upper left hand corner of the flight envelope where the aircraft is traveling at low Mach numbers and at high-altitude. This results in conditions in the augmentor that are less favorable for robust ignition and flame holding. In this portion of the flight envelope the pressure in the afterburner is very low and the air entering the afterburner is vitiated with low oxygen content, both of which challenge robust combustion. Further, low pressure and vitiation reduces the required fuel flow, resulting in poor fuel preparation to the flame holder prior to combustion.

Novel flame holding concepts are desired for the improvement of static stability. Concepts should not be limited to flame holding architecture, but also should consider fuel delivery and fuel mixing into an integrated concept. Concepts should take advantage of the existing augmentor architectures in legacy and pipeline augmentor systems. Design modifications should only minimally affect the overall augmentor design, thus allowing for retrofits into legacy and advanced engines. Novel concepts should enhance stability without sacrificing durability or performance from the baseline.

PHASE I: Determine the feasibility of the proposed flame holding concept through both numerical analysis and reacting bench scale experiments. Perform accurate numerical simulations to assess which design configurations best improve lean blowout. Fabricate and test the best designs in a single flame holder rig to demonstrate improved lean blowout characteristics. Phase I tests may be performed at ambient pressure and temperature inlet conditions.

PHASE II: Optimize Phase I design using validated numerical simulation to further develop the prototype flame holding concept. The improved design should be demonstrated in a single flame holder rig at the same flow conditions as used in Phase I. Perform follow-on testing at realistic augmentor operating conditions. Two rounds of testing should be proposed to ensure the best designs are demonstrated. Close interaction with an engine original equipment manufacturer (OEM) is desired.

PHASE III: Finalize the flame holding concept design and testing in compliance with OEM specifications. Fabricate engine-quality hardware and perform testing in an engine augmentor. Transition the flame holding technology to a military gas turbine engine.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be used by any engine manufacturers working with after-burners.

REFERENCES:
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2. Flame Stabilization of Bluff Bodies at Low and Intermediate Reynolds Numbers, Edward E. Zukowski, PhD Dissertation, California Institute of Technology, January, 1954.

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4. Advanced Demonstration of Fuel Injector/Flame holder for High Speed Ramburners, S. Alan Spring, Clifford E. Smith, and Andy D. Leonard, Air Force Report WL-TR-95-2068 (Approved for Public Release, Distribution Is Unlimited), May, 1995.

KEYWORDS: Flame Holder; Augmentor; Afterburner; Stability; Lean Blowout; Combustion

N07-041 TITLE: 20/20 Immersive Display System Based on Eye Tracking

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Take advantage of human eye performance to provide 20/20 clarity display that is also immersive in field of view (FOV). The eye sees 20/20 clarity only in the foveal direction a few degrees across while the rest of the eye's FOV is seen only with very low clarity.

DESCRIPTION: Pilots should be trained in high fidelity-high-resolution training simulators that provide 20/20 clarity and immersive FOV. A traditional immersive display system would require about 100 quad XGA display channels to provide this performance and thus is not feasible. A 20/20 immersive display system that tracks the pilot's "look direction" is feasible by providing a small eye-tracked FOV with high resolution while also providing a much lower resolution immersive FOV. Also, since the eye-tracked 20/20 FOV is small, the Image Generator can provide extremely high fidelity in the foveal region (the limited number of pixels slows extreme antialiasing, extreme depth complexity, and extremely dense number of polygons per square degree). The net result is an imaging system with 20/20 resolution, which is able to run real time virtual environments an order of magnitude more complex than current systems. Eye-tracked high-resolution immersive displays have been tried in the past but due to older technology but they have never reached their potential.

PHASE I: Develop a preliminary design of prototype cost-effective immersive display with 20/20 clarity and demonstrate proof-of-concept. Define the risks and performance in a training simulation environment.

PHASE II: Develop, build, and demonstrate a prototype system.

PHASE III: Specific Phase III implementation depends on the system performance limitation,(e.g., is it compact enough for deployable environments). The product will transition into a real-time training device. This could be an upgrade of an existing system or a new system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Possible applications for a cost-effective 20/20 immersive display system include remotely operated medical equipment, visualizing new architectural designs, visualization research tools, etc.

REFERENCES:
1. Engineering Data Compendium Human Perception and Performance Volume II page 1489 Library of Congress "TA166.E54 1988 620.8'2 87-19560"

2. Military Standardization Handbook Optical Design, Mil-HDBK-141 5 October 1962 page 4-9

KEYWORDS: Eye Tracking; Display Systems; Simulation; Virtual Reality; 20/20; Training

N07-042 TITLE: Real-Time Modeling of Rotor Induced Flow with Shipboard Interactions

TECHNOLOGY AREAS: Air Platform, Information Systems, Human Systems

ACQUISITION PROGRAM: PMA-205 Naval Aviation Training Systems ACAT IV, PMA-275 V-22 Program

OBJECTIVE: Develop a robust physics-based model of the rotor induced flow for use in a real-time simulation. The final product should be capable of capturing the interactions associated with the rotor-induced velocity in a naval shipboard landing environment (or other complex environments) to allow pilots to conduct accurate real-time simulations.

DESCRIPTION: In the development of helicopter training systems, modeling of the induced flow of a rotor system is quite complex and computationally extensive, thus pushing the limits of modeling and simulation technology. Typically, the modeling and simulation of the induced flow can be done many different ways with varying degrees of success. Because simplifying assumptions have to be made in the typical rotor inflow model, the interactions of the inflow with its environment (fuselage, empennages, in ground effect, autorotation, vortex ring state etc.) are also done on an ad-hoc basis. Overall, this has resulted in both numerous models being developed from scratch and poor engineering fidelity. Recent advances have pointed to the feasibility of increasing the fidelity of inflow modeling while maintaining the real-time simulation capability. But challenges remain in the phyiscal understanding of the initial turbulent shed vortex roll up and vortex to vortex interacations (or wake evolution), along with the numerical methods to allow their fast computation. By overcoming these challenges an increase in model fidelity should allow for the inclusion of higher fidelity environment effects directly into the inflow model. Because the model will be physic based and not tailored to a specific airframe, the model should be capable of being applied across multiple helicopter simulations. Therefore as processor speeds increase and the physics-based model is upgraded, these upgrades can be applied across the range of simulations as opposed to developing specific upgrades for each helicopter simulation. This will lead to a reduction of duplication of effort and a reduction in implementation risk. Because helicopter simulations are often used in handling qualities evaluations, the improvement in engineering fidelity will result in improved accuracy at a reduced risk.

PHASE I: Conduct a feasibility study to determine the potential of creating a real-time software module to represent helicopter rotor induced inflow. The study will examine the following areas: 1) maximizing the physics captured in the flow field, 2) integrating advanced features that can take advantage of the physics-based inflow model (ground planes, air wake effects, etc.), 3) providing fast numerical algorithms to allow implementation in a real-time environment and 4) scaling the model to take advantage of increasing computer performance. The study will result in the software approach that best meets the key areas listed above.

PHASE II: Develop the software module proposed in Phase I. A prototype software module that can run in a 'stand alone' mode will be developed to demonstrate the benefits of the algorithm. Define interfaces that the host simulation/trainer will require in order to work with the model. Provide recommendation as to how a typical rotor model should be modified to maximize the benefits of the new algorithm.

PHASE III: Integrate the software module into two Navy rotary wing flight simulations. Conduct validation testing to determine that the model has been properly integrated and to define the benefits of the new software integration. Demonstrate the scalability of the inflow model. All testing should be demonstrated in a real-time environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The creation of a physics-based model of the inflow of a rotary wing aircraft that runs in a real time environment will be beneficial to the development of commercial rotary wing training devices.

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KEYWORDS: Rotary Wing Aircraft; Inflow; Trainers; Air Wake; Ground Effect; Shipboard Landing

N07-043 TITLE: Tactile Situational Awareness System (TSAS)

TECHNOLOGY AREAS: Air Platform, Information Systems, Human Systems

ACQUISITION PROGRAM: AH-1W/UH-1N Helicopters

OBJECTIVE: Develop a tactile sensory display system that will enhance pilot spatial awareness in all phases of flight and prevent aircraft mishaps.

DESCRIPTION: The primary goal of this SBIR topic is to advance the development of innovative tactile sensory displays in aircraft. As humans grow and develop, sensory systems mature to control and coordinate movements subconsciously using all of the human senses. Pilots have to be trained to ignore nearly all of these well developed and extremely accurate senses except that of visual stimuli. During times of high mission tasking, at night, or other conditions of low visibility, visual stimuli is unavailable, ignored, or another sense overwhelms pilots with the wrong information. This results in loss of situational awareness and often with catastrophic results. The tactile sensory display system will restore the sense of feel and contribute to pilot awareness of aircraft position, attitude, and rates of movement about each aircraft axis. The system will not replace visual displays but will restore human systems synergies through a innovative interface integration of existing technologies directly with the human sense of feel. Like computerized monitoring of current flight control system sensors and visual displays, TSAS will provide confirmation human sensory truth data to and better maintain aircraft situational awareness in all mission scenarios.

Air vehicle systems development has matured numerous technology sensors to detect and report aircraft attitudes, rates, and vector velocities to visual display systems with remarkable accuracies. The innovative TSAS system will interface these same sensors to a tactile sensor display mounted on the pilot. The tactile sensor display will consist of a torso garment with embedded miniature operated vibrating devices. These devices, known as tactors, will vibrate in response to information reported by traditional aircraft sensors. This SBIR seeks two goals. The first is to demonstrate the integration of a common modern processor with current aircraft sensors, and embedded rate sensors or accelerometers. Current tactors have been shown to experience significant damping after loading by the skin and flight equipment resulting in a reduction in stimulation amplitude. A smaller tactor is required that is lighter, and capable of producing a stronger vibratory stimulus with amplitude control across a wide frequency range (10-350Hz) and enable a lower profile integration to pilot clothing.

PHASE I: Determine the feasibility of developing a processor which will receive aircraft attitude and rate data, process this data and produce algorithms which will direct accurately timed discrete signals to appropriate positional tactors located in the torso vest. Identify or develop and integrate a small, lightweight, multi-frequency tactor capable of safely producing the stimulus at low energy consumption.

PHASE II: Develop and demonstrate a final application for the processor requirements, algorithms, and torso vest in an aircraft simulator. Optimize the tactor performance to include manufacturability and reliability considerations. Provide system performance level specification for processor software requirements, functional system component requirements, and aircrew torso garment requirements.

PHASE III: Demonstrate the system on-board a helicopter with flight qualified hardware and software. Produce detailed specifications for system functional components.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The TSAS system promises to revolutionize aircraft display systems and will improve pilot situational awareness in any aircraft. The system will have wide application in all military, commercial, and general aviation aircraft.

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KEYWORDS: Tactor, Situational Awareness; Displays; Tactile; Sensory; Human Systems

N07-044 TITLE: Inverse Synthetic Aperture Radar (ISAR) Imagery Feature Extraction and Database

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMA-290 Multi-mission Maritime Aircraft, ACAT 1

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

OBJECTIVE: Create image processing techniques and automated functions to perform object recognition and imagery matching of disparate imagery sources (ISAR, electro-optic) to enable recognition of maritime targets.

DESCRIPTION: Disparate imagery sources that rely on different fundamental methods of imagery generation typically reside in military surveillance platforms (SAR, ISAR, electro-optic). Automated and semi-automated methods to extract and match relevant features from these imagery sources are not available. Recognition of maritime targets using these systems typically relies on outdated models of maritime targets to aid identification. The ability to effectively determine appropriate match points from live, real-time imagery will greatly improve surveillance capabilities and greatly improve recognition time. A fundamental problem for computer object recognition is determining correspondence between two sets of image feature from a pair of views of the same scene. This "matching problem" has proved to be very difficult to solve due to the fact that common physical phenomena, changes in illumination, perspective, distortion, etc, can have significant impact on the appearance of a scene and any object in it. This problem is compounded for imagery from very disparate sources such as ISAR and electro-optics.

Additionally, while there has been significant active research into content based image retrieval (CBIR), the ability to search image databases using the content of the imagery instead of textual descriptions of the images in the database, has been focused on imagery from non-disparate sources. CBIR functionality is required by military platforms that need to classify and identify military targets using on-board sensors via autonomous or semi-autonomous means using search functions that do not require extensive image metadata to search. Adding in the additional complexity of disparate imagery sets makes this a research problem that can yield significant military utility with commercial viability.

PHASE I: Design a methodology that will automatically determine image match points, and identify high interest objects from disparate sources of maritime target imagery to populate a image database that can be queried. Include imagery from ISAR, SAR, electro-optics (EO) sensors, photos and intelligence as sources for features. Determine methodology to query this database using CBIR techniques. Demonstrate the feasibility of improving recognition time for high interest objects.

PHASE II: Develop a prototype, standard, open architecture database and automated software to extract objects of interest and populate an image database from a wide set of targets. Develop concept of operations for military operators to use real time data to query the image database to identify targets of interest. Demonstrate operator recognition enhancement. Whenever possible, evaluate the performance using sponsor provided data sets.

PHASE III: Working with the original equipment manufacturer (OEM), transition technology into the Multi-Mission Maritime Aircraft (MMA) via low rate initial production (LRIP) insertion or serial development.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The general methods developed could be applicable to a wide range of feature classification needs ranging from those of homeland security to the medical field. Recognition time improvements for detecting objects in disparate imagery using CBIR techniques should be of significant value for homeland security applications in particular.

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KEYWORDS: ISAR; Database; Ship Classification; Intelligence; Image Processing; Surveillance

N07-045 TITLE: Geospecific Night Imagery for Real-time Training Simulators

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

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

OBJECTIVE: Develop software tools to automatically derive manmade lighting from night imagery source data and incorporate into real time visual & sensor databases to provide geospecific virtual environments for real time training simulators.

DESCRIPTION: Currently, night time terrain imagery for real time training simulators is mostly geotypical (not geospecific) due to costly hand modeling man hours. Thus only the most critical light points are correctly modeled while most lighting is typical and not geospecific. Also, recent graphics board technology hardware advances opens possibilities to insert/modify a large number of light points within a virtual world for correct display in real time simulation. Innovative software tools are needed to take advantage of the new graphics hardware by automatically deriving man made lighting from night time imagery and incorporating it into visual & sensor databases that define a geospecific world used for real time training simulators. Currently, state of the art database generation tools for creating virtual world databases do not take advantage of night imagery source data.

Software algorithms and tools must be developed to perform several tasks including deriving the following from night time satellite/aerial imagery: correlation to day time imagery, correlation to existing visual & sensor databases, identify location of light points (including height above the ground from stereoscopic imagery), determine brightness, color and type of lights from imagery, identify correlated illumination of terrain and surface features due to light points (such as street lights), differentiate moving/blinking/occluding light points from multiple images.

The software tools developed must also incorporate the resulting geospecific data into the visual/sensor virtual world databases used by new hardware graphics board technology. The resulting improvements in database environments should include the Image generators (IG) to recreate geospecific night terrain. It also should be used to identify low flight obstructions from the light points, which could then be included in day simulations (e.g. geospecific power line towers). There are possibilities to extract lots of geospecific terrain surface features which could be useful for night time mission rehearsal. There is no reason a night time training scenario can't be based on night time terrain imagery which could have accurate terrain light points and terrain illumination caused by light points just as seen in the real world. Traditionally, IGs have been limited by the number of light points that can be displayed. However, if they are included in the terrain texture, there is no limit. Also graphics board shaders may be able to quickly process light points to include occulting as a function of look angle, shifting as a function of look angle and the light point's height above ground, adjust light point size to simulate radiant energy, dynamically control the terrain illumination from light points, etc.

PHASE I: Develop a system design approach and determine the feasibility of incorporating night time source imagery into a real time simulation suitable for training simulators. This system design approach includes obtaining source imagery, processing source imagery, distilling source imagery into a form that can be incorporated into the visual/sensor database, how the IG will process the database to provide the real time imagery. Evaluate benefits and risks of the proposed design. Reduce risk by demonstrating any new techniques (such as shader utilization) upon which the design depends.

PHASE II: Complete/enhance the proposed design. Build a prototype starting with geospecific night imagery. This includes software tools to process imagery and any new IG algorithms.

PHASE III: Incorporate the new capability into training simulation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial training flight simulators could benefit from this technology. Improved geospecific databases could also be employed by regional governments for tracking of land use. This technology could also be used to monitor the existence of any infrared hot spots for control of forest fires and could also be used to help locate missing people lost in unpopulated areas if IR band is low enough.

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KEYWORDS: Training; Simulation; Aerial Satellite Imagery; Virtual Reality; Visual; Night

N07-046 TITLE: Advanced Liquid Surface Tracking Software for Predicting Atomization in Gas Turbine Combustors and Augmentors

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

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

OBJECTIVE: Develop and validate an advanced two-phase, surface-tracking computational fluid dynamics (CFD) code that accurately models the fuel atomization process in gas turbine combustors and augmentors. Use the code to develop phenomenological atomization models for Reynolds Average Navier-Stokes (RANS) and large eddy simulation (LES) combustion analysis of advanced and legacy military combustion systems.

DESCRIPTION: The spray atomization process that occurs in military gas turbines significantly affects many aspects of combustor/augmentor stability, durability and performance. The atomization process involves the growth of surface waves on the liquid jet or film, followed by the stripping of ligaments and drops. The individual drops can undergo even further breakup (secondary atomization).

Current CFD codes used in combustor/augmentor design are based on empirical stripping/breakup correlations either derived from experimental measurements of single drops or inferred from far-field droplet measurements. These methods provide poor results and fail to accurately predict the atomization process. For example, RANS and LES predictions have been shown to underestimate the fuel-air ratio in the wake of augmentor flame holders by 50 percent or more.

Improved correlations are needed to better predict the physics of the fuel atomization process. One way of getting improved correlations is to measure the near field stripping process, but this is extremely difficult to accomplish. An alternative approach is to numerically resolve the liquid jet breakup process by volume of fluid (VOF) and/or level set (LS) methods. In VOF and LS, the complete Navier-Stokes equations are solved for both the liquid jet and gas cross-flow, along with the surface interface. Waves are predicted on the liquid surface and the stripping process is resolved numerically. Consequently, VOF/LS can be used to understand and build highly reliable phenomenological models for use as spray design tools at the conditions of interest in gas turbine combustor/augmentor operation. Solutions should be implemented into an existing CFD framework.

PHASE I: Demonstrate feasibility by developing an advanced surface tracking algorithm (VOF or LF), implement it into an existing CFD framework, and predict liquid jet in-cross flow at various conditions typical of gas turbine augmentors. Demonstrate the ability to accurately capture the atomization process, including mass stripping rate, drop velocities, and drop and make comparisons to existing near-field and far-field experimental data.

PHASE II: Implement, text, and validate major modifications to the prototype tracking software. The ability to generate grid independent, high order solutions in one day or less should be the goal. In addition to jet-in cross-flow modeling (from Phase I), model other forms of atomization (i.e., air-blast atomization and pressure-swirl atomization) and develop phenomenological correlations CFD design codes. Strong interaction with original equipment manufacturers I(OEMs) is desired.

PHASE III: Apply the CFD software and atomization correlations to OEM combustion challenges, particularly to military combustors/augmentors of importance to the Navy.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The surface-tracking CFD code will be applicable to many different industries involved in two-phase flow and liquid atomization. In addition to the gas turbine industry, other industries that would be interested in licensing the software include rocket industry, materials industry, paint industry, plasma industry, process industry, etc.

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KEYWORDS: Atomization;; Gas Turbine; Combustion; Aerosols; Volume-Of-Fluid; Level Set

N07-047		TITLE: Three-Dimensional Control Panel Simulation

TECHNOLOGY AREAS: Air Platform, Information Systems, Human Systems

ACQUISITION PROGRAM: PMA-205 Aviation Training Systems

OBJECTIVE: Develop an innovative, reconfigurable, conformable screen capable of simulating, visually and tactically, the control panels, buttons, keyboards and switches of a variety of aircraft.

DESCRIPTION: Nearly ten years ago, Hoffman (1998) provided converging evidence for the value of adding physical qualities to virtual objects used in training. That same year Peterson, Wells, Furness, and Hunt provided evidence that an interface that uses the body enhances certain components of navigation in virtual environments. Historically these requirements have been met by building custom mock-ups for each cockpit or operator interface training device. Today researchers are now exploring how to train tomorrow’s surgeons with the use of simulated images with physical qualities by leveraging recent developments in the modeling and simulation industry (Hatwell, et al, 2003; Kahol, et. al, 2005). Such innovations could also enable a single training device to serve for multiple training requirements (at sea) where available space is at a premium. These developments include but are not limited to: organic light emitting display (OLED) panels, flexible organic light emitting displays (FOLEDs), and fiber optics. Active materials used for shape deformation such as the shape memory alloys used in the Smart Wing program, piezoelectric materials such as isotropic wafers, and anisotropic forms (i.e., active fiber composites, macro fiber composites, and single crystal fiber composites, or even the new flexible transistors that provide paper-like electronic ink displays are also options for consideration. A deformable material with photorealistic images of a control panel could present an unlimited number of interactive trainer control panels, in one training device. These advancements could address the requirements for forward deployed mission rehearsal trainers, such as those cited in the Navy Aviation Simulation Master Plan. Such multi-platform trainers would enable tomorrow's at sea trainee to observe and then interact with physical representations of objects and surfaces in a digitized/morphed "mock-up" of any cockpit or control panel during mission rehearsals.

Development of a prototype methodology that enables visually simulated panels, buttons, key boards, and switches to cross from a flat panel touch-screen visual presentation to an actual or representative physical state would result in a reconfigurable conformable screen that could simulate the control panels, buttons, keyboards and switches of a variety of aircraft visually and tactically. Prior research indicates that unlike the visual and auditory sensory systems, only the haptic system is capable of implementing direct action (NSF Workshop). Haptic interfaces such as joysticks and force-reflecting mechanisms can create a feeling of immersion, provided they convey a realistic sense of touch and exploration to the user. Considering the highly tactual nature of naval tasks (i.e., manually locating and operating navigational controls), the creation of effective haptic environments is viewed as a critical step in realizing the potential of VE training technologies. As Srinivasan et. al. suggested, "It is quite likely that much greater immersion in a virtual environment can be achieved by the synchronous operation of even a simple haptic interface with a visual display, than by large improvements in the fidelity of the visual display alone."

PHASE I: Determine the feasibility of generating two different representative physical surfaces from digitized images of an aircraft's control panel's and recommend an approach.

PHASE II: Develop, evaluate, and refine the prototype to demonstrate at least two different training applications identified by the fleet. It is possible the sponsor would seek development of a complete re-conformable cockpit for demonstrations of transforming the panels from one aircraft type to another, and then back again. Additional tailoring for demonstrations could be pursued through options as funds became available.

PHASE III: Transition the prototype-training panel to Navy, Marine Corps, and Coast Guard training facilities throughout the world.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Developments and innovations from this effort could be applied to industrial training devices, the prototyping of controls, architectural modeling, the computer gaming industry, and to other tactile simulations.

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2. "Flexible Microelectronics & Displays Workshop," US Display Consortium (www.usdc.org)

3. Beverly Rosenbaum, "The Eyes Have It." HAL PC, Trumors, January 2002. http://www.hal-pc.org/journal/2003/03_jan/column/trumors/trumors.html

4. Cesnik, Carlos "Wing Shape Deformation for High Performance Vehicles," ICASE Morphing Seminar Series, NASA LaRC, 26 June 2002.

5. K. Kahol, P. Tripathi, and S. Panchanathan, "Tactile Cueing in Haptic Visualization," to appear in Proc. ACM Workshop on Haptic Visualization at AMC Computer Human Interface Conference (CHI 2005).

6. Hatwell, Y., Streri, A., and Gentaz, E., Touching forKnowing. Cognitive psychology of haptic manual perception. Philadelphia, PA, USA: John Benjamins Publishing Company, 2003.

7. Hoffman, H.G. (1998). Physically touching virtual objects using tactile augmentation enhances the realism of virtual environments. Proceedings of the IEEE Virtual Reality Annual International Symposium '98, Atlanta GA, p. 59-63. IEEE Computer Society, Los Alamitos, California.

8. Barry Peterson, Maxwell Wells, Thomas A. Furness III, Earl Hunt (1998). The Effects of the Interface on Navigation in Virtual Environments. Presented at the Human Factors and Ergonomics Society 1998 Annual Meeting.

9. Srinivasan, M.A., Salisbury, J.K., Brock, D., & Beauregard, G.L . (1995). Haptic interfaces for naval training with virtual environments (Final report on contract no. N61339-93-C-0083).

KEYWORDS: Tactile Stimulation; Reconfigurable Training Surfaces; Mock-ups; Flexible Microelectronics; Organic Light Emitting Display Panels; Flexible Organic Light Emitting Displays

N07-048 TITLE: Innovative Approaches for Improving the Hot/Wet Performance of Polyimide Matrix Composites

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter Program Office F-35

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

OBJECTIVE: Develop and demonstrate innovative approaches to minimize material property degradation and scatter associated with hot/wet conditions as polyimide matrix composites approach their thermal capability.

DESCRIPTION: Polyimide composites offer weight saving opportunities over metallic materials for elevated temperature propulsion and air vehicle components. Unfortunately, as these polyimide systems approach the desired upper use temperatures (500 degrees F-600 degrees F range) their mechanical properties tend to degrade significantly, especially when exposed to a hot/wet environment. This “hot/wet knockdown” phenomenon is limiting the application of polyimide matrix composites and thus reducing weight saving opportunities enabled by the deployment of these materials.

Innovative and novel approaches are sought that would reduce the knockdowns associated with the hot/wet environment and also provide more consistent material properties. Proposed solutions may involve but are not limited to modifications to the current family of polyimide systems and/or processing improvements. The solutions should be demonstrated through representative panel and element fabrication as well as testing at the critical conditions.

PHASE I: Identify and define innovative approaches for improving the performance of polyimide matrix composites through reductions in data scatter and elimination of material property knockdowns associated with the hot/wet condition. Demonstrate the feasibility of the innovation by fabricating the panels using a production representative process; determining the material properties under environmental conditions; and comparing the material properties with those from the baseline system/process.

PHASE II: Scale the selected approache(s) up to a prototype production level. Demonstrate that the solution(s) reduce the data scatter, eliminate environmental degradation, and are repeatable by testing coupons and elements at various environmental conditions from multiple material batches and processing runs. Prepare the requisite guidance that will enable end users to prepare material and process specifications.

PHASE III: Perform additional fabrication and testing to develop statistically based static and fatigue allowables. Apply the solution(s) to propulsion and air vehicle components.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed would be readily applicable to commercial aircraft engine, airframe, and space launch propulsion applications that require elevated temperature performance.

REFERENCES:
1. “AFR-PE-4 Composite Material and Processing Issues for Bypass Duct Applications” Dr. John Putnam and Dr. Charles Watson Pratt Whitney, High Temple Workshop XXVI, 2006 Austin Texas.

2. “Compression Molding Process Development of AFR-PE-4/Carbon Fiber Composites” Joe Jalowka and Dr. Charles Watson Pratt Whitney, High Temple Workshop XXVI, 2006 Austin Texas.

3. “Development of a Material Characterization Protocol for Evaluation of High Temperature Polymer Matrix Composites” T Bullions GE Aircraft Engines and Kelly Hoover Pratt Whitney, SAMPE 2006 Long Beach CA.

KEYWORDS: Polyimide; High Temperature Composites; Hot/Wet Property Knockdowns; Material

N07-049 TITLE: High Performance Computing in Laptop Environment

TECHNOLOGY AREAS: Information Systems, Weapons

ACQUISITION PROGRAM: Exploratory Development/ACAT I, II, III or IV

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

OBJECTIVE: Achieve super computing performance levels in commercial off-the-shelf (COTS) computer workstations/laptops through the use of one or more reconfigurable central algorithm accelerators that maximize processing speeds and throughput with minimal acquisition, maintenance, and sustainment expenses.

DESCRIPTION: Central to the approach is the emerging technology of reconfigurable computing (RCC). First envisioned in the early 1960’s it is a computing philosophy wherein the computational elements’ execution logic is adapted (reconfigured) to match the application. In an RCC system the data path as well as the order of execution is dynamically reconfigurable. This computing philosophy was impractical until 1985 with the introduction of the modern FPGA (field programmable gate array) by the Xilinx Corporation. Considerable research and engineering efforts were invested in RCC but limitations in programming tools and FPGA capacity and speed kept it out of the mainstream of computational theory and practice. Many of the difficulties have been resolved and RCC is now entering the mainstream of system design. Leaders in conventional high performance computing including Cray and Silicon Graphics are now including RCC components in their high-end platforms. Laptop employment of RCC technology will allow the warfighter to rapidly process vast amounts of data on the battlefield in near real time.

Moving the Cruise Missile Command and Control System’s imagery intensive computational environment from the central processing environment to the service oriented architecture, laptop based environment will exponentially increase the warfighter’s efficiency and effectiveness in the target mensuration process thus for practical purposes considerably reducing the kill-chain timeline. Project risks center on complete understanding of the mission specific algorithms.

This FPGA technology can be generically applied across numerous laptop computing environments throughout the warfighting community. In essence, providing a super computing environment to even the most disadvantaged battlefield users without virtually any increase in computer size, weight and power consumption.

PHASE I: Determine the feasibility of developing an RCC algorithm accelerator to augment COTS computer workstations/laptops. Survey existing program’s software intense algorithms and recommend candidates for conversion. Design mission specific prototype.

PHASE II: Implement and demonstrate a production representative prototype of the algorithm accelerator. Evaluate the effectiveness and reliability of the approach.

PHASE III: Mature the prototype capability for use in the Tomahawk Command and Control Station (TC2S) workstations, Joint Mission Planning System (JMPS), Precision Strike Suite – Special Operations Forces (PSS-SOF) and Digital Precision Strike Suite (DPSS) laptop environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential commercial applications include machine vision for automatic industrial quality control and Earth resource monitoring

REFERENCES:

1. Robert Greybill, "Cognitive Systems,"MIT LL High Performance Embedded Computing Workshop, DARPA Presentation, September 2004

2. Matthew Krzych, Using FPGA in a Beowolf Cluster, MIT LL High Performance Embedded Computing Workshop NUSC Presentation, September 2004

3. Jim Dear,, "Joint Time Sensitive Targeting (TST) Experimentation;" http://www.mitre.org/news/events/tech03/briefings/collaboration/dear.pdf

4. A Future Naval Capability: Time Critical Strike; Office of Naval Research http://www.onr.navy.mil/media/extra/fncs_fact_sheets/time_critical.pdf

5. Dr. Stephanie Guerlain, Julie Besselman, Meredith Logsdon, Brian Whisnant, Timothy Yewcic, "The Tactical Tomahawk Weapon Control System: Interface Design Project;" http://www.sys.virginia.edu/hci/papers/capstone%20paper5.doc

KEYWORDS: Reconfigurable computing; Field Programmable Gate Arrays; Time-Critical Target; Emerging Target; Process Control; Mission Planning; Intelligent Agents

N07-050 TITLE: Ultra Reliable Input Entry Devices and Sensors

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

ACQUISITION PROGRAM: T-45 PMA 273 . JSF, F-18, V-22, PMA 209, PMA 206

OBJECTIVE: Develop novel ice and crack/defect sensors embedded into flight surfaces, rotor blades, and structural members, using recent advances in acoustic wave ultrasonic technology

DESCRIPTION: Acoustic wave ultrasonic sensors require acoustic resonators to be fabricated in metal switch plates by machined surface contouring. The resonators are excited, and then interrogated, by piezo-electric transducers bonded to a switch plate surface. When used as TTM switches they do not require physical closure of a contact, and are capable of self-diagnostics including failure prediction. Real-time diagnostic and failure prediction is an important attribute of these switches. It is these attributes and others discovered since the original TTM switch development phase that extend the performance, range of applicability, and cost effectiveness of the technology associated with acoustic wave ultrasonic sensors. The discoveries include the following: 1) Resonators can be excited and interrogated without the need to bond a transducer to the resonator. 2) Engineering plastics with low enough acoustic losses to form practical acoustic resonators have been found. 3) A new trapped acoustic mode was found, with potential advantages for sensor applications. 4) Resonators can be formed with bonded decals as well as surface contouring. Each one of these discoveries enhances the reliability, cost effectiveness, and range of applicability of the acoustic wave ultrasonic technology. Non-contact transducers based on item 1, for example, will eliminate bonded piezo transducers, thereby enhancing the ruggedness and reliability of the device as well as the development of novel ice and crack detectors in metals and composite materials. The proposed solutions should all have self-diagnostic and predictive capability, and communicate via inexpensive microcontrollers.

PHASE I: Design a non-contact electromagnetic acoustic transducer (EMAT) with low power and small footprint sensor. Demonstrate bench top ice and crack detection in metal and plastic composite sheet without the need to machine contour the lower surface.

PHASE II: Develop and demonstrate a prototype low-cost ice and crack detector integrated into aluminum and composite sheets.

PHASE III: Transition the technology by identifying and selecting several certified primary flight instrumentation manufacturing companies and transfer technology, know how, testing procedures, and documentation to the companies via licensing agreements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications include all vehicular, sailing vessels and aircraft applications. Machine interfaces, appliances, consumer electronics and rugged/explosion proof markets.

REFERENCES:
1. Knowles, T., Huang, R., and Kang, M. K., "Trapped Torsional Vibrations in Elastic Plates," Applied Physics Letters., Vol. 87, 14 November 2005

2. Kang, M.K., Huang, R., and .Knowles, T, "Torsional Vibrations of Circular Elastic Plates," IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, Vol. 53, No. 2, February 2006.

3. Hirao, M and Ogi, H. EMAT's for Science and Industry: Non Contacting Ultrasonic Measurements. Springer 2003. ISBN 140207948

KEYWORDS: Input Entry Devices; TTM Technology; Non-Contact EMAT, Cursor Control; Acoustic Wave Ultrasonic Technology; Sensors

N07-051 TITLE: Rapid Low Cost Evaluation of Fiber Coatings

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

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

OBJECTIVE: Develop and demonstrate low cost, rapid methods for evaluating fiber coatings for ceramic matrix composites (CMCs).

DESCRIPTION: The Joint Strike Fighter and other military platforms are considering ceramic matrix composites (CMCs) for engine applications due to their potential for weight reduction, reduced cooling, and durability improvements. Most CMCs require one or more thin coatings (<1 micron thick) on the fibers in order to achieve the weak interface that is required for high toughness. These coatings turn out to be key to the composite properties and also cost and cycle time drivers. Routine evaluation of the coatings is required to ensure that they meet specifications. Key coating parameters that need to be evaluated include the thickness and chemistry with morphology and crystallinity also of interest. Traditionally, techniques such as scanning electron microscopy (SEM), transmission electron microscopy (TEM) and auger analysis are used to characterize the coatings. These techniques are both expensive and time consuming. Lower cost, more rapid techniques are required to reduce coating cost and cycle time. The existing techniques are also limited to evaluation of extremely small areas; techniques that sample from larger surface areas are desirable.

Techniques exist and are used commercially to characterize thin coatings in various industries. However, the characteristics for fiber tow/fabric/preform coatings is more complex due to the substrates being non-planar, the coatings often having multiple layers with different chemistries, and the chemistries being more complex. Recent advances in advanced optical and other characterization techniques and instrumentation offer possibilities, but will need to be developed for this complex application. Nondestructive methods are highly desirable. Teaming which includes a military engine manufacturer and a composite fabricator will be key to ensuring that suitable and sufficient techniques are developed and demonstrated on composite systems of interest.

PHASE I: Adapt the characterization technique(s) proposed for the fiber coating application. Explore the capabilities and demonstrate the technique on samples with different coating thickness & chemistry. Estimate the cost and time required for coating characterization and identify improvements for Phase II.

PHASE II: Make the improvements identified at the end of Phase I and quantify the capability enhancement. Demonstrate the characterization technique in a commercial fiber coating setting. Characterize sufficient samples of coated fiber/fabric/preform to validate the capability, cost, and cycle time.

PHASE III: Optimize the coating characterization methodology for the chosen fiber coating process and chemistry. Modify the existing quality control (QC) specifications for the new methodology. Undertake the demonstration necessary to qualify the new QC methodology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The quality control methodology developed will benefit a broad range of CMCs with applications that include military and commercial aircraft as well as various industrial applications.

REFERENCES:
1. L. Sun, C. Berndt, A. Kucuk, R. Lima, K. Khor, "Surface Characterization of Plasma Sprayed Hydroxyapatite Coatings," Cer. Eng Sci. Proc., 21, [4], p251-258 (2000).

2. J. Eldridge, C. Spuckler, J. Nesbitt, and K. Street, " Health Monitoring of Thermal Barrier Coatings by Mid-Infrared Reflectance," Cer. Eng. Sci. Proc., 24, [3], p511-516 (2003).

KEYWORDS: Ceramic Matrix Composite (CMC); Fiber Coatings; Coating Characterization; Nondestructive Evaluation (NDE); Quality Control, Cost Reduction

N07-052 TITLE: Security Community of Interest Communications

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO IWS 7.0, Open Architecture, Captain James Shannon, (202) 781-3139

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OBJECTIVE: Develop protocols, services, and methodologies for controlling and securing communications between communities of interest (COI) over WAN environments such as GIG.

DESCRIPTION: Navy missions are increasingly being peformed as part of a joint-service or coalition of communities. The ability to quickly establish, configure, and dissolve relationships between parties of these communities is vital to the successful completion of the mission. An important aspect of these relationships is the ability to secure and control communications within the COI. As the Navy begins to leverage FORCEnet and the GIG, technology is needed to play a significant role in distributed operations.

However, most commercial security technology does not fully address this need. Current security technology does not support the concept of "multi-level security". In particular, the ability to parse and control information based on classification or membership in a COI is limited to proprietary systems that do not fully support real-time requirements needed to support the warfighter.

PHASE I: Assess the technical feasibility of implementing a fault-tolerant and real-time mechanisms to control and protect the information exchange between multiple communities of interest. If the assessment is favorable, then produce a plan to accomplish the work. Such a plan should document the development phases, the achievements and corresponding tasks for each phase, and estimates for the allocation of resources to given tasks. Produce a schedule which shows how the work undertaken will be realistically completed within the temporal and monetary constraints imposed by the contract.

Also, supply a plan for demonstrating that the product meets the requirements for supporting warfighters as they use the FORCEnet and GIG , as well as for demonstrating that the product fulfills the goals of security with fault tolerance and real-time performance.

PHASE II: Use the artifacts of Phase I to develop a fault-tolerant and real-time capability that enables the secure communication amongst communities of interest. Demonstrate that the result can be used in conjunction with existing standards-based security products to quickly setup and teardown COIs.

PHASE III: Work with commercial security vendors and standards organizations to implement a real-time, fault-tolerant security system that controls and protects COI communications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The need for fault-tolerant, real-time secure communications goes far beyond Defense warfare systems; such a technology would be of great value in any distributed application where community of interest communications must be protected. Other domains of interest include transportation, finance, and telecommunications.

REFERENCES:
1. "Building Multilevel Secure Web Services-Based Components for the Global Information Grid", Dylan McNamee , Galois Connections, Inc., CDR Scott Heller , Program Executive Office C4I and Space, Dave Huff , Fleet Numerical Meteorology and Oceanographic Center, Crosstalk the Journal of Defense Software Engineering, May 2006.

2. "The MILS Architecture for a Secure Global Information Grid", Dr. W. Scott Harrison, Center for Secure and Dependable Systems, Dr. Nadine Hanebutte, Center for Secure and Dependable Systems, Dr. Paul W. Oman, Center for Secure and Dependable Systems, Dr. Jim Alves-Foss, Center for Secure and Dependable Systems, Crosstalk the Journal of Defense Software Engineering, October 2005.

KEYWORDS: Coalition Communications; Real-time; Fault Tolerance; Secure; Global Information Grid; Multi-Level Security

N07-053 TITLE: Dynamic Information Interchange

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: PEO IWS 7.0, Open Architecture, Captain James Shannon, (202) 781-3139

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OBJECTIVE: Design and develop an enabling technology that allows for a system, application or database to dynamically integrate, adapt and interoperate within mixed environments thereby allowing for the meaningful exchange of information among disparate systems.

DESCRIPTION: Interoperability among the numerous engineering applications used within today's military and commercial domain is quite limited due to the various data representations, file formats, application interfaces, and internal databases applied and used by each system. Building and maintaining point-to-point translators between applications has not proven to be a viable mechanism for enabling data interchange. For example, interface documents can change, making the translators unusable and the cost and effort to upgrade the translators can become unafordable. As such, there is a great need within the market (both commercial and military) for an automatic and dynamic information exchange mechanism that allows the ability for a given process, application, or system to perform real-time discovery, adaptation and response to meet the needs and requests of other processes, applications, and systems. Such a capability must also offer minimal change impact to a system's underlying code and framework.

The recent advancement of internet and simulation technologies such as the eXtensible Markup Language (XML), XML Schemas, the eXtensible Stylesheet Language Transformation (XSLT), Web Service Description Langague (WSDL), the Simple Object Access Protocol (SOAP), and Base Object Models (BOMs) provide promising mechanisms for enabling flexible, dynamic and adaptable interchange among disparate systems. By applying such technologies, it is believed that this need can be addressed through the design, development and use of specific tools, runtime components and web services, which can be distributed over common network environments and platforms, and leveraged by various systems to ensure effective communication.

PHASE I: Investigate ways to support the dynamic adaptability of dissimliar systems within a common network environment. Explore the integration of current and emerging internet and simulation technologies to produce dynamic information interchange transformation modules that can be applied dynamically to support meaningful interoperability of a given, process, application or systems with other processes, applications or systems. Explore the use of cataloging such transformation modules with relevant metadata for supporting search and discovery

PHASE II: Building on the results of Phase I, create a supporting object mapping prototype for rapidly and efficiently generating supporting transformation modules that would allow dissimar systems to interoperate. Adaptation of this prototype to support object mapping and adding the ability to enter pre-coded reusable transformation blocks creates Dynamic Information Interchange components that provide a unique opportunity for commercial success. Proposals need to consider a means and mechanism to distribute and offer these Dynamic Information Interchange components to the various systems to be engaged.

PHASE III: Productize and integrate this prototype in various Navy Open Architecture Engineering Environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A single Dynamic Information Interchange for any one "system" (hereafter used to denote process, application, or system) is composed of description metadata, an identifying schema describing its structure, and one or more transformations. In short, these components allow data to be validated, verified, and translated real-time so that all participants (users of the data) can understand and participate in the information exchange. A non-intrusive Dynamic Exchange server would primarily provide the management and mechanisms for storing and distributing these components to systems that desire to be a part of a collaborative community. A Dynamic Exchange device could also be used to provide secondary services such as middleware translation, monitoring, and logging.

REFERENCES:
1. Sisson, Gustavson, Crosson, "Adding Aggregate Services to the Mix: An SOA Implementation Use Case" , 06S-SIW-116, 2006 Spring Simulation Interoperability Workshop (SIW), Huntsville, AL, April 2006

2. Gustavson, Chase, Root, Crosson, "Moving Towards a Service-Oriented Architecture (SOA) for Distributed Component Simulation Environments", 05S-SIW-091, 2005 Spring Simulation Interoperability Workshop (SIW), San Diego, CA, April 2005

3. Pullen, J. M., Brunton, R., Brutzman, D., Drake, D., Hieb, M.R., Morse, K.L., Tolk, A. “Using Web Services to Integrate Heterogeneous Simulations in a Grid Environment”, Proceedings of the International Conference on Computational Science 2004, Krakow, Poland, June 2004. Also published in a Special Issue on Grid Computing, Future Generation Computer Systems Journal, Issue 21, Pages 97-106. Elsevier. 2005.

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KEYWORDS: Interoperability; Point-to-Point Translator; Data Interchange; Discovery; Adaptation, Network; Communication, Schema

N07-054 TITLE: Modeling Within an Open Modeling & Simulation Framework

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: PEO IWS 7.0, Open Architecture, Captain James Shannon, (202) 781-3139

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OBJECTIVE: Design and develop a capability to use M&S to verify and validate conceptual models being identified for the US Navy adaptation of Open Architecture (OA).

DESCRIPTION: Some of the central tenants of Modeling and Simulation (M&S) can be applied to support community understanding and early validation and verification of the conceptual models being identified for the US Navy adaptation of Open Architecture.

It is desired that methods for achieving automatic coupling between the OA Conceptual Modeling Efforts and an M&S framework be evaluated and analyzed for application.   Specifically, explore how patterns of interplay can be identified from the architecture description and then codified as Models providing a way for representing the “interplay and communication” of OA and other C4ISR infrastructure elements, and provide an automated mechanism for identifying shortfall gaps and deficiencies early in the engineering process.

To date, the Navy OA efforts among the IPTs have produced various presentations, technical white papers, electronic capturing of requirements, and electronic capturing of the conceptual model (via analysis class diagrams and activity diagrams) using Rational Rose. What is needed is the ability to cull and analyze the information collected to represent OA elements and produce a couping between the OA elements and a modeling and simulation environment. Thus the opportunity exists to begin to represent the OA elements, which may be described using DoDAF system views and technical views at a M&S conceptual level. This will provide the opportunity to marry M&S with the Navy OA effort and it’s produced artifacts thereby supporting the transitions from conceptual model description to early draft prototypes and final implementations.

PHASE I: Investigate ways to represent executable conceptual models as they are laid out in the conceptual descriptions that were produced using tools such as Rational Rose. Such descriptions (class and activity diagrams) could provide a useful foundation for building the overall executable conceptual models. The summary of conceptual information can be blended (as best as possible) into Use Case templates and represented, if necessary, as a UML Use Case diagram to understand the larger picture. However, more importantly, the examination of the conceptual information can ultimately lead to the discovery of “pattern descriptions”, for representing the conceptual model.

PHASE II: Building on the results of Phase I, develop and demonstrate a prototype model of a selected OA component that could be taken through the various system and technical views in compliance with the DoDAF.

PHASE III: Integrate this prototype in various Navy Open Architecture Engineering Environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability will provide for greater understanding of the capabilities and requirements of the Navy systems being represented and which are intended to interoperate. Furthermore, it will help achieve the OA goal of facilitating the introduction of new capabilities into warfighting enhancements rapidly and effectively.

REFERENCES:
1. Chase, Gustavson, Root, “From FOMs to BOMs and Back Again”, 06S-SIW-115, 2006 Spring Simulation Interoperability Workshop (SIW), Huntsville, AL, April 2006

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3. Chase, Gustavson, Latika, “Using BOMs to support Multi-Resolution Models”, 04F-SIW-052, Orlando, FL, September 2004

4. Root, Oesterheld, McAuliffe, “Development Baton Handoffs - Transitioning from Repeat to Model-Centric,” Fall 2003 SIW, Orlando, FL, September 2003

5. Mall, H., Thumim K., Clay B., McKenzie, F., Hieb M.R., Cosby M. 1997. “MRCI Use of Modular Translation of Command and Control Messages between C4I Systems and Simulations”, Paper 97S-SIW-201, 1997 Spring Simulation Interoperability Workshop, Orlando, FL, March 1997

6. Tolk, A., Hieb, M.R., Galvin, K., Khimeche, L. “Merging National Battle Management Language Initiatives for NATO Projects,” Paper 12 in Proceedings of the NATO Research and Technology Agency/Modelling and Simulation Group Conference on “M&S to Address NATO’s New and Existing Military Requirements”, RTO-MP-123, Koblenz, Germany, October 2004

KEYWORDS: Modeling & Simulation; Open Architecture; C4ISR; DoDAF; Pattern Descriptions; Verification & Validation

N07-055 TITLE: Long-Life High-Current-Density Cathode for Low-Convergence Electron Beam Guns

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: ACAT I, PEO IWS 2.0, DDG-51

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

OBJECTIVE: Develop and demonstrate thermionic cathodes that simultaneously support high-current-density (> 10 amps/cm2) and long-life (~ 50 khr) operation in low-convergence electron beam guns, thereby enabling reliable high-average-power microwave amplification for various radar, electronic attack, and communication system applications.

DESCRIPTION: High-average-power linear-beam vacuum electronic microwave amplifiers (e.g., klystrons, multiple beam klystrons, traveling-wave tubes) used in military radar, electronic attack, and communication systems require electron beam currents in the range from a few to several tens of amperes based on high electron current densities in the range from 5 to 20 amps/cm2. Conventional thermionic cathode electron emitter technology can provide these high current densities at the expense of severely reduced lifetimes (associated with increased life-cycle costs) by operating the cathode at high temperatures. An alternative approach uses a high-convergence configuration (with a high ratio of electron emitter area to electron beam cross-sectional area) to reduce the current density at the emitter surface, lower the operating temperature, and thereby increase lifetime, but these designs carry system penalties of higher mechanical and electrical complexity and cost. However, low-convergence electron beam guns that simultaneously support high current density (> 10 amps/cm2) and long-life (~ 50 khr) would not carry this penalty and are the focus of this project. Three pathways of innovation, not all necessarily separate, have been identified to meet this need: new electron emitter materials, emitter coatings, and cathode designs. To fully exploit thermionic dispenser cathode technology to meet these performance objectives, it is clear that further research and innovation is necessary ¨C the development, for example, of novel low-work-function coatings capable of providing a greater than three-fold increase in current density, scandate cathodes in any of several stoichiometries, or the exploration of reservoir cathode configurations. Any new approach must be capable of integration with existing and emerging high-power vacuum electronic amplifier designs.

PHASE I: Separately or in combination, develop novel emitter materials, emission-enhancing coatings, and/or reservoir mixtures capable of simultaneously achieving current density and lifetime goals. Demonstrate the technical feasibility of meeting current density (> 10 amps/cm2) through either analysis and/or experiment; support the operational lifetime goal (~ 50 khr) using techniques such as Miram plot evaluations and analyses.

PHASE II: Refine, implement, and deliver prototype cathode technology that demonstrates > 10 amps/cm2 uniform emission in an appropriate high-power amplifier test device (to be mutually determined by the Government and contractor) and conduct life cycle and environmental tests to verify that the cathode/gun design supports a 50-khr lifetime. Document and deliver a complete description of the fabrication technique and parameters to include the chemical composition and topographic characterization of the optimized product. Develop fabrication processes for high production yields. Interaction and collaboration with the developer of the amplifier test vehicle will be required.

PHASE III: Develop pre-production and production components and sub-systems for integration into power amplifiers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Improvements in cathode lifetimes will lead to significant cost reductions in all cases; high current density will enable RF amplification in the millimeter-wave portion of the spectrum. High-current-density electron beams allow RF power amplification at lower beam voltages, as well. Commercial applications of long-life high-current-density cathode technology are pervasive and would be exploited rapidly by the U.S. vacuum electronics industry. Applications range from multiple broadband high-power amplifiers for commercial satellite communications to millimeter-wave amplifiers for both defense and civil applications. Scientific applications for this technology include enabling technology for microwave frequency amplifiers for high-energy accelerators.

REFERENCES:
1. M. Feinleib and M. C. Greene, "High-Current-Density Cathodes ¨C An Update," IEDM Technical Digest, pp.314-17 (1984).

2. B. Ch. Djubua, “Research and Development of Dispenser, Metal Alloy, and Oxide Thermionic Cathodes,” Conference Record, 1994 Tri-Service / NASA Cathode Workshop, March 29 ¨C 31 1995, pp 3 ¨C 6.

3. B. Ch. Djubua, E.M. Zemchikhin, A.P. Makarov, and O.V. Politnikova “Secondary Electron Emission, Surface Composition, and Modes of Activation of Metal Alloy Cathodes”, Appl. Surf Sc 111 (1997), p 285.

4. B. K. Vancil and E. G. Wintucky, "Reservoir Cathodes Revisited," International Vacuum Electron Sources Digest, C-3 (2000).

5. L. Falce, “High Current Density Dispenser Cathode Surface Activation Phenomena in Long Life Vacuum Electron Devices,” Conference Record, IEEE Int¡¯l Conf. on Plasma Science, 2002.

KEYWORDS: thermionic cathodes; high-current-density cathodes; dispenser cathodes; reservoir cathodes; microwave amplifiers; emitter materials

N07-056 TITLE: Advanced Structural Development for Air Cushion Vehicles

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Maritime Assault Connector (JMAC), ACAT is TBD, PMS 377

OBJECTIVE: Development of lightweight advanced material solutions for the primary Air Cushion Vehicle (ACV) hull structure and superstructure that will reduce corrosion, weight and life-cycle costs thereby improving craft performance.

DESCRIPTION: Amphibious ACVs are very weight sensitive and operate in a very unique and often severe marine environment. This environment includes direct exposure to salt, sand, sediment, and seawater spray. In addition to the typical hullborne and cushionborne hydrodynamic loads associated with a high-speed ACV, the vessel is also subjected to varied non-hydrodynamic loads such as well deck landings in increasing sea states and groundings on rough terrain. These craft, such as the Navy's Landing Craft, Air Cushion (LCAC), often have lightweight aluminum hulls; however, this material solution is prone to corrosion and erosion, is not damage tolerant and is repair intensive which requires specialized training. The future Joint Maritime Assault Connector (JMAC) will have a vessel footprint similar to the LCAC and will operate in potentially more severe environments with a requirement for an increased cargo carrying capacity.

This topic seeks innovative advanced material and structural concepts to provide an alternative hull structure and superstructure solution for the JMAC that is resistant to the environmental challenges inherent in the target operating arena. This may include new and innovative ways of combining two or more advanced structural materials in a structure to use the attractive features of each where they are most needed. Addressing these challenges will increase the ruggedness and durability of the JMAC which will in turn reduce the life-cycle and maintenance costs. A reduction in weight while maintaining the structural integrity will allow for an increase in the cargo carrying capacity of the vessel. The proposed solution must provide adequate vehicle buoyancy and stability with payload and be easily repairable in the field. At a minimum, any craft structure must be able to withstand the following loads: Upward 3.0g; Downward 4.5g; Forward 8.0g; Aft 3.0g; Side 3.0g.

PHASE I: Conduct a feasibility analysis to determine the best durable, lightweight advanced material and structural concepts. Compare the proposed solution(s) to the currently used materials to evaluate the benefits and disadvantages of using alternative materials for the target application. Develop an initial conceptual design and establish performance goals and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability.

PHASE II: Finalize the design from Phase I and fabricate scaled prototype sections and/or components. Validate prototype using laboratory testing and provide results. The testing should include evaluation of the materials solution in a representative operating environment, load capability, and vibration exposure. Develop full-scale test plan.

PHASE III: Design and manufacture one full-scale prototype ACV using the selected advanced materials. Test and evaluate full-scale prototype ACV in typical operating environment, including the ability to repair in the field.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Lightweight advanced materials for primary hull structure and superstructure could be used through out the marine industry, but could have an additional benefit in the commercial car/ferry sector.

REFERENCES:
1. LCAC Outboard and Inboard Profiles, available via SITIS, http://www.dodsbir.net/sitis/

2. http://www.globalsecurity.org/military/systems/ship/lcac.htm

KEYWORDS: advanced materials; JMAC; LCAC; structure; super structure; ACV

N07-057 TITLE: Advanced Emergency Leak Arresting Technology

TECHNOLOGY AREAS: Materials/Processes

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

OBJECTIVE: Develop a device that can be rapidly applied and instantaneously seal water, gas, or petroleum based products leaking from shipboard piping systems of a variety of configurations while under pressure.

DESCRIPTION: The current US Navy emergency pipe patching and plugging procedure requires a multitude of different techniques to combat different leak situations. With the technology currently available, each pipe rupture scenario requires securing of the leak source as well as the use of highly trained individuals and cumbersome equipment. In most cases, more than one person is required to effectively control and repair the leak in a timely manner. When there are jagged or deformed edges or nonlinear pipe configurations involved, all of the US Navy patch repair kits currently available become ineffective.

This topic seeks to explore the development and application of a universal pipe patch system that will simplify and expedite the pipe patching process. The ideal solution would be a system that is capable of immediately stopping leaks in pipes ranging from ½" – 12" in diameter, constructed from a wide variety of metals and composites. The innovative new system would have the ability to immediately seal all water or petroleum based liquid leaks and steam or gaseous pipe leaks while under pressure. The universal new system should meet or exceed the pressure and temperature limitations of the current multitude of US Navy pipe repair devices. The desired new product should have the ability to be applied with or without securing the leak source and should not subject the sailor to possible injury. The final product shall be fire resistant and continue to operate effectively while submersed. The device shall not be cumbersome in nature and be readily deployable using minimal manpower to dispatch and install. This single pipe patching solution shall work effectively on rough jagged surfaces, all pipe elbows, pipe tees, valves, and other pipe configurations currently used in US Naval shipbuilding with no pretreatment required. This device should be rugged enough to withstand storage aboard a US Navy Ship and have a shelf life of not less than 5-years.

PHASE I: Demonstrate the feasibility of an advanced leak arresting system. Identify suitable candidate materials, equipment(s), and manufacturing processes and methods of installation anticipated to enable the developed and deployment of the proposed system. Establish performance goals and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability. Create required sketches and drawings to demonstrate the concept of operation.

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 installation methodologies in a representative laboratory environment and provide results. Develop a cost benefit analysis and a Phase III testing and validation plan. Create an installation training video and a device maintenance and storage guide.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential commercial applications include all classes of U.S. Naval and Commercial ships and land based manufacturing/utility plants. An effective emergency pipe patching and repair system would be applicable to any building or structure that have a multitude of piping systems.

REFERENCES:
Available on the NAVSEA Damage Control, Fire Protection Engineering and CBR-D Website: http://www.dcfp.navy.mil/

1. MIL-R-17882E, Repair Kits, Metallic Pipe and General Purpose, Damage Control

2. NAVSEA S9086-CH-STM-020/CH-079V2R2 Damage Control Practical Damage Control

3. NAVSEA S5090-B1-TAB-010 Training Aid Booklet For Damage Control Equipment

4. NAVSEA SS-100-AG-MAN-010 Damage Control and Firefighting Equipment Layout Booklet

KEYWORDS: Damage Control; Pipes; Leaks; Patch: Plug; Repair; Rupture

N07-058 TITLE: Affordable Virtual Environment for Shipbuilding

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1D, PMS 500 DDG 1000

OBJECTIVE: To develop and implement innovative technologies that will revolutionize the interactive communication lines between ship designers and shipbuilders. The solutions must make a dramatic change to the cost and resources demands that limit the efficient transmission of design product model data, build strategy, processing sequencing and work instructions.

DESCRIPTION: The Navy's Program Executive Office for Ships is leveraging the National Research Program (NSRP) to effect change across the non-nuclear surface shipbuilding, modernization and repair enterprise by coordinating with U. S. shipbuilders to adapt and implement "World Class" commercial best manufacturing practices. This topic seeks innovative scientific and engineering solutions to inefficiencies in long-standing design and engineering methods. This topic offers an opportunity to infuse new ideas/innovations into the smaller, domestic shipbuilding industry. Of particular interest are initiatives with a clear business case. Proposals should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the estimated benefits will be and how it might be transitioned into the shipbuilding industry.

Proposals under this topic must address integration of the research areas identified. Efforts cited within each research area are illustrative only and proposals dealing with related efforts within each research area are also solicited.

1. Affordable virtual reality environment for the shipbuilding community – Innovative approaches to allowing remote designers and customers to interact in real-time on a common virtual product model are sought. The current virtual reality technology is cost and resource prohibitive and is not accessible to or affordable by the domestic shipbuilding industry. In order for this technology to infiltrate the shipbuilding industry, the environment must utilize affordable hardware and software solutions, be user-friendly, portable and require minimal upkeep and support. Technological advances in the electronic gaming industry suggest that such an affordable, user-friendly system for engineering analysis is possible. Research is sought to develop this affordable technology for the needs of the shipbuilding community to allow simulatneous, multi-site visualization.

2. Shop-floor access to product model details for training and knowledge development - Approaches that allow for transmission of visual representation of product models to fabrication sites to support skills development and transmit designer's intent are sought. More information is often sought, that can best be presented in animation or 3D form. Solutions that can transmit such information rapidly to the personnel needing a resolution to a manufacturing issue would improve productivity.

Of particular interest are initiatives with a clear business case. Proposal should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the specific benefit will be and how it might be transitioned into the shipbuilding industry. NSRP members are available to provide guidance and assistance in the identification of common issues and needs. Contact with these resources is encouraged both prior to proposal development and during any subsequent SBIR-related activity. Teaming with a NSRP member (or Government shipyard) is voluntary and will not be a factor in proposal selection.

PHASE I: Demonstrate feasibility for improvements being developed and also identify impact upon shipbuilding affordability. Include a first order Return-On-Investment (ROI) analysis for industry implementation and estimate potential Total Ownership Cost (TOC) reduction. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the design, as appropriate, and demonstrate a working prototype of the proposed system. Perform laboratory tests to validate the performance characteristics established in Phase I. Develop a detailed plan and method of implementation into a full-scale application.

PHASE III: Implement the Phase III plan developed in Phase II in coordination with the shipbuilding and repair industry.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic shall be directly applicable to current military and commercial shipbuilding operation and repair practices. The products developed should find wide use in most heavy industrial plant/processing facilities such as the power industry and will be marketable to the shipbuilding and repair industry.

REFERENCES:

1. NSRP ASE Strategic Investment Plan, available on line at http://www.nsrp.org

2. Visualization Introduction at http://evlweb.eecs.uic.edu/core.php?mod=9&type=6&cat=28

3. Daniel Steinwand, Brian Davis, Nathan Weeks, "GeoWall: Investigations into Low-Cost Stereo Display Systems", 2002 USGS Open File Report.

4. Czernuszenko, Marek, David Pape, Daniel Sandin, Thomas DeFanti, L. Gregory and Maxine Brown, "The ImmerseaDesk and Infinity Wall Projection-Based Virtual Reality Displays", In Computer Graphics, Vol. 31, No. 2, May 1997, pp 46-49.

5. US Naval Shipyard information is available at http://www.shipyards.navy.mil

KEYWORDS: design environment; virtual reality; manufacturing design; affordability;

N07-059 TITLE: Advanced Structural Development of a Deployable Cargo Deck Covering System

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Maritime Assault Connector (JMAC), ACAT is TBD, PMS 377

OBJECTIVE: Develop a durable, lightweight, deployable cargo deck covering system for the Joint Maritime Assault Connector (JMAC) and Landing Craft, Air Cushion (LCAC) that will protect the cargo and the craft’s propulsors from foreign object damage.

DESCRIPTION: The next generation of high-speed Air Cushion Vehicles (ACVs), the JMAC, will have a similar vessel footprint to the current LCAC and will operate in a similar or possibly more severe littoral environments. The unique environment in which the LCAC currently operates subjects the vessel and its open-deck stowed cargo to damage from high-winds (50+ knots) as well as foreign object debris such as salt, sand, and seawater spray. This open-deck stowage configuration also allows for loose debris from the cargo to potentially foul or damage the main propeller fan blades.

This topic seeks to apply innovative advanced materials and structural concepts to provide a durable, lightweight, deployable cargo deck covering system able to conform to a multitude of stowage configurations to protect cargo and the craft’s propeller fan blades in potentially severe marine operating environments. Potential stowage configurations range from providing single-side coverage to a full five-sided enclosure. Concepts proposed must be able to perform within the required speed and sea-state operational envelopes. Stowage should not interfere with craft operation and the concept should be able to be deployed with minimal manpower and time. The small business is encouraged to explore design modifications that provide adequate ventilation as well as interior and exterior attachment points in the event that the cargo carried is personnel and their personal gear. The attachment points should allow for the stowage of assorted loads from lifeboats to personnel packs and gear. The covering system and its attachments must be able to withstand the following loads: Upward 3.0g; Downward 4.5g; Forward 8.0g; Aft 3.0g; Side 3.0g. Specific testing to be addressed during development and fleet integration will include, but is not limited to: structural and mechanical/materials integrity, maintainability and repairability by ship's force in the field, external wind loads, and time to deploy/stow.

PHASE I: Demonstrate the feasibility of an advanced materials and structural solution for a cargo deck covering system. Develop an initial conceptual design and establish performance goals and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability.

PHASE II: Finalize the design from Phase I and fabricate a prototype. Validate prototype using laboratory testing and provide results. The testing should include evaluation of the materials solution as well as critical structural sections and joints. Develop full-scale test plan.

PHASE III: Design and manufacture a full-scale prototype cargo deck covering system for the LCAC . Test and evaluate in a typical operating environment. Tests should include the ability to be installed, easily retractable for on/off loadings and be repairable in the field.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This type of covering system would be of use to any large-decking operating platform such as offshore oil supply boats or oil platforms.

REFERENCES:
1. LCAC Outboard and Inboard Profiles and Interface Requirements, available via SITIS, http://www.dodsbir.net/sitis/

2. http://www.globalsecurity.org/military/systems/ship/lcac.htm

KEYWORDS: covers; cargo deck closures; advanced materials; JMAC; LCAC; ACV

N07-060 TITLE: <u>Shipboard Energy Conservation and Fuel Management Decision Tools</u>

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: NAVSEA 05Z, Mr. Mark McLean - CBM NAVSEA Technical Warrant Holder

OBJECTIVE: Demonstrate an approach that will provide a quantitative energy conservation and fuel management analysis and decision tool for the purposes of optimizing a ship's operating profile.

DESCRIPTION: As the Navy experiences an escalation in fuel prices (Since September FY 04 the Navy fuel price increased 203% from $35.28 to $106 per barrel), the need to develop and integrate energy conservation analysis tools and fuel management capabilities is of critical importance to ensuring mission readiness and effectiveness. Currently, ships perform rudimentary fuel consumption calculations by manually collecting information and generating their own fuel curves. This is a time and resource intensive process that requires specially trained ship's force to be able to collect the necessary data while the ship operates at different speeds, analyze it and create fuel curves. This method does clearly articulate or anticipate impacting operational variables such as load displacement, engine condition, sea-state, weather, etc.

This topic seeks the development of an automated approach to quantitatively collect, analyze, and present data to enable existing and future ship's force to employ energy conservation and fuel management solutions thereby optimizing a ship's operational profile based on dynamic, real-time, ship-specific variables. The proposed tool shall be able to interface with the Integrated Condition Assessment System (ICAS) for the purposes of obtaining machinery system performance data. As the tool progress in development, other ship sensors might be identified that could provide ship performance and weather data. For this reason, the approach proposed should employ the use of open architecture principles as practicable.

PHASE I: Demonstrate the feasibility of an approach for an automated energy conservation and fuel management tool for shipboard use. Establish validation goals and metrics to analyze the feasibility of the proposed solution(s). Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Finalize the design approach and fabricate a prototype system based on the results in Phase I. In a laboratory environment, use representative inputs/data to demonstrate the viability of the prototype product. Develop testing procedures to measure the effectiveness of the tool. Provide a detailed plan for software certification, validation, and method of implementation into a future ship support environment, as applicable.

PHASE III: Expanding the concept developed in Phase I and II, work with Navy and industry to certify and implement this technology on a future surface combatant system. Coordinate and plan the selected automated energy conservation and fuel management solution rollout with ship availabilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology approach would have application with Commercial Marine Fleet owners where existing instrumentation can be augmented to provide data for on-board analysis of energy conservation performance and input for fuel management tools.

REFERENCES:
1. Opportunity Analysis for Collaborative-Energy Conservation
(C-ENCON)/Fuel Status Board (FSB), Prepared by: DON eBusiness Operations Office And Naval Sea Systems Command (NAVSEA) and Network Warfare Command (NETWARCOM), Dated: 14 February 2005, http://www.don-ebusiness.navsup.navy.mil

2. NAVSEA ENERGY GUIDE (http://www. i-encon.com)

3. ICAS Web site: https://icas.navsses.navy.mil/ (accessible without username/password)

KEYWORDS: ENCON; ICAS; Fuel Curves; Automation; Conservation; Fuel Consumption

N07-061 TITLE: <u>Power Transmission Shafting for Air Cushion Vehicles</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Maritime Assault Connector (JMAC), ACAT is TBD, PMS 377

OBJECTIVE: Development of an improved materials solution for the power transmission shafting of an amphibious Air Cushion Vehicle (ACV).

DESCRIPTION: Amphibious ACVs are very weight sensitive and operate in an extremely harsh environment of saltwater spray and sand. The purpose of these ACVs is to transport payloads between ships or between a ship and the shore. These craft, such as the Navy’s Landing Craft, Air Cushion (LCAC), often have lightweight hulls (aluminum or composites); however, the existing carbon steel transmission machinery is not specialized and is relatively heavy compared to other craft components. The LCAC currently uses twelve painted carbon steel shafts to transmit lift and propulsion power. The next generation of ACVs, Joint Maritime Assault Connector (JMAC), will operate in a similar environment and will have a similar vessel footprint, but will most likely have greater lift capacity requirements and will therefore experience larger transmission loads. While carbon steel has been an adequate material solution for the erosive and corrosive operating environment, scaling the technology to allow for greater transmission loads and greater cargo lift capability would also increase the overall weight of the craft as well as the craft’s fuel consumption ratio. Each pound of craft weight equates to one less pound of cargo capacity.

This topic seeks to explore the application of advanced material solutions for the power transmission shafting to reduce overall craft weight and mitigate vibration propagation while enabling the increased the payload lift capacity of the JMAC. Rotation speeds of JMAC will likely be similar to LCAC speeds. JMAC shafting loads could range between current LCAC torque loading and 65% more than LCAC capacity. Concepts proposed must be able to a) transmit the drive train power and torque under extreme dynamic loading environments, b) maintain integrity, alignment and balance under sand and salt exposure as well as normal deflections associated with hull bending, 3) withstand significant vibration and 4) mate to carbon steel gearboxes without creating galvanic corrosion cells.

PHASE I: Demonstrate the feasibility of an advanced materials solution for the power transmission shaft of an ACV. Compare the proposed material solutions to the current carbon steel configuration to evaluate the benefits and disadvantages of using alternative materials for this application. Provide a preliminary concept design and component validation plan.

PHASE II: Finalize the design from Phase I and fabricate a prototype shaft. Validate prototype using laboratory testing and provide results. The testing should include evaluation of erosion, corrosion, load capability, overspeed, and vibration exposure.

PHASE III: Design and manufacture one drive train set of shafts (six shafts) for full scale testing on an LCAC. As applicable, the small business will work with the Navy to define the field test objectives, install the shafting and conduct the testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial potential for lightweight, durable shafting will transcend to all aspects of power transmission industry including marine, aviation and automotive.

REFERENCES:
1. ASME Technical Paper 2000-GT-603; Integration of the ETF40B Gas Turbine Engine and FADEC System into the Landing Craft Air Cushion Vehicle; by M. Dvornak, H. Harris, J. Richards and P. Schneider; May 2000.

2. http://www.globalsecurity.org/military/systems/ship/lcac.htm
Available via the SBIR/STTR Interactive Topic Information System (SITIS) website at www.dodsbir.net/sitis:

3. NAVSEA Drawing No. 802-5748948; Landing Craft Air Cushion, Transmission and Shafting Arrangement.

KEYWORDS: Driveshaft; Advanced Materials; Shafting; Power Transmission; ACV; JMAC

N07-062 TITLE: Affordable Anti-Corrosion Coatings for Navy Ships

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: ACAT 1D, PMS 500 DDG 1000

OBJECTIVE: Develop innovative solutions to address the cost of preparing steel and aluminum surfaces, applying and repairing of standard Navy epoxy-paint coatings. These solutions must meet all existing requirements for the standard coatings while demonstrating improvements in material costs, man-power resources and application schedule time.

DESCRIPTION: The Navy's Program Executive Office for Ships is leveraging the National Shipbuilding Research Program (NSRP) to effect change across the non-nuclear surface shipbuilding, modernization and repair enterprise by coordinating with U. S. shipbuilders to adapt and implement "World Class" commercial best practices in the area of surface preparation and coatings.

Current Naval ship anti-corrosion coating practices contribute significantly to the ship construction schedule and cost. Innovative paint chemistry and surface-adhesion solutions are sought that will allow for more efficient application of these coatings. Specific interest includes:

- Superior surface preparation methods for confined spaces where abrasive blasting is not feasible and standard needle-guns wil not fit.
- Coatings for steel and aluminum hulls, tanks and free-flood spaces that can provide good adhesion and service with a reduction in current minimum surface preparation requirements (for example, SSPC-SP-6 in lieu of SSPC-SP10 see reference 4).
- Rapid-curing coatings that can reduce the repair time for small areas of paint failures on hulls, inside tanks and free-flood spaces.
- One-coat paint systems for interior dry space surfaces to replace current multi-coat systems.

Incorporation of these innovative solutions will reduce the cost and time for coating shipboard surfaces and reduce associated monitoring and inspection steps. Ultimately, the introduction of the new technology will provide significant savings to the shipbuilders and as well as the U. S. Navy. The proposed solution must meet all the requirements of current anti-corrosion paints for the application specified, as well as compatibility with current and pending environmental, safety and health regulations.

Of particular interest are initiatives with a clear business case. Proposals should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the estimated benefits will be and how it might be transitioned into the shipbuilding industry. While NSRP members are available to provide guidance, assistance in the preparation of proposals and in the execution of efforts awarded from this solicitation, teaming or consulting with the shipbuilder and repair industry (both public and private yards) is not required and will not be a factor in proposal selection. Shipbuilding and repair industry contacts are available at (under the Panels button) http://www.nsrp.org. US Naval Shipyard information is available at http://www.shipyards.navy.mil.

PHASE I: Demonstrate feasibility for improvements being developed and also identify impact upon shipbuilding affordability. Include a first order Return-On-Investment (ROI) analysis for industry implementation and estimate potential Total Ownership Cost (TOC) reduction. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the design, as appropriate, and demonstrate a working prototype of the proposed system(s). Perform laboratory tests to validate the performance characteristics established in phase I. Develop a detailed plan and method of implementation into a full-scale application.

PHASE III: Implement the Phase III plan developed in Phase II in coordination with the shipbuilding and repair industry.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic shall be applicable to both military and commercial shipbuilding and repair practices and marketable to the shipbuilding and repair industry. The products developed should find wide use in the manufacturing, automobile, and construction (infrastructure application, bridges, etc) as well.

REFERENCES:
1. NSRP ASE Strategic Investment Plan, available on line at http://www.nsrp.org

2. US Naval Shipyard information is available at http://www.shipyards.navy.mil

3. MIL-PRF-2323C, "Coating Systems for Ship Structures" via http://assist.daps.dla.mil/quicksearch

KEYWORDS: shipbuilding; affordability; coatings; resin; application; automation;

N07-063 TITLE: Hydrophobic, Non-Fouling, Non-Hazardous Coatings for Periscope Head Windows (Periscope Head Window Coating)

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 435, Submarine Imaging and Electronic Warfare Sensors

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

OBJECTIVE: Develop a new, environment-friendly coating system with improved water-shedding (hydrophobicity), non-fouling and service life performance for periscope fused silica head windows.

DESCRIPTION: The Navy requires innovative solution to improve fused-silica periscope headwindow watershedding. Residual water (seawater, rain) on a periscope headwindow leads to distortion in the optical image. Removing this water fully and quickly is critical to the successful operation of the periscope optical system. The 3-HEPT Coating used some years ago has proven to be hazardous during the application procedure. Polysiloxane chemistry developed by Ameron as a replacement for 3-HEPT requires periodic application at sea to maintain proper watershedding of the periscope headwindow. This alcohol-based system is considered a hazardous material and, therefore, cannot be stored aboard the submarine. In addition, periscope headwindows are affected by microfouling which is currently one of the prime causes of reduced watershedding performance. Current watershedding longevity is only 3 months due to microfouling degradation. The visible headwindows for all US submarine periscopes are manufactured from optical grade fused silica (silicon oxide, SiO_2).

An innovative watershedding coating system which provides superior watershedding (hydrophobicity, with contact angle >105 deg, with a goal of >150 deg), optical transmission in the visible 300 to 700 nanometer wavelengths of >95 percent, low reflectivity, a service life of 1 year between applications, and that sustains minimal micro fouling over a 3 month period, with water shedding degraded by microfouling by no more than 10 percent, is required. In addition it should be capable of being cleaned using normal maintenance and cleaning procedures without damage to the watershedding surface or coating, survive in an environment including temperatures from -40 deg C to 50 deg C, thermal shock (hot air at +66 deg C to warm water at +20 deg C and cold air at -54 deg C to cold water at 0 deg C), severe icing, and UV sunlight. A watershedding technology that meets the above requirements and can in addition be applied to other periscope headwindow materials such as sapphire, germanium, and spinel is desirable. Most importantly, any materials in the new coating system should not have to be stored aboard the submarine and any coating or recoating process should be performed under controlled, non-hazardous conditions.

PHASE I: Perform a feasibility study of an improved hydrophobic, non-fouling, non-hazardous fused silica coating technology for periscope headwindows and document the results. The study shall identify suitable candidate materials, processes, and techniques to improve periscope headwindow watershedding. Develop candidate fused silica coating technology(s), including material selection and/or development and application processes, to improve abrasion/erosion resistance, microfouling and water-shedding performance in a seawater-immersion environment. Evaluate candidate coating technology(s) on fused silica samples (coupons) in a controlled seawater-immersed environment to establish their characteristics, especially the wear/erosion, water-shedding, electro-optic and micro-fouling characteristics. Recommend the selection of a final coating technology candidate(s).

PHASE II: Develop a water-shedding coating system based on the mechanical and environmental constraints of the periscope imaging system and the appropriate application technique for use by the Head Window Original Equipment Manufacturer. Characterize the service life and determine service life protocols (service life, in-service maintenance, etc.) of the developed coating on actual fused silica headwindows.

PHASE III: Manufacture the successful coating based on the mechanical and environmental constraints of the periscope imaging system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Non-hazardous, non-fouling, environmentally friendly (non-heavy metal) hydrophobic coatings would be a significant economic success for use on ship hulls, electro-optical and acoustic sensors, etc.

REFERENCES:
1. Jones, Richard, G. Silicon-Containing Polymers. The Royal Society of Chemistry; Cambridge 1995.

2. Zeigler, John M. and Fearon, F. W. Gordon. Silicon-Based Polymer Science. The American Chemical Society; Washington DC 1990.

KEYWORDS: Electro-Optics; Hydrophobic, Non-Fouling, Non-Hazardous, Seawater Immersion, Periscopes.

N07-064 TITLE: The use of Self-Managing Software Agents to Improve Application and Network Reliability and Data Accessibility

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: SEA073R

OBJECTIVE: Develop and demonstrate the application of certifiably accurate, self-managing software agents to improve continuity of operations of the shipboard application environment. In addition, demonstrate how Semantic Web software agents can be employed to improve cross-venue data sharing capability for application to improve support of the operation, material maintenance and tactical war fighting missions of Naval submarines.

DESCRIPTION: Modern Submarines operate with the support of many IT applications running on a common shipboard tactical and logistics support network. The non-tactical shipboard network software environment has become increasingly complex to maintain with the delivery of the Non-Tactical Data Processing System (NTDPS), the Distance Support software suite, the Submarine Non-tactical Delivery Interface System (SNADIS), and the Navy Tactical Command Support System (NTCSS). This is furthered complicated by Fleet management desire to have near-real time readiness reporting and assessments sent off-hull on a regular basis to support optimize Fleet mission deployment. The level of expertise required to maintain these capabilities can easily exceed the skill set of shipboard network administrators. While considerable effort has been made by software developers to simplify the administration of individual applications, the aggregation and level of integration of these applications taken as whole is a very challenging environment to maintain a high Quality of Service (QoS). When problems occur, they can go undetected and/or unresolved, because there is nobody on board who is sufficiently proficient to understand and restore the lost capability. The potential for this condition is ever increasing as more and more network applications with cross-application dependencies get added to this environment every year. The use of self-managing/self-healing software agents/components could offset this lack of expertise and be used to correct and restore the non-tactical software environment to the desired optimum conditions.

In addition, there is a Fleet need to evolve these non-tactical shipboard information systems to work more effectively and synergistically to support shipboard tasks. Vast amounts of data are provided to and generated by ships for use under the guise of shipboard maintenance, operations and training. The nature of shipboard operations are such that this data can often be consumed and acted upon by many activities; however, the data is seldom utilized for purposes other than those for which it was originally developed. This condition exists because there is no overarching search/discovery/association capability sitting in the shipboard information environment. As consequence of this inefficiency, data is often recreated as if new vice being repurposed and associated from an existing ship data store or application. Many man-hours and dollars are being expended and wasted by the Fleet as result of this condition.

This SBIR would develop and demonstrate the use of self-managing software agents to address ongoing maintenance and support requirements of the evolving sophisticated shipboard network environment. In addition, this SBIR would demonstrate the use and viability of Semantic Web software technology/tools as a solution service/application to improve data access and interoperability.

These self-managing software agents need to be able to adapt to handle changing user needs, system faults, changes in the operational environment, and resource variability. Such a software system must configure and reconfigure itself, augment its functionality, continually optimize itself, protect and recover itself, all the while keeping the complexity of the system hidden from the user. This technology is particularly important where the complexity of software continually challenges the organic skills of shipboard network administrator. The requirement to address the enclave environment of the shipboard networks is needed because current industry research and practice concerning self-adaptive/self-managing systems tends to focus on the big solutions providers working in a large fully connected enterprise environment.

The support of all IT applications running on a common shipboard tactical and logistics support network is the responsibility of a small group of individuals that have this assignment either as collateral duty on older submarines or as dedicated function on newer submarines. These individuals are required to be capable of operating and maintaining all the hardware and software resources of the shipboard network. While formal training is provided by the Navy to help these individuals to become proficient and qualified to perform these duties, the enormous complexity of the evolving heterogeneous software environment on ships makes this job extremely challenging and creates opportunities for system failures. The operational nature of submarines does not always permit the use of shore-based resources to augment and assist the shipboard network administrator; consequently, there is a strong need to offset this condition with software agents that can detect, analyze, and initiate the use self-healing, self-optimizing, and self-configuring software.

In addition, recent developments in the area of Semantic Web technology show substantial promise for augmenting the existing data sources with semantic markup so that the existing database can be processed as a true machine searchable knowledge base. Knowledge-base data mark-up technology is now emerging for production use after a substantial incubation period with significant DOD (DARPA) and University support. The World Wide Web Consortium (W3C) formally published the core specifications in 2004 permitting the development of initial sets of Semantic Web tools. However, this is a technology in which knowledge assertions are developed through a computational process. In doing so, there is, by design, little human involvement, and it is critical that the software agents be trusted both as to their accuracy to implement their design function and as to their reliability in carrying out their designated functions.

This effort has four specific goals: 1.) To evolve an open software architecture within the existing operational environment that includes the methods, algorithms, techniques, and tools that can be used to support dynamic adaptive behavior in software; 2.) To demonstrate the ability to create useful scenarios in which data developed for one mission area can usefully be applied to another mission area with emphasis on bridging the logistics-support tactical-mission gap; 3.) To show that the software agents employed can be formally certified to accurately perform their design process; 4.) To demonstrate that the agent management capability employed is self-healing in its execution with emphasis on detecting and correcting abnormal system and software states.

PHASE I: Perform general high-level assessment of the types of faults causing problems in current submarine operations based on interviews with system personnel (but not invasive examination of the actual operational system).

Analyze the potential data sharing scenarios on an operational submarine and develop an operational concept description, select technology and design a demonstration platform.

Specify and evaluate the needed software engineering tools to certify the software agents and self-healing capability that monitors their activity in execution so as to detect and correct session failures, and prepare an implementation plan for Phase II.

Develop a candidate-shopping list of the kinds of tool characteristics that might be applicable. The candidate tools will include measurement and assessment tools for measuring a real system to facilitate the adjustment of operational agents for long-term operation.

Working with Government representatives, select a comprehensive list of system monitoring and self-healing tools for a solution set targeted at the Submarine environment.

Develop an acquisition/development plan to assemble a solution set composed of these identified tools.

PHASE II: Execute the acquisition/development plan developed in Phase I and assemble a candidate tool set. Adapt specific measurement and monitoring tools for subsequent installation on a Government system.

Demonstrate performance of this tool set on a contractor-created test system.

Working with Government System personnel (who may be required to conduct actual measurements), conduct an assessment of system operations on an actual submarine platform employing the measurement tools developed earlier in Phase II. Develop a list of requirements for Phase III pilot capability.

Update software and other tool assessments as needed to assure optimal software selection for Phase II demonstration. Acquire and/or develop agent software modules needed to execute scenario. Acquire and/or develop certification tools for agents. Acquire and/or develop self-healing, monitoring and restoration tools for activity monitoring capability. Load test system with representative data as mutually agreed with the Government.

Rigorously test both the self-healing and certified data integrity using the tools in accordance with a multi-dimensional testing plan.

Based on assessment, design set of run-time tools and agents for Phase III pilot system.

Prepare implementation plan for Phase III pilot system test and demonstration.

PHASE III: Conduct additional operational assessment and perform detailed requirements analysis for selected shipboard Pilot system and refine system design. Working with Government representatives select specific requirements to be satisfied by the Pilot capability.

Design, acquire, implement, field, and support operation of a pilot production-level capability on selected submarine platform to be specified by the Government. Develop and/or acquire additional software agents as needed to implement the user requirements that are identified in the pilot testing.

Conduct system test and reassess system performance after pilot system operational. Document measured benefits of installed system performance tools.

Prepare full system description and other documentation as needed to replicate the operation on other Naval platforms. Update technology recommendations as needed to assure that recommended implementation is employing the current technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: While the technology proposed for this solution set targeted at enclave intranets, there are many such legacy intranet systems in the government and the private sector and there will be for the foreseeable future. If the technology is demonstrated and proven in this effort for these legacy enclave environments, the commercial potential is virtually certain and will be in great demand. The approach is directly applicable to many commercial data environments and not unique to military environments.

REFERENCES:
1. “Toward Architecture-based Self-healing Systems”, Dashofy, E.M.; van der Hoek, A.; Taylor, R.N.; The ACM Digital Library, Proceedings of the first workshop on Self-healing systems, 2002 (There is a substantial amount of material available on the subject of self-healing software online in the ACM Digital Library)

2. “Self-Managing Software”, Hinchey, M.G.; Sterritt, R.; Computer (An IEEE Journal)
Volume 39, Issue 2, Feb. 2006 Page(s): 107 – 109

3. “Services and autonomic computing: a practical approach for designing manageability”
Kapoor, V.; Services Computing, 2005 IEEE International Conference on; Volume 2, 11-15 July 2005 Page(s): 41 - 48 vol.2

4. Resource Description Framework (RDF): Concepts and Abstract Syntax, W3C Recommendation, February 10, 2004, Graham Klyne, Jeremy Carroll, eds.

5. RDF/XML Syntax Specification (Revised), W3C Recommendation, February 10, 2004, Dave Beckett, ed.
http://www.daml.org/ The DARPA Agent Markup Language (DAML) Program

KEYWORDS: Semantic Web; autonomics; self-healing software; RDF; XML; Knowledge base

N07-065 TITLE: Multi-Level Security Smart Proxy Agent for Bandwidth and Time Constrained Users

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Battlespace

ACQUISITION PROGRAM: PMS 425; AN/BYG-1 Combat Control

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

OBJECTIVE: Incorporate "smart" tools to provide the Operator prioritized information in order to optimize the submarine's minimal bandwidth and limited access to external communications. The tool set will also allow the user to tailor the information sent to and from multiple workstations in such a way that it will minimize transmission time. This effort will result in a ForceNet compatible proxy for all classified (unclassified, secret, and top secret) enclaves.

DESCRIPTION: The submarine's ability to send and receive the right information at the right time within the submarine's intermittent external communication profile and bandwidth constrained environment has become more complex for the Operator (watch stander) due to increased Submarine external communications information exchange requirements (IERs). This environment is intermittent and bandwidth limited, therefore a transmission plan is necessary for the Operator to determine what information and requests should be transmitted to and from the submarine according to time, policy, mission, and size of files. The transmission plan will ensure that the information is efficiently sent to and from the submarine to meet various missions within existing bandwidth limitations. The "smart" tool or proxy needs to include FORCEnet concepts: 1) Store, catalogue and retrieve all information produced by any node on the network in a comprehensive, standard repository so that the information is readily accessible to all nodes and compatible with the forms required by any nodes, within security restrictions; 2) Meet information assurance requirements; 3) Function in multiple security domains and multiple security levels within a domain and be able to manage and access the data dynamically; 4) Allow individual nodes to function while temporarily disconnected from the network; 5) Incorporate new capabilities into the system quickly without causing undue disruption to the performance of the system; and 6) Provide decision makers the ability to make and implement good decisions quickly under conditions of uncertainty, friction, time, pressure, and other stresses.

Therefore, the evaluation of IERs and the employment of creative and innovative "smart" tools must be explored based on limited bandwidth and intermittent access. The submarine shall be able to dynamically specify information to be retrieved, while end user customers shall be able to receive specific information from the submarine. Further, the Tool Set must be able to prioritize the information that is gathered and requested. Therefore, dynamic, intelligent data compression techniques for standard files types and custom compression algorithms for mission-specific data types must also be explored based on limited bandwidth and intermittent access. Design problem / risk lies in the software development, knowledge engineering and protocol limitations. The development and incorporation of these "smart" tools will aid the Operator in satisfying defined IERs across submarine Tactical and Operational decision processes.

PHASE I: Develop and document methods and techniques to support research of innovative "smart" tools to determine information exchange requirements (IERs) (e.g., Collaboration, mission and distance support, navigation updates, Sea Warrior, Sub Broadcast) for "smart" tools to automatically prioritize information for Internet Protocol communications of multiple security level "smart" proxies. Pending this analysis; produce a "smart" tools feasibility study.

PHASE II: Develop a "smart" tool prototype and perform initial stand-alone and integrated laboratory testing with FORCEnet compatible interfaces that support multiple-security levels. Demonstrate effectiveness and efficiency of the tool in a submarine Beta site.

PHASE III: The tools and methods developed under Phase I and tested under Phase II will be sufficiently commercialized that they can be applied to a wide set of products and will be transitioned into the Advanced Processor Build (APB) testing process of open architecture (OA) and sea based systems on-board submarines and surface vessels.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied to any environment that involves information exchange in a bandwidth constrained environment or external communication opportunity-constrained environment such as commercial maritime shipping, Navy surface combatants during varying MCON conditions trucking and commercial passenger air transportation.

REFERENCES:

1. Navy FORCEnet Web Site: http://forcenet.navy.mil

2. World Wide Consortium for the Grid: http://www.w2cog.org/

3. NCES DISA public web site: http://www.disa.mil/nces/

4. NCES Security Service Briefing:
http://www.disa.mil/nces/servicesecurity.ppt

5. NCES Service Discovery Help Guide:
http://www.disa.mil/nces/servicediscovery.ppt

KEYWORDS: bandwidth management, FORCEnet, SoA, Proxy, multi-level security, IP communications

N07-066 TITLE: Common Low Cost Sonar Transmit Capability

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: Virginia Class Attack Submarine Program (ACAT 1D)

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

OBJECTIVE: Utilize new sensor materials (e.g. single crystal) and advance high power electronic devices to provide a more robust active transmit capability that can support submarine communications “at speed and depth” in addition to covertly and securely mapping ocean bottoms, detecting other ships, and navigating channels.

DESCRIPTION: Submarine and surface ship active sonar systems are used in a variety of applications such as mapping the ocean bottom, ice keel avoidance, acoustic communications, depth sounders, mine detection, and navigation. Existing systems do not support communications at speed and depth (one of the highest priorities for submarines). During the last several decades, there has not been much in the way of technology that has changed the approaches used to perform active sonar functions. New advances in sensor materials and high power electronic devices have theoretically made it possible for significant active sonar improvements (size, weight, power, and cost). For example, single crystal materials can provide significant performance enhancements associated with power density and broader transmit/receive spectrum coverage. Additionally, for the past several years the growth in power electronics has been widespread, reflecting what some have called a “second electronic revolution.” This growth has been largely driven by silicon power electronics because of the levels of integration that silicon technology provides. These advancements in high power electronics have many different dynamic characteristics, including dc, pulsed dc, continuous-wave ac, and burst ac that can be applied to sonar system amplifiers and power conversion. There is a need to minimize the cost while significantly increasing the performance and density (reducing the footprint) of submarine active transmit systems. The successful proposal will seek to identify innovative approaches to improve active sonar capabilities while reducing cost associated with this functionality. Submissions should identify strategies to minimize the total cost of ownership including procurement, installation, ILS, maintenance and commonality across existing submarine platforms. Proposals should clearly identify the risks associated with the candidate technologies during phase I. Submissions should provide a path to mitigate those risks through Phase II to ensure that a producible design can be achieved in Phase III that meets the technical and cost objectives outlined above.

PHASE I: Identify candidate technologies that can meet the required performance and power density. Provide an architecture that utilizes these technologies to support the requirements stated above. Design must consider life cycle costs (installation, ILS, maintenance, etc).

PHASE II: Prototype leading technologies and evaluate technical performance. Build a cost model clearly identifying performance gains and cost savings of candidate technologies/architectures.

PHASE III: Using a "System Design Approach" utilize advanced sensor materials and high power electronics to build an active sonar system that can support existing and emerging requirements such as acoustic communications "at speed at depth.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technologies developed under this effort could be applied in any high power signal amplification environment such as commercial or DoD RADAR applications, commercial SONAR, etc.

KEYWORDS: transmit; sonar; active; ASW; cost

N07-067 TITLE: New Flexible-Hose for Submarine Operating Environments

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO-Submarines; Undersea Weapons Program Office, PMS 404; ACAT III

CLARIFICATION: The Phase I paragraph within Solicitation Topic N07-067 contains an unintended ambiguity, which could lead potential bidders to believe they could receive certain Government Furnished Information (GFI) prior to submitting Phase I proposals. The government never intended to release restricted GFI prior to award, as this information cannot be publicly posted. All unrestricted information relative to this topic has been posted on SITIS. Proposals are to provide proof of concept and will be evaluated only on information available to all potential bidders.

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

OBJECTIVE: To develop an innovative and cost effective new hollow flexible-hose system capable of being deployed from USN Submarines by Mk 48 torpedoes. The new hollow flexible hose system to be developed from feasible concepts derived from computational models, prototype development and testing. The hollow flexible hose system must be capable of being wrapped in and deployed from an existing torpedo mounted dispenser (TMD) design that is affixed in a submarine's torpedo tube. It must allow a communication cable (small diameter fiber optic cable or solid copper wire) to payout through its hollow core from a dispenser mounted within the TMD. It must also be capable of producing sufficient tow angles over both slow and high submarine tow speeds that positions the communication cable to within a prescribed submarine hull radial standoff envelope. Production costs for the innovative hollow flexible hose system must be comparable to present systems. Provide monthly status reports, prototype assemblies and detailed drawings and specifications of selected designs.

DESCRIPTION: The hollow flexible-hose is needed to protect an existing solid copper guidance wire (or future fiber optic cable) by preventing it from dragging across submarine torpedo tube and shutter area surfaces, the ocean bottom, or positioning it too close to the submarine's hull at high speeds thus resulting in entanglement with its appendages or propeller. These events, should they occur, will impede the integrity of the communication cable preventing data transfer to/from the submarine and torpedo. The Submarine Tactical Requirements Group has developed new submarine operating requirements that include torpedo employment in very shallow water or while operating in close proximity to the ocean bottom while communicating with post-launched Mk 48 torpedoes via a fiber optic or wire communication link. Initial hydrodynamic modeling studies have shown that traditional non-buoyant weighted hollow flexible-hose technologies having a uniform diameter can no longer support these new requirements. Therefore, a novel flexible hose system is now required.

PHASE I: Develop computational simulations and models and perform hydrodynamic parametric studies to predict the performance of prospective innovative hollow flexible hose system concepts. Performance parameters of interest include, but are not limited to, the radial standoff, and the depth/altitude of the flexible hose end relative to the tow point as a function of the tow speed during both deployment and steady state tow phases. The government shall provide desired ranges for these parameters in order to evaluate prospective concepts. Characterization of concepts to include basic definitions for the flexible hose such as length, diameter, normal and tangential drag coefficients, wet weight per unit length and basic sizing for lifting bodies, depressors or other innovative devices that might be used to control placement of the hose end relative to the submarine. Concepts must consider the feasibility of being wound and housed in the present TMD design and deployed by Mk 48 Torpedoes from USN Submarine torpedo tubes. The government shall provide drawings and photos showing present TMD system. The contractor shall present feasible concepts to Government representatives for consideration and down-selection to no more than two concepts for Phase II prototype development. Unclassified Government Furnished Information (GFI) in regard to the TMD, submarine torpedo tubes, torpedo interfaces, submarine details and environmental and operational requirements will be provided in support of the Phase I efforts. Potential bidders or DoD contractors must be certified under the Joint Certification Program (JCP) in order to receive the Government Furnished Information (GFI). Phase I deliverables to include a final report documenting the phase I effort and any computational models developed in support of this effort.

PHASE II: Develop preliminary designs, specifications and 6 prototypes of the two down-selected Phase I concepts. Perform prototype fitment assessments with TMDs, Mk 48 torpedo interface components and submarine torpedo tubes. Perform dynamic payout and hydrodynamic tow tests with prototypes to verify the two concepts' performance and validate the computational models and simulations developed under phase I initiatives. Incorporate modifications to existing prototypes or develop new prototypes as required to develop a successful design. The contractor shall work with Government representatives to review fitment and performance data to down-select to a single design. Revise and finalize drawings and specifications for down-selected design. Obtain multiple potential sources of supply for producing down selected design based on a production basis. Develop cost model that includes development cost, production costs, and life cycle costs. Deliverables to include a final report describing the development process, test results, conclusions/recommendations, computational models and simulations developed under this effort, drawings of the selected prototype design, and the prototype hardware.

PHASE III: The Government shall procure additional prototypes of flexible cable systems. The contractor shall provide technical services during the procurement and production phases. The government to perform environmental qualification tests to verify the design is suitable for Mk 48 torpedo system employment. The Government and contractor shall develop at-sea test plans and procedures. The government shall perform a series of at-sea tests from submarines using Mk 48 exercise torpedoes. The contractor shall provide technical consultation in support of the at-sea testing efforts. The contractor shall incorporate lessons learned from the at-sea tests and develop final drawings and specifications for the new hollow flexible hose system. Upon satisfactory environmental qualification and at-sea operational tests the Government to integrate the new hollow flexible hose system for use with Mk 48 torpedoes via an approved Class I Engineering Change Proposal (ECP). Deliverables for the contractor shall be revised technical drawings and specifications for the new hollow flexible hose system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technologies developed under this SBIR can be applied to commercial fishing and oil exploration industries.

KEYWORDS: Hydrodynamic modeling; hollow flexible cable; hybrid flex-hose; Parametric Study; Torpedo Mounted Dispenser; Flex-Hose

N07-068 TITLE: Elimination of Electromagnetic Radiation Hazards in support of Ship Material Loadout Automation

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Navy Automatic Identification Technology Program - not designated ACAT

OBJECTIVE: To develop an Automated Identification Technology (AIT) reader (interrogator), capable of reading passive Radio Frequency Identification Devices (pRFID), that is certified to be Hazards of Electromagnetic Radiation to Ordnance (HERO) safe for zero stand-off (separation). Readers will be integrated into the automated cargo loading process on board U.S. Navy ships.

DESCRIPTION: Naval Supply Systems Command (NAVSUP) seeks innovative approaches to provide zero stand-off AIT capability for reading passive Radio Frequency Identification Devices (pRFID) and can be certified as HERO safe. This capability will be integrated into the automated cargo loading process with a goal of operating at a rate of over 400 pallets per hour on board U.S. Navy ships.

During pre-deployment loadouts and underway replenishments, materiel is manually loaded aboard Navy ships and processed into storerooms. This materiel includes Ordnance which is susceptible to HERO. The Office for the Secretary of Defense (OSD) has had issued an interim change to the DFAR clause Section 211.275-2 and is advising vendors to apply pRFID tags to cases and pallets to assist with automating shipboard receipt, stowage, segregation and issue (RSSI) operations. This capability is absolutely critical to facilitating the transfer of workload ashore, a mandatory evolution in light of new ship designs which call for optimized (reduced) shipboard manning.

HERO safe, Electromagnetic Radiation (EMR)-free readers (interrogators) do not exist for zero stand-off (separation). Therefore, pRFID tags applied to Ordnance devices should require zero stand-off. HERO-safety should be “read” automatically and not have to be processed manually. Initial testing of pRFID readers and tags onboard USS NASSAU (LHA-4) and at engineering test facilities determined that a separation distance of 11’ is required for the safe use of pRFID in the receipt, stow processing of Ordnance which is subject to HERO constraints in and around other materiel that may be present. This restriction is very limiting for automated materiel receipt processing. In fact, lessons learned from the USS NASSAU AIT Value Chain Demonstration during the summer of 2005 concluded that currently available pRFID readers would have to be turned off at the materiel receiving station to maintain a safe separation distance from ordnance being received aboard ship, since they do not operate at an acceptable level of power and frequency.

An unrestrictive AIT stand-off distance is desired to enable the safe use of handheld readers throughout the ship and in ordnance spaces. In total, the zero stand-off technological development has the potential to yield significant efficiencies for the integrated processing and tracking/visibility of materiel directly supporting ship operations and mission readiness ... an integrated process ranging from the inventory pipeline, to initial materiel staging areas, and ultimately, onboard the ship.

The desired technology solution demands revolutionary/alternative AIT development, testing, evaluation and certification to provide a zero separation, safe operating reader capability, including EMR-free, non-line-of-sight, materiel tracking and inventory management functionality. The designed solution must be flexible enough to process data captured from multiple technologies and frequencies, while being capable of being employed for all classes of supply (including ordnance) located throughout the ship, from topside receiving stations to below decks storerooms and magazines. Radio frequency (RF) technology should not be dismissed for experimentation purposes under this SBIR, and should be considered a candidate R&D technology to possibly provide a shipboard safe solution.

The Naval Surface Warfare Center activities, in Dahlgren VA and Philadelphia PA, would ultimately manage the HERO-certification process for the Navy implementation of the developed alternative AIT solution, which should also be compliant/compatible with the use of Office of the Secretary of Defense (OSD) sanctioned pRFID tags and infrastructure.

PHASE I: Investigate alternative technologies/approaches to develop an EMR-free, AIT material tracking/reader capability, certifiable for HERO-safe, zero stand-off (separation) operations. Evaluate and document alternatives and a development approach for one or more candidate devices. Devices will be expected to successfully meet the stated SBIR objectives, while accurately reading pRFID tags affixed by vendors in accordance with prevailing DFARS contract clauses.

PHASE II: Develop a prototype and demonstrate performance in either a controlled U.S. Navy shipboard environment, or in an environment simulating shipboard power sources and battlespace constraints.

PHASE III: Develop units scaleable for use on Navy ships both in the central receiving areas and portable (mobile/handheld) use mitigating the hazards and interference caused by radiated energies.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The susceptibility of electronic devices to interference from electromagnetic fields is of general concern in hospitals, clinics, and industry. Development of an alternative, EMR-free, line-of-sight, signal carrying, material tracking technology would be very marketable. However, the best potential of the targeted technology development is to help eliminate HERO, or Radiation Hazard (RadHaz), emissions pertinent to military and industrial applications.

REFERENCES:
1. Department of Defense Instruction (DoDI) 6055.11, (Subj: Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers).

2. Naval Sea Systems Command (NAVSEA), Publication OP 3565, Vol. 1 -Technical Manual, Electromagnetic Radiation Hazards (Hazards to Personnel, Fuel and other Flammable Material) and Vol. 2 – Technical Manual, Electromagnetic Radiation Hazards (Hazards to Ordnance).

3. Institute of Electrical and Electronics Engineers (IEEE) C95.1 (Subj: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz.

4. DoD Handbook (MIL-HDBK-464) Electromagnetic Environmental Effects, Requirements for Systems.

5. DoD Handbook (MIL-HDBK-240) HERO Test Guide.

6. NAVSEA Publication OD 30393, Design Principles and Practices for Controlling Hazards of Electromagnetic Radiation to Ordnance (HERO Design Guide)

7. Navy AIT Value Chain Demonstration, (report) dtd 27 January 2006

8. U.S. Navy RFID Implementation Plan, (report) dtd 26 January 2005

KEYWORDS: Automated Materiel Handling; Optimized Shipboard Manning; Ship’s Force Workload Reduction; Electromagnetic Radiation (EMR); Hazards Of Electromagnetic Radiation to Ordnance (HERO), Personnel (HERP), and Fuel (HERF); Stand-Off Distance; HERO Safe Separation Distance.

N07-069 TITLE: Pulse Detonation Engines Cycle Analysis and Performance Prediction Code

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

ACQUISITION PROGRAM: Tomahawk

OBJECTIVE: Develop generic pulse detonation engine cycle efficiency and integrated systems performance code for a broad spectrum of Pulse Detonation Engines (PDE) applications. Develop simplified component models that can be integrated in the systems code to provide a user-friendly basic design tool.

DESCRIPTION: Pulse detonation engines offer the potential of propelling weapons/vehicles from subsonic to supersonic speeds utilizing a relatively simple and scaleable configuration without ejecting boosters. This can be achieved within a relatively short development period and with lower cost. However, in order for the PDE technology to compete with conventional turbojet, ramjet and scramjet technologies, the performance merit has to be established. Since PDE operates on a much more efficient constant volume Humphrey cycle (as opposed to constant pressure Brayton cycle utilized in gas turbines), and multi-cycle, multi-tube configurations are possible, improved performance and decreased fuel consumptions are possible. Detailed numerical simulations done over the past decades give an insight into the detonation process, its confinement, propagation and control. Reduced chemistry and mechanisms have been used in the reactive flow simulation. It is proposed to develop a system analysis and performance mapping code that can be utilized by designers to perform studies of basic configurations for various applications. This will enable sponsors to make educated investments on the technology, and tailor configurations to applications. Instead of time-consuming, elaborate, numerical simulations on super computers and massive parallel processors, this project will provide a user-friendly modeling tool for the design and development engineer for design and manufacture of PDEs.

PHASE I: Develop simplified models for the various components, such as inlet, detonation tube, exit nozzle, as well as the fuel vaporization, deflagration to detonation transition processes, and direct fuel injection for detonation. Develop transient cycle code.

PHASE II: Develop integrated performance models considering mainframe integration, optimization of thrust to weight ratio, fuel consumption, detonation chamber length, firing sequence etc; and provide a system code that can be applied for basic configurations for a variety of applications.

PHASE III: Develop geometry-specific performance and design codes for a weapon and a vehicle configuration (e.g.: Tomahawk, UAV)

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: PDEs are presently considered by industry for aircraft propulsion and several other applications. As this technology matures, it can benefit commercial aviation. Reduction in operational (fuel and maintenance) cost will favor reduced cost per passenger mile.

REFERENCES:
1. Roy, G.D., Frolov, S.M, Borisov, A.A., and Netzer, D.W., “Pulse Detonation Propulsion: Challenges, Current Status, and Future Perspective,” Progress in Energy and Combustion Science 30 (2004), pp. 545 – 672

2. Combustion Processes in Propulsion: Control, Noise, and Pulse Detonation, (Ed. G.D. Roy) Elsevier, Oxford, UK, 2006.

KEYWORDS: Combustion, Detonation, Missile Propulsion, Aircraft Propulsion; Specific Impulse; Fuel Consumption

N07-070		TITLE: <u>Distributed Sensor System Innovations</u>

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Sensors

ACQUISITION PROGRAM: PEO-IWS-5A, Sub Combat Sys Adv Devel, NAVAIR, PMA264, PMS450 VA Class Sub

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

OBJECTIVE: Develop cost effective distributed sensor options that reduce the total costs attributable to achieving improved or currently specified distributed sensor system performance.

DESCRIPTION: The objective may be achieved by reducing the cost of discrete components (materials, signal conditioning, communications in support of control and contact reporting, telemetry, acoustic/magnetic or other sensors, engineering sensors, mechanical support structures, etc.) within some existing sensor technology, by improved sensor manufacturing and construction methods, by new sensor technologies that are more cost effectively scaled to higher performance applications, by fusion of the output of either a homogeneous or heterogeneous set of sensors, by more optimal employment methods that enhance performance or enhance sensor persistence, or by improving the useful employment life of sensors by means including more cost effective, and/or higher energy density sources of energy.

PHASE I: Develop the conceptual design of alternative sensors and/or sensor components, communication strategies and technologies, more optimal employment and/or data fusion methodologies, and/or more cost effective sources of energy.

PHASE II: Demonstrate, in a structured test and evaluation environment, alternative sensors and/or sensor components, more optimal employment and/or data fusion methodologies, more cost effective manufacturing approaches, and/or more cost effective sources of energy

PHASE III: Transition the technology to use in operational DoD systems, specifically including sonobuoys, platform mounted or platform deployed sensors, telemetry, and/or arrays, bottom mounted surveillance arrays, and/or mobile autonomous distributed sensors

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications may include enhanced instrumentation for oceanographic and environmental data collection and monitoring for Integrated Ocean Observing (IOOS) supported by NOAA, port security, and other remote sensing applications.

REFERENCES:
1. Anti-Submarine Warfare, Concept of Operations for the 21st Century, Task Force ASW; http://www.chinfo.navy.mil/navpalib/policy/asw/asw-conops.pdf

2. Littoral Undersea Warfare in 2025, Naval Post Graduate School http://www.nps.navy.mil/SEA/USW%202025/SEAreport.pdf

3. Sea Power 21 Series—Part II; Sea Shield: Projecting Global Defensive Assurance; By Vice Admiral Mike Bucchi, U.S. Navy, and Vice Admiral Mike Mullen, U.S. NavyProceedings, November 2002; http://www.nwdc.navy.mil/Conops/Sea_Shield/SeaShieldM.aspx

4. Technology for the United States Navy and Marine Corps, 2000-2035 Becoming a 21st-Century Force: Volume 7: Undersea Warfare (1997); Commission on Physical Sciences, Mathematics, and Applications (CPSMA); http://darwin.nap.edu/books/0309059267/html/1.html

KEYWORDS: sensors, distributed sensors, materials, manufacturing, telemetry, data fusion, communications, control, employment, energy density, persistence

N07-071 TITLE: Information Processing and Knowledge Representation For Automated Image Understanding

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: USSOCOM, PM-SOMPE, PMA 281, PE-C4I, JSF

OBJECTIVE: Design an automated system capable of accepting data (typically, but not exclusively, image data) and incorporating this into a coherent and comprehensive model of a scene or region.

DESCRIPTION: In order to be able to address the multitude of issues involved in so broad an area as "Automated Image Understanding," it is necessary to sufficiently circumscribe one (or several) subtopics for consideration. Occupying a fundamental position in the design of any potential C4ISR architecture are issues of information processing and knowledge representation; these, in turn, necessitate a careful examination of the methods by which data, which may come from many different sources, can be categorized, encoded and organized. To guide analysis, many, if not all, of the following objectives need to be considered: a system needs to accommodate data from many sources; represent data into an unified framework that will mediate between different application expectations; deal with information of varying granularity with regards to timeliness, accuracy, etc.; allow for possible in situ modification of data representation; provide a mathematically consistent and robust solution that enables automated multi-level fusion processing; and, encapsulate notions of uncertainty and provide mechanisms for managing such.

A successful strategy for dealing with some of these items might fall under the heading of "data management" considerations; there exist multiple tools (such as Database Management Systems) that can be used to address these concerns. However, when considering issues not merely of data organization but of knowledge representation (KR), there are multiple paths that can be explored. One such path may comprise a rule-based approach (an "Expert System"). This methodology suffers from being brittle i.e., not adaptable, being next to impossible to verify in terms of consistency, and perhaps also in terms of robustness. Also, expert systems typically are not structured to have a temporal component. However, the appeal of an expert system-like approach is obvious, as it allows for straightforward introduction of auxiliary information. Because context plays a vital role in being able to use whatever information is available effectively, any proffered system must provide such context-based information intrinsically.

An example of one approach to addressing these issues could be based on Description/Hybrid Logics (DHLs) [2]. These could potentially produce a system which is demonstrably (mathematically) consistent and robust, while simultaneously flexible enough to accommodate real-world requirements such as data throughput and latency. In addition, such a system would offer a framework in which all manner of propositions could be encoded, and that includes in a fundamental way notions of state and context. (These are known sometimes in the literature as "world" and "frame," respectively.) Moreover, these languages have been axiomatized, and hence issues such as consistency, completeness, decidability, etc. can be addressed mathematically. Uniformity comes for free, as a well-defined language schema forces this upon us. Finally, this type of formulation ensures that subsequent processing by applications attempting data fusion, etc., can be effected efficiently, since the data is already optimally encoded.

Description Logics and their extensions (which subsume the aforementioned Hybrid Logic) have been investigated by various researchers; examples of implementations in situations which parallel the ones that we are considering can be found in Medical Informatics, Digital Libraries and Web-Based Information Systems (the so-called "Semantic Web"). The common unifying theme throughout is the ability to mechanize the process of inference, allowing for efficient processing of information, and increased situational awareness.

PHASE I: Demonstrate a capability to ingest a single preprocessed data stream, categorize and encode its relevant information content, and respond to (a subset of) queries.

PHASE II: Extend the approach to multiple input streams, comprising image and non-image data. Develop algorithms and software for converting extracted information in to a unified KR frame and exhibit utility as a front-end to automated reasoning (understanding) systems.

PHASE III: Extend phase II efforts to incorporate the algorithms as part of a Navy surveillance/security operations system. Collaborate with Navy laboratories and industry to transition the algorithms to naval and/or other DoD systems and other commercial applications such as content-based storage and retrieval system for large amounts of spatial-temporal-related data (e.g. medical informatics, digital library).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Automatic information representation and a unified knowledge representation are needed in many content-based storage and retrieval systems. The algorithms developed under this SBIR topic will have direct impact on these commercial applications. For example, in a content based meeting summarization system, a person who did not attend the meeting could generate a summary of the meeting based on the topic of interest.

REFERENCES:
1. Brachman, R. and Levesque, H. J., Knowledge Representation and Reasoning, Elsevier, Inc., 2004

2. Baader, F., et al., The Description Logic Handbook, Cambridge University Press, 2003

KEYWORDS: Information representation; Knowledge representation; Unified framework; Descriptive Hybrid Language; Automated image understanding; Expert System.

N07-072 TITLE: Degradable Taggant

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Sensors

ACQUISITION PROGRAM: Marine Corps Intel, TRSS, ACAT IV

OBJECTIVE: Develop a more effective and informative method of change detection in order to help solve the asymmetric attack problem. This will be accomplished through the development of a low cost degradable taggant that can be dispersed over a wide area. Once dispersed, the taggant will serve as a witness to activity in the area and can be used to queue other sensors for forensics.

DESCRIPTION: The Degradable taggant project will provide a robust passive tagging system that will enable near-real time change detection along a given route. As contrasted to image recognition software, this technique only records the location and intensity of a signal. In addition, the passive tags will enable the collection of movement data by examining tracks in the area of interest. Lastly, marking an area with passive tags will also enable the identification of entities that were once in the area of interest. The simplicity of this system, as compared to other image recognition/change detection approaches, means that it can be developed into a working product ready for field user evaluation in a relatively short amount of time and expense.

The degradable taggant will give the warfighter a real-time change detection tool for identifying objects of interest. The key technology challenges to implementing this strategy is to create taggants that degrade over time so that the area of interest does not become "polluted" with tags and the ability to register sensor data (intensity images).

While taggants already exist, the purpose of this effort is to find out if it is possible to create a taggant that is degradable meaning its photoluminescence drops off as a function of time. New taggants, whose intensity could be reduced by 50% in a two week time period, are desired. (If it turns out that it is not possible to create degradable taggants then non-degradable taggants can be used.)

Outside the scope of this effort is the development of a payload that can take the before and after pictures and detect changes.

Operational Concept:
Delivery – indiscriminant aerial dispersion over an area of interest

Baseline – initial data collection of relative photoluminescence intensities

Real Time – scan the region ahead of transport, either via a UAV or with a vehicle mounted sensor, and compare intensity map with the baseline to see if any changes can be found. (ground that has been turned, any unexpected traffic patterns appear, etc.)

Re-zero – store intensity scan for future use (re-base lining when appropriate)

Key functions of the Single State Taggant include the following:
1. Real-Time change detection based on Taggant intensity image.
2. Possible intelligence data gathering of routes/paths of traffic through AOI.
3. Degradable taggants allow for a time identification component to the tagging issue.

PHASE I: Conduct research to evaluate the viability of a degradable Taggant. Conduct research to evaluate the limitations of this change detection approach that uses intensity mapping. (Are paths visible, etc…) Develop a system design and make recommendations on the large scale production of the Taggant. Describe hardware and software requirements. Submit a report covering the approach, design and results.

PHASE II: Provide a working prototype of a degradable Taggant and use COTS sensors to test applications and limitations of the Single State Taggant approach. Coordinate a demonstration of the Single State Taggant system. Deliver a final report documenting the performance and capability.

PHASE III: Provide a Single State Taggant System to many DoD and contractor test facilities for field evaluations.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Degradable, low cost passive tags, have application to homeland security (border security) and private security applications. The developed tags would enable a security official to monitor borders and areas of responsibility at a much lower cost. Sensor planning could effectively be based on information obtained from taggant track observations.

REFERENCES:
1. http://www.nap.edu/nap-cgi/skimit.cgi?isbn=0309092450&chap=3-6

2. http://www.cs.colorado.edu/~mishras/research/papers/siumi05.pdf (same application, different approach)

KEYWORDS: Photoluminescence, Change Detection, Infrared, Optical, Real-time, Optical, TTL, Taggant

N07-073 TITLE: <u>Display Technology for 360 Degree Imagery and Situation Awareness for Combat Vehicles</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: PM-Light Armored Vehicle, PM Stryker, PM Cougar, PM Motor Transportation.

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

OBJECTIVE: To develop display technology suitable for use in combat vehicles and other restricted spaces to provide full 360 degree imagery and situation awareness and provide immediate threat identification and localization.

DESCRIPTION: Combat vehicles are subjected to a variety of threats from all directions, and the required response times can be short. Moreover, newer armored vehicles, such as the LAV, provide severely restricted or no direct view of the exterior for many of the occupants. 360 degree imaging can be created by sensor technology. Omnidirectional imagery can be provided by catadioptric optics, multiple cameras, or scanning cameras. Unfortunately the sensor data may not be easily presented with useful spatial relationships on a flat screen. Where is the target I see on the flat screen? Is it behind me or to my left? Hazards, potential threats, targeting information, characterization of object or terrain and escape routes and the relative position of enemy and friendly assets need to be presented in an intuitively easy to understand display that maintains spatial relationships and maximizes the ability of the brain to exploit situational awareness cues from the imagery. The human visual system has powerful innate capabilities. For example human abilities for detection of changes, movement, motion parallax, stereo depth perception, data fusion, or the detection of salience based on features like color, could be exploited by display techniques. The best methods to present sensor technology to the vehicle commander in a moving vehicle will be able to interpret the data as if he was directly looking at the world with his eyes, ears. Various software tools that have been developed such as object tracking, data fusion and change detection for example also can benefit from a 360 degree volumetric display. Non-imaging sensors also need to be displayed, For example, in a vehicle with acoustic gunfire detection and source localization, the predicted location of the shooter needs to be overlaid on imagery or other spatial representations. Hence, the approach should be extensible to fusion of information from other imaging or non-imaging sensors.

360 degree panoramic views could potentially be expressed on a number of different types of displays, including flat screen, curved screen, flexible displays, goggles, 3d and holographic displays or distortion corrected projection onto display surfaces of arbitrary shape. Development of new sensor technologies is not the focus of this topic.

Each of these technologies have physical and mental limitations. Space claims in a vehicle are limited due to egress, safety and available volume. Motion sickness due to terrain irregularities and speed variations, changing lighting conditions, pixel movement incongruence with vestibular cues and fields of view are concerns that need to be minimized. Soldiers may not tolerate devices that block direct views. Combat vehicle information should be readily accessible and easily customized according to the needs of the mission.

PHASE I: Conduct a design study to determine the best means for presentation of very wide and omnidirectional sensor information, especially video (visible, low light and/or IR) to soldiers within a vehicle, identify the display technologies and necessary software for transformation of the sensor information and generation of the display. Develop a system design from sensors to display. The displays should depict threats in relationship to the current vehicle position in a 360 degree three vector space, enable visual identification for accurate characterization of the kind of threat, and make provision for possible fusion of multi sensors with proper scaling in order to analyze a current situation and formulate an immediate response. The response for example can be the aiming of a weapon at the perceived threat.

PHASE II: A low cost and practical display technique is to be developed that considers the physical limitations of the interior of a combat vehicle, presents 3D or other panoramic computer generated graphics and interactive targeting information, can present a fusion of multiple sensor information in three space and can integrate 360 degree panoramic information to a vehicle commander so that he can quickly identify and respond to a change in his status. Build and evaluate a prototype system from sensor to display.

PHASE III: Develop ruggedized prototypes for test and evaluation of the display technology in combat vehicles. This would include field evaluations with structured user feedback to guide refinements of the design. Work with a Marine Corps or Army vehicle program manager on defining acceptable performance metrics and configuration.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is strong commercial potential for this technology in improving highway and loading safety, in the trucking industry, buses and any large vehicle that requires good rear visibility, railroads, boating and commercial vessels.

REFERENCES:
1. S. Nayar, “Catadioptric Omnidirectional Cameras,” Proc. IEEE Conf. Computer Vision and Pattern Recognition, pp. 482-488, June 1997.

2. T.E. Boult, “Personal panoramic perception,” <http://www.vast.uccs.edu/%7Etboult/PAPERS/CISST99-Personal-panoramic-perception--Boult.pdf> in Proc. Int. Conf. on Imaging Science, Systems and Technology, pp. 383-390, World Sci. Eng. Soc., July 1999.

3. Sun, X., Kimber, D., Foote, J., Manjunath, B., Detecting path intersections in panoramic video,” IEEE International Conference on Multimedia and Expo 2002, August 26, 2002.

4. Tzavidas, S.; Katsaggelos, A.K.. “A multicamera setup for generating stereo panoramic video.” IEEE Transactions on Multimedia Volume 7,Issue 5, Oct. 2005 Page(s):880 – 890.

KEYWORDS: Display; Situation Awareness; EO/IR Imagery;Combat Vehicles; Omnidirectional

N07-074 TITLE: <u>‘Jellyfish’ Smart Sensor</u>

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PEO-IWS

OBJECTIVE: Develop a self-contained node that includes sensor, locomotion, energy storage and collection and communications.

DESCRIPTION: Develop a smart sensor that combines sensing, energy collecting, electro-elastic actuation and communications in one self-contained autonomous device. The utilization of electro-active polymers (EAP) for sensing acoustic pressure and/or intensity along with the potential use of EAPs in energy harvesting and storage will permit a relatively buoyant device. The EAPs can also be employed to provide locomotion for both variable depth and horizontal motion by employing the polymer as artificial muscles to mimic a Cartesian Diver or other type motion.

PHASE I: Identify a concept and develop detailed simulations to predict the performance of the complete system.

PHASE II: Develop and test a prototype node that combines all aspects of the node. Based on the proposed approach and current Naval needs the Phase II effort may include the need for access to classified data.

PHASE III: Fabricate several prototype nodes to demonstrate array behavior and performance

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a continuing need in the commercial sector for smart sensors and systems for the oceanographic community. There would be a market in both military systems and oceanographic systems.

REFERENCES:

1. J.B. Blottman, R.T. Richards, "The Jellyfish: "Smart" Electro-active Polymers for autonomous distributed sensing node," Defense and Security 2006: Space Technologies, Displays, Modeling and Simulation, and Intelligent and Unmanned Systems, SPIE vol. CDS214 (2006)

2. H. Xu, Z.Y. Cheng, D. Olson, T. Mai, Q.M.Zhang, and G. Kavarnos, "Ferroelectric and electromechanical properties of P(VDF/TrFE/CTFE) terpolymer," Appl. Phys. Lett. 78, 2360 (2001)

3. J.J. Allen, A.J. Smits, "Energy harvesting eel," J. Fluid Struct. vol. 15, 1-12 (2001)

KEYWORDS: transducer, array, sonar, electro-active polymer, energy harvesting, distributed sensing

N07-075 TITLE: High Frequency Broadband Hybrid Transducer/Amplifier

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO-IWS

OBJECTIVE: Develop a very compact underwater projector/power amplifier module that can be assembled in various array configurations.

DESCRIPTION: Develop a broadband underwater transducer that is very compact and has an integral power amplifier configured such that the total package can be treated as a module for inclusion in an array that can be affixed to or embedded in the hull or structure of a small unmanned undersea vehicle or glider or in the coating of a surface combatant or submarine. The desire to develop a self-contained transducer/amplifier in a volume that is considerably smaller than present systems dictate transduction material and mechanism needs that must be novel. Nesting and hybrid combinations of materials and mechanisms are encouraged. The overall efficiency of the module is an important factor and it can be envisioned that an advanced energy source (stored or collected from the environment) that could be added to the module would be an excellent total self-contained system.

PHASE I: Identify the concept and develop detailed models to simulate the performance of the complete device.

PHASE II: Develop and test a prototype transducer and amplifier. Based on the proposed approach and current Naval needs the Phase II effort may include the need for access to classified data.

PHASE III: Fabricate several prototype modules to demonstrate array behavior and performance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a continuing need in the commercial sector for small transducer arrays operating over several octaves of frequency and capable of reasonable output powers. There would be a market in both military systems and in commercial fishing and oceanographic systems.

REFERENCES:
1. K.R. Erikson, G. Zipfel, S.C. Butler, G.S. Edelson and E.W. Will, "Innovative Power Amplifier and Technologies for High Frequency, Broadband Sonar Arrays," Acoustical Imaging, Volume 28, edited by M.P. Andre, Kluwer Academic Publishers, Boston, MA, 2006.

2. S.C. Butler, "Integrated Co-Fired Triply Resonant Broadband Projector and Copolymer Hydrophone Transducer", Proceedings of the Institute of Acoustics, Sonar Transducers and Numerical Modelling in Underwater Acoustics at National Physical Lab. Teddington, UK, 21-22 March 2005.

3. R. F. W. Coates, "The Design of Transducers and Arrays for Underwater Data Transmission," IEEE Journal of Oceanic Engineering, Vol. 16, No. 1, January 1991.

4. S. C. Thompson, M. P. Johnson, E. A. McLaughlin and J. F. Lindberg, "Performance and Recent Developments with Doubly Resonant Wideband Transducers," Proceedings of the Third International Workshop Transducers for Sonics and Ultrasonics, Orlando, Florida, U.S., May 1992.

KEYWORDS: transducer, array, power amplifier, digital, energy harvesting, conformal, underwater

N07-076 TITLE: Naval Device Applications of Relaxor Piezoelectric Single Crystals

TECHNOLOGY AREAS: Materials/Processes, Sensors, Weapons

ACQUISITION PROGRAM: PMS 415 Undersea Defensive Warfare Systems

OBJECTIVE: Devise and fabricate practical devices for Navy and civilian applications that exploit the extraordinary electromechanical properties (high coupling: 90-95 %; high strain: ~ 1 %) of single crystal relaxor piezoelectrics.

DESCRIPTION: Near the onset of 1997 came the discovery that single crystals of certain relaxor ferroelectric (lead magnesium niobate – lead titanate, and lead zinc niobate – lead titanate) materials exhibit extraordinary piezoelectric properties, namely, strains exceeding 1%, and electromechanical coupling exceeding 90% (compared to 0.1% and 70-75 %, respectively, in state-of-the-art piezoceramics)(References 1 and 2). Concerted efforts to grow these materials in a variety of forms (bulk, multilayer, fibers, thin films, etc.) now yield materials in quantities, and at a price, suitable for devices.   Three domestic manufacturing firms now supply these materials as well as several more overseas; initial devices have been developed and commercialized (References 3, 4 and 5). This topic aims to exploit these enhanced electromechanical properties in practical devices. For example: in acoustic transducers, the high coupling leads to higher bandwidth (doubled to two octaves or more), while the high strain leads to higher source levels (more than an order of magnitude increase); actuators employing these materials are more efficient and compact; and sensors are smaller and more sensitive. While this topic is open to a broad range of applications, the proposed device should rely on the special properties of the relaxor piezocrystals. In describing the application, state what property of these crystals is being exploited and why this is essential to the success of the proposed application. A design—no matter how clever—that could be realized effectively with conventional materials is not responsive to the intent of this topic. A Navy application specialist endorsing the importance of the enhanced performance in the proposed device would be a big plus. Multiple Phase I and Phase II awards are anticipated for diverse systems applications.

PHASE I: Design and show the feasibility of a practical device exploiting high-strain, high-coupling relaxor piezocrystals with a laboratory test.

PHASE II: Refine the design and show the performance enhancements of the proposed device with a brassboard prototype in a laboratory or (if possible) field environment.

PHASE III: Demonstrate the cost-effective manufacturability of the targeted device structure in quantities appropriate to defense and civilian markets.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Applications in the defense sector from Navy sonar, through Army rotorblade control, to Air Force airfoil shape control—all have analogs in the civilian sector. Other applications will have their primary impact in the civilian arena, including medical ultrasonics, active machine tool control, and vibration suppression in HVAC systems.

REFERENCES:
1. S.-E Park and T.R. Shrout, “Ultrahigh Strain and Piezoelectric Behavior in Relaxor based Ferroelectric Single Crystals, “ J. Appl. Phys., 82[4], 1804-1881 (1997).

2. S.-E Park and T.R. Shrout, “Characteristics of Relaxor-Based Piezoelectric Single Crystals for Ultrasonic Transducers,” IEEE Trans. On Ultrasonic Ferroelectrics and Frequency Control, Vol. 44, No. 5, 1140-1147 (1997).

3. J. M. Powers, M. B. Moffett, and F. Nussbaum, "Single Crystal Naval Transducer Development," Proceedings of the IEEE International Symposium on the Applications of Ferroelectrics, 351-354 (2000).

4. Jie Chen and Rajesh Panda, "Review: Commercialization of Piezoelectric Single Crystals for Medical Imaging Applications," Proceedings of the 2005 IEEE Ultrasonics Symposium, 235-240 (2005).

5. Harold C. Robinson, James M. Powers, and Mark B. Moffett, "Development of broadband, high power single crystal transducers," Proceedings of the 2006 SPIE International Symposium on Smart Structures and Materials, in press (2006).

KEYWORDS: Electromechanical Sensors and Actuators; Vibration Control; SONAR; Piezoelectrics; Lead Magnesium Niobate –Lead Titanate; Lead Zinc Niobate–Lead Titanate

N07-077 TITLE: Embeddable Software Programmable Radio

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Tactical Radio System, ACAT I

OBJECTIVE: Develop compact software programmable military radio chip/chipset that is capable of being embedded in unitary computing, display and position location devices envisioned for future Marine Corps ground forces. Such a development will need to take into account classified and unclassified information handling within the embedded radio within the framework of the joint tactical radio system (JTRS) software communications architecture.

DESCRIPTION: The JTRS program portends a major change in the way the Department of Defense will be acquiring future communications devices. Additionally, the small form-fit versions and the soldier radio waveform are specifically targeted at small unit operations and sensor networks. An ongoing Army SBIR, A05-105, is exploring the development of low-cost, low weight, low volume, and low-power-consumption broadband power amplifiers for use in small unit devices. The next logical step for future Marine Corps, and Army, small unit operations is to exploit commercial software programmable technologies to develop low-cost communications devices that can be embedded in future unitary devices. The goal is to produce a chipset, composed of commercially available components, that can take advantage of the JTRS software communications architecture (SCA) and software waveform library.

Because of the need for this device to operate at both unclassified and SECRET classification levels on a single processor, with a single operating system, a necessary thrust of this effort will be to devise verifiable partitioning methods to prevent intermingling of differently classified information.

The desired frequency range of such a device is 2MHz to 2 GHz at a transmit power level of 5 W. Note that antennas and power amplifiers are explicitly not part of this topic, so an output power level of approximately 100 mW containing interfaces compatible with power amplifiers of this class is desirable.

PHASE I: After reviewing current commercial and Government software programmable radio capabilities and outlook, identify promising approaches through analysis, modeling and simulation to provide low-cost solutions to meet the needs of this topic.

PHASE II: Design, build, test and demonstrate communications between at least two brassboard prototype devices. Produce a final technical report describing development methodology, features, noted shortcomings, and path for further development, transition, and commercialization.

PHASE III: Build and demonstrate prototype devices in a field environment. Document design and demonstration.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Such a flexible, and ostensibly low-cost, communications device has applications in military, Government, public service and commercial markets where communications in multiple bands, modulations, and coding schemes is necessary or desired.

REFERENCES:

1. JTRS SCA version 2.2.2 (draft) http://jtrs.spawar.navy.mil/sca/downloads.asp

2. SBIR Topic A05-105 (Army) http://jtrs.spawar.navy.mil

3. JTRS ORD 3.2.1 (Joint-draft)

KEYWORDS: software communications architecture; joint tactical radio system (JTRS); JTRS small form-fit; soldier radio waveform;

N07-078 TITLE: Incorporating Affective Stressors in Virtual Training Environments

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PM TRAINING SYSTEMS, PMA-205 and NAVAIR TSD

OBJECTIVE: Virtual Environment (VE) training systems typically focus on developing providing either cognitive or psychomotor types of training. A third category of training, the affective domain, is poorly addressed by these types of tools. The goal of this topic is to develop a technique and technology that inserts an affective component into virtual environments. This will result in more effective training, which, in turn should lead to enhanced transfer of skills for Navy and Marine Warfighters while reducing the cost (time and money) to deliver this training.

DESCRIPTION: Bloom's taxonomy (Bloom et al, 1956) provides one of the most well-known foundations for developing targeted learning applications. The taxonomy decomposes learning into three types of behaviors: Cognitive, which focuses on gaining and manipulating information; Psychomotor, which focuses on hands-on types of skills; and, Affective, the attitudes that students have towards learning. Currently, VE training systems focus primarily on the first two learning domains, while ignoring the third. Yet, evidence suggests that student attitudes towards learning, even on very simple, low fidelity, types of VE systems may have a significant, positive impact on the rate with which materials are learned (Kulik & Kulik, 1991) as well as the effectiveness of this learning

(Torkzadeh, Pflughoeft, & Hall, 1999). In the absence of this third domain, training may take longer, and be less effective, resulting in lower returns on investment.

There is currently no well established process for developing, implementing and assessing how to structure affective learning nor is their guidance for how to develop tools to support implementing any such structure within VE. One promising avenue for research focuses on developing systems that increase a trainee's sense of presence and immersion (Maria & Chalmers, 2001; Meehan, et al', 2005). By imparting a sense of 'being there' these systems could force trainees to develop learning strategies similar to those elicited by real world contexts, leading to a more effective type of learning that would be more likely to transfer and generalize to operational settings. There is mounting evidence that training for high pressure/high intensity environments is best accomplished using training environments that are similar to these domains (Seidel & Chatelier, 1997). This suggests that affective learning can be included into VE systems, by introducing a context specific approach to enhancing immersion.

PHASE I: Develop a framework for introducing an affective component to learning. Focus on a model that leverages scaffolding approaches, in which different learning behaviors are interdependent in a hierarchical fashion and that combines them with other elements that create an immersive experience (capitalizing on stimulating different sensory modalities). This framework should include an architecture for determining trainee context, instructional context, desired approaches for creating immersion and a set of strategies for aligning these contexts. Product should be an Affective Strategies Matrix that maps affective capabilities to learner states and a plan for developing a tool to implement this in real time, integrated with a VE – based training system.

PHASE II: Develop prototype system, to be used as a component for Navy-Marine Corps virtual training applications (e. g., flight simulation, dismounted infantry training) and conduct empirical study for validation. Develop and implement Training Effectiveness Evaluation to assess utility of incorporating affective learning into VE training.

PHASE III: Produce and market Affective Training Network stand alone capability for integration with existing or planned virtual systems for the Navy/Marine Corps.

COMMERCIAL POTENTIAL: This methodology will have widespread applications to military, government, and private sector organizations in which human-centered training systems are designed and developed and where SIT is required (e.g., law enforcement, fire fighting, medical responders, phobia treatment, etc.).

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2. Kulik, C.C. & Kulik, J.A. (1991). Effectiveness of computer-based instruction: An updated analysis. Computers in Human Behaviour, 7, 75-94.

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KEYWORDS: training systems; human-centered design; system requirements specification; requirements engineering; system architecture; human performance, stress inoculation training (SIT)

N07-079 TITLE: Surfzone Water Properties Sensor

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: Mine Warfare (N752), Space & Naval Warfare (PMW180-ISR/IO), PEO-LMW,PEO-NSW

OBJECTIVE: Develop an inexpensive, autonomous, easily deployed, surfzone optical properties sensor.

DESCRIPTION: Rapid, typically overt environmental assessment of the optical properties of the surf zone prior to, during, or shortly after deployment of aerial Mine Counter Measure (MCM) systems will provide information to significantly enhance MCM performance. A compact, autonomous, easily-deployed, inexpensive sensor (nominally expendable) is desired to measure optical and perhaps other water properties in the surf zone and then communicate information back to operators via satellite or RF communications. Operationally relevant measurements are desired as opposed to research quality ones. Specifically, the sensor must accurately measure inherent optical properties (IOPs), such as backscatter and attenuation coefficients, which may vary with optical wavelength. Due to waves and currents in the surfzone, IOPs may vary on a relatively short time scale. This variability must be resolved in order to characterize, for example, mine hunting performance. Variation in optically relevant parameters other than backscatter and attenuation should be considered.

PHASE I: Determine the feasibility of the proposed sampling methodology; determine its expected accuracy and resolution; estimate cost, performance and operational deployment strategies. The range of optical wavelengths of interest include those typically used in hyperspectral imaging systems. Phase I analysis must clearly indicate the sensor’s effectiveness at estimating IOPs over this bandwidth and relate IOP estimation errors to errors in image interpretation (including depth and seafloor property characterization). Additionally, Phase I analysis must clearly indicate the sensors effectiveness over a range of surfzone conditions, including mild surf to heavy surf and clear to turbid water.

PHASE II: Develop and evaluate prototype sensors over the range of environmental conditions listed above and at the range of optical wavelengths of interest. Establish and verify the viability of communication options. Develop and demonstrate data processing. Demonstrate sensor prototype in a field test. Demonstrate utility of IOPs in characterizing the environment.

PHASE III: Produce sensors and conduct field validation under a range of conditions for confirmation by operating forces. Demonstrate that IOP estimation errors are well understood and IOP estimates are suitable for mine hunting and environmental characterization.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Sensors should have civilian application to monitoring nearshore or riverine water quality, for example, after a hurricane or accidental hazardous waste spill, or harmful algal bloom. Sensor could be used to complement environmental assessment activities, including habitat evaluation. A small, inexpensive sensor that can be easily deployed offers the same advantages to non-DoD users as it does to the Navy.

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1. Mobley, C. D., Light and Water: Radiative Transfer in Natural Waters. Academic, San Diego, Calif., 1994.

2. Schmidt, W.E., Woodward, B.T., Millikan, K.S., Guza, R.T., Raubenheimer, B., and Elgar, S., 2003, A GPS-tracked surf zone drifter: Journal of Atmospheric and Oceanic Technology, v. 20 no.7, p.1069-1075.

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4. Twardowski, M.S., J.R.V. Zaneveld, C.M. Moore, J. Mueller, C. Trees, O. Schofield, S. Freeman, T. Helble, and G. Hong. 2005. Diver visibility measured with a compact scattering-attenuation meter (SAM) compatible with

AUVs and other small deployment platforms. from SPIE Port and Harbor Security Conference, Vol. 5780, February, Orlando, FL.

KEYWORDS: ocean optical sensor, seawater optical properties, bubbles, sediment, mine countermeasures, telemetry, expendable, diver visibility, ocean color remote sensing

N07-080 TITLE: Predictive models for improvised explosive device countermeasures

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: Joint Improvised Explosives Devices Defeat Organization (JIEDDO), ACAT IV

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

OBJECTIVE: Development of predictive modeling and simulations tools that can be used to plan Improvised Explosives Devices (IED) countermeasures.

DESCRIPTION: IED activity, in Iraq alone, involves participation by a variety of terrorist groups such as Al-Qaeda cells, Iraqi Baath factions including Fedayeen Saddam, Sunni Islamists, and Pro-Iran Shia radicals. Globally, the number of such groups increases vastly. These terrorist groups are autonomous entities that, while united in the overarching goal of thwarting US interests, differ in their doctrinal interpretations, skills, resources, and strategies. While one faction may prefer suicide bombers, another faction might specialize in remotely triggered roadside bombs. Coordinated IED activity, involving joint operation by several of these groups, is particularly hard to predict and simulate. To devise effective countermeasures, predictive tools are needed to model and simulate the numerous potential combinations of coordinated IED attacks by these various groups. In addition to identifying the likely “coalitions” of these terrorist groups, the predictive tools should enable the planning of IED countermeasures.

One of the hurdles to the development of such predictive tools is the availability of historical data of sufficient quality and granularity. Data about past IED attacks is often scattered and not readily available in a form suitable for data mining. In addition, much of this data is sensitive and often classified. Proposed solution approaches should clearly state how this hurdle will be overcome. The sensitivity of the proposed predictive tools to data quality/availability should be addressed. Any assumptions about Government-Furnished Information (GFI) should be clearly documented and substantiated.

PHASE I: Propose and test the feasibility of the predictive approach for IED countermeasure modeling and simulation. The solution architecture including input data sources, the predictive model(s), and the output user-interface should be designed and tested.

PHASE II: The predictive tool will be implemented and demonstrated on realistic use-cases. Open-source intelligence data such as IED activity news reports can be used for Phase II demonstration. The developed software should be HLA-compliant to facilitate interaction with other relevant modeling and simulation tools.

PHASE III: Transition technology in coordination with the Navy counter-IED program and the broader Joint IED Defeat Organization. Other DoD counter-IED programs, such as the Combat Terrorism Technology Task Force (CT3F a.k.a “Team Tango”) are also transition paths for the predictive modeling tool. Homeland security and law enforcement applications are additional commercialization alternatives.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector commercial potential lies in the creation of IED predictive tools and techniques for delivery to the military and intelligence services of the United States and its allies.

REFERENCES:

1. ONR spearheads high-priority counter IED project, STARLINK Winter 2005/2006, http://www.nstarweb.com/enews/STARLINKWinter05_06.pdf

2. ONR funds basic science in support of counter-IED efforts, ONR media release, November 2005, http://www.onr.navy.mil/media/article.asp?ID=101

3. ONR BAA 05-024 http://www.onr.navy.mil/02/baa/docs/baa_05_024.pdf

4. Adaptive Foe Thwarts Counter-IED Efforts, National Defense, January 2006, http://www.nationaldefensemagazine.org/issues/2006/jan/adaptive_foe.htm

5. DoD Taps Industry Know-How in Ongoing Counter-IED Efforts, American Forces Press Service, http://www.defenselink.mil/news/Jan2006/20060124_4000.html

KEYWORDS: counter-IED; prediction; terrorist coalitions; modeling and simulation

N07-081 TITLE: Transient Electrical Power Response Enhancement for Turbine Driven Generators

TECHNOLOGY AREAS: Air Platform, Space Platforms, Weapons

ACQUISITION PROGRAM: PEO(W) Strike Weapons and Unmanned Aviation (pre-milestone A, ACAT TBD)

OBJECTIVE: Improve the transient response of a lightweight turbine engine serving as the prime mover for an electrical generator which has a relatively large rating compared to the engine's shaft power output.

DESCRIPTION: Airborne electrical power requirements are increasing significantly to support Intelligence, Surveillance, and Reconnaissance (ISR) sensors, electronic attack suites, and possibly directed energy weapons for military applications. For commercial applications, the increase is being driven by passenger comfort and more electric subsystems. One approach to supplying this power is to add a separate propulsion-class turboshaft engine to the platform which is dedicated to driving a lightweight electrical generator. Another approach for some applications is to integrate the generator directly into the propulsion engine. This approach is being considered for high Mach missiles, where any transient effects on the engine cycle have more significant impacts than on other cycles with the luxury of higher operating margins. An issue with these approaches is that the turbine engine cannot respond to load changes as quickly as the generator itself. Effectively, the engine / generator system cannot respond adequately to electrical load changes and this will be exacerbated by the trend toward lighter systems of larger power output. Innovative techniques to enhance the transient response of the turbine engine / generator system for airborne applications are the focus of this topic. Adding inertia to the rotor in the form of a flywheel has been investigated previously and is not the focus. Offerors are strongly encouraged to establish relationships with relevant aerospace system suppliers.

PHASE I: Investigate approaches to improve the transient response of the turbine engine to rapidly applied electrical loads and analytically estimate possible positive impacts on response as well as negative system impacts. Modeling and simulation to guide the research is encouraged as appropriate.

PHASE II: Develop and demonstrate technology approaches to the extent allowed by the scope, preferably with an industry partner. Develop a technology transition and/or insertion plan for future systems and commercial ventures.

PHASE III: Integrate these technologies into an engine driven power generation demonstration and reduce the technologies to a marketable product via licensing or well established relationships with system supplier(s).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These methods could be applied on several planned military and commercial platforms requiring significant levels of electrical power as well as commercial microturbines and larger gensets being developed for distributed power installations.

REFERENCES:

1. Power System Analysis; Grainger & Stevenson, 1994, McGraw-Hill Publishing ISBN 0-07-061293-5, Chapter 16.

2. Improvement of Power System Transient Stability by Coordinated Operation of Fast Valving and Braking Resistor; Patel, R., Bhatti, T.S., and Kothari, D.P.; IEE Proceedings – Generation, Transmission, and Distribution Vol 150, Issue 3 pp. 311-316, May 2003.

3. Asynchronous Motor Protection Against Dynamic Instabilities; Martinez, Jorge et. al.; IEEE Transactions on Industry Applications, Vol. 36 No 4, Jul/Aug 2000.

4. MIL-STD-704E, "Aircraft Electrical Power Characteristics", May 1991.

KEYWORDS: Power, electrical power, turbine engine, turbogenerator, and turbine engine transient response

N07-082 TITLE: Energetic Secondary Fuel Injection for Propulsion System Performance Improvement

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

ACQUISITION PROGRAM: F-18 E/F Aircrafts, 414 Engine

OBJECTIVE: Develop a sequential energetic secondary fuel injection scheme in order to reduce combustion instabilities and to enhance performance of chemical propulsion systems.

DESCRIPTION: Combustion instabilities not only result in deterioration of combustor performance that affects the overall propulsion system performance, but also may lead to extensive fatigue and vibration that can reduce the operational life, and may even lead to premature failure. Among the various technologies tried over the past decades, secondary fuel injection has shown promise and ease of retrofit. Research has shown that the timing of secondary fuel injection (with respect to the vortex formation in the combustor flow) has a tremendous impact on the stability enhancement. However, the secondary fuel injection involves additional components and weight, which may affect the overall system performance. It is proposed that a pulsed fuel delivery system is used, and highly energetic secondary fuel is utilized. This will enable a reduction in secondary fuel otherwise required, lead to complete combustion, and increase thermal output. An increased thrust will thus be possible without an increase in the combustor volume, and the specific primary fuel consumption can also be reduced. The secondary fuel can be high energy strained hydrocarbon fuels, such as cubane and benzvalene derivatives or nano metallic particle of aluminum (Alex), boron etc.

PHASE I: Identify a suitable high energy secondary fuel, and develop injection scheme for sequential injection. Conduct flow and/or computational studies to understand particle size, distribution and trajectories.

PHASE II: Design and fabricate a secondary fuel injection and a simple test combustor or modify an off the shelf combustor (simple liquid fuel engine), and perform pulsed secondary fuel injection studies. Investigate vibration levels, noise and thermal output with and without secondary fuel injection. Validate computational tools for use in Phase III.

PHASE III: Install the secondary fuel system in a realistic engine (Government-provided), and perform a full parametric evaluation of thrust performance, vibration and noise, and fuel utilization. Optimize system integration for retrofit, and provide new design criteria.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology will have an impact on all types of chemical propulsion devices used. Further, this will be applicable to stationary power generators and auxiliary power units, pulse combustors and pulse detonation engines.

REFERENCES:
1. B. Pang et.al, "Combustion and Mixing Control Studies for Advanced Propulsion", Combustion Processes in Propulsion: Control, Noise and Pulse Detonation, Elsevier, pp.169-180, 2006.

2. K.H. Yu et. al, "Liquid Fuel Active Control for RAMJET Combustors", Advances in Chemical Propulsion - Science to Technology, CRC Press , pp 341-360., 2002.

KEYWORDS: Combustion Instability, Performance Improvement, Fuel consumption, Vibrations, Missile and Aircraft Propulsion

N07-083 TITLE: Affordable Signal Distribution, Beamforming and Drivers for Highly Efficient Switched-Mode Amplifiers in Electronically Scanned Transmit Arrays

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: CGX radar suites

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

OBJECTIVE: Develop and demonstrate an affordable digitally programmable waveform distribution and beamforming architecture that exploits recent advances in highly efficient “digital” switched-mode amplifiers. The preferred approach will enable lower cost by providing reduced part count, size, weight, power consumption and increased efficiency when compared to more conventional approaches based on heterodyning (analog up-conversion) and analog beamforming.

DESCRIPTION: Electronically scanned arrays (ESAs) are of considerable interest to the DoD and are realized in both analog and digital beamforming approaches [1]. Conventional analog systems are based on the generation of analog signals which are distributed through power splitters and provided in analog form to each of the elements in an array (or subarray). Analog beamforming is accomplished by use of phase shifters or time delay units which are provided to each element (or subarray). For microwave frequency of operation it is often necessary to perform up conversion of baseband signals via use of analog mixers, filters and preamplifiers. For arrays of 1k – 10k elements this conventional process can be costly due to the relatively high part count and power consumption. Improved art is highly desired.

Recent advances in both wide-bandgap semiconductors and switched-mode amplifiers [1] have demonstrated power added efficiencies (PAE) of 57% PAE for GaN MMICs Class-E amplifiers[2]. Switched-mode amplifiers are expected to yield PAE of about 70-80% at microwave frequencies. Electronically scanned arrays (ESAs) that can exploit these high efficiencies [3] are expected to eventually replace more conventional arrays based on conventional amplifiers, vacuum electronics and analog beamforming technology. ESAs that employ switched-mode amplifiers offer potential to provide improved performance, higher efficiency and lower cost.

The topic seeks innovative solutions to signal distribution, beamforming and driver circuitry that optimizes the use of switched-mode amplifiers, from an array system perspective. The focus of the effort is to perform a rigorous investigation into architectures, methodology, and technology that includes both analysis and proof of principal. Subsequent phases will validate the approach by demonstration with representative hardware. Offerors may consider a wide range of innovative technologies however the preferred approach must demonstrate an improvement in performance and / or cost relative to conventional methodology. Solutions must be able to perform in open interfaces and open architectures as envisioned in future Navy and DoD systems planned for acquisition.

PHASE I: Perform architecture trade studies, modeling and simulations. Architectures are assessed in terms of bandwidth, efficiency, phase noise, phase stability (capacity to be calibrated in array environment) and electronic scanning limitations and other parameters which may be of interest to array performance. Any significant cost drivers are identified.

PHASE II: Demonstration of a digital distribution and beamforming network that supports a partial array nominally consisting of 16 elements which are driven by digital switched-mode amplifiers. The array shall operate in the transmitter mode.

PHASE III: Participate in industry development efforts for a full transmitter array demo that exploits open system and open interface architectures. This includes but is not limited to any of the following: Radar (at microwave frequencies), electronic countermeasures, and communications systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The private sector communications systems such as cell phone towers and satellite tracking systems could benefit from more efficient amplifiers and signal distribution systems. The capacity for frequency reuse enabled by efficient digital beamforming is particularly attractive because it utilizes the frequency spectrum more efficiently.

REFERENCES:
1. M. I. Skolnik, An Introduction to Radar Systems, McGraw Hill, 2001.

2. F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, N. O. Sokal," Power Amplifiers and Transmitters for RF and Microwave" IEEE Trans Microwave Theory and Tech, Vol. 50, No. 3, MARCH 2002

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4. S. Pajic, Z. B. Povovic, "An Efficient X-Band 16-Element Spatial Combiner of Switched Mode Amplifiers", IEEE Trans on Microwave Theory and Tech, Vol. 51, No. 7, July 2003.

KEYWORDS: Switched-mode (Switching) Amplifiers, Electronically Scanned Phased Arrays, Antennas, Digital Beamforming, Transmitters, Wide-Bandgap Semiconductors

N07-084 TITLE: Dynamically Reconfigurable Data Architectures for Aircraft Data Analysis and Anomaly Detection

TECHNOLOGY AREAS: Air Platform, Information Systems

ACQUISITION PROGRAM: PEO (T), Tactical: PMA-265, PMA-299, PMA-275, PMA-261, PMA 209

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

OBJECTIVE: Develop an adaptive approach for advanced data analysis using automated reasoning and highly dynamic data architectures with integrated data fusion and adaptive analysis techniques for the detection of system anomalies and multi-variate trends only apparent through the integration and analysis of disparate data sources.

DESCRIPTION: Massive quantities of data are collected regularly from aircraft flight data recorders, maintenance, logistics, and readiness reporting systems. Typically, each of the data sources are designed to satisfy a unique requirement and are processed to provide only the requisite information to the intended audience. Through integration of these data sources, further insight into aircraft fleet usage, system performance, and readiness factors can be realized (for instance: rotor system vibration levels recorded by aircraft data systems may only make full sense when linked with operational usage data and component replacement information noted in the logistics system). However, due to the quantity and disparity of the data available across multiple DON data systems and aircraft, there is currently no way to automatically identify, access, retrieve, and integrate data sources to provide useable information from an amalgamation of these data sources.

Advanced methods of processing the vast quantities of these disparate data is needed in order to accomplish this. Intelligent adaptive methods of accessing, integrating, mining, characterizing, and presenting the data must therefore be developed. These techniques must be able to account for a variety of data from multiple sources and extract useful information. Of particular interest are the detection of mechanical issues that are, as of yet, unknown or undocumented and the association of faults with their causal factors. Possible solutions include, but are not limited to artificial intelligence, intelligent software agents, advanced fusion algorithms, as well as meta-base or multi-base categorization and storage techniques.

This topic is directly applicable to the mission requirements of Air ASW Assault & Special Missions Programs, and well as PEO (T), Tactical Air Programs. This topic will also support the following platforms: PMA-265 (F-18), PMA-299 (H-60), PMA-275 (V-22), PMA-261 (H-53), and PMA-209 (Common Avionics).

PHASE I: Develop an approach for dynamically reconfigurable database architecture(s) and methods of data set integration with integrated data analysis and fusion algorithms. Apply to an illustrative example.

PHASE II: Implement a test case of one aircraft type utilizing the architectures and methods developed.

PHASE III: Implement the same for multiple aircraft type/model/series.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology is directly applicable to maintenance cost reduction in commercial aircraft fleets.

REFERENCES:
1. An Introduction to Predictive Maintenance, R. Keith Mobley, Elseveir, 2002

2. Condition Monitoring, E. D. Yardley, Wiley, 2002

KEYWORDS: aircraft;health-maintenance;condition-based;data;architectures;anomaly; prediction

N07-085 TITLE: Automatic extraction and representation of syntactic, perceptual, semantic and conceptual content of images

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PMA 281, PM-SOMPE, PEO-C4I

OBJECTIVE: The main objective of this SBIR topic is to develop techniques for automatic extraction and representation of contents of images that helps in automatic understanding of complex scenes.

DESCRIPTION: Automatic scene understanding is essential to reduce the workload of a commander or a warfighter in maritime or urban security operations where the environment is demanding, complex and changing dynamically. Currently, mainly imaging sensors such as visual and/or IR cameras are used for security operations. Several algorithms have been developed for image enhancement, segmentation and object recognition. However, for scene understanding, there is a need for automatic extraction and representation of image contents in the form of semantics, syntax, perception and grammar development. This kind of extraction and representation is similar to language modeling i.e., probabilistic grammar and knowledge representation that is used in automatic speech understanding by applying natural language processing techniques [1-2]. Similar trend can be currently seen in the areas of vision and relational database systems [3-5]. However, there is a need for rigorous algorithm development for the image content extraction, representation and grammar development for automated image understanding. This SBIR topic is addressing this need.

PHASE I: (a) develop algorithms for image content extraction, representation (e.g., temporal-spatial), grammar (e.g., context sensitive) and text generation (e.g., sentence generation that describes the image) and (b) proof of concept demonstration on a chosen example image/scene

PHASE II: (a) extend algorithms for disparate distributed data sources (e.g., audio and video) and (b) extend and demonstrate the performance of algorithms on complex urban or maritime surveillance/security scenes.

PHASE III: Extend phase II efforts to incorporate the algorithms as part of a Navy surveillance/security operations system. Collaborate with Navy laboratories and industry to transition the algorithms to naval and/or other DoD systems and other commercial applications such as digital library, description of points of interest using wireless devices like cellular phone and Personal Digital Aids (PDAs).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Automatic generation of image content is needed in many information retrieval, navigation and digital library systems. The algorithms developed under this SBIR topic will have direct impact on these commercial applications. For example, in a navigation system, these algorithms can be used to annotate the current scene that the system has captured using the visual camera in terms of points of interest (e.g. type of a museum based on the icon on the building or text on the building), restaurants by food type, etc

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3. S. Kumar, ``Models for learning spatial interactions in natural images for context-based classification'', Ph.D Thesis, CMU-RI-TR-05-28, CMU, August, 2005.

4. S. Casadei, "Hierarchical estimation of image features with compensation of model approximation errors", International Conference on Computer Vision Theory and Applications, 25 - 28 February, 2006, Setúbal, Portugal.

5. F. Han and S.-C. Zhu, "Bottom-up/top-down image parsing with attribute grammar", Preprint, 2005

KEYWORDS: Image content extraction; Image parsing; probabilistic grammar; text generation; Image content representation.

N07-086 TITLE: High-Efficiency Thermoelectric Generator

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: MARCOR SYSCOM - Marine Corps PM Expeditionary Power Systems

OBJECTIVE: Develop a high conversion efficiency 100W thermoelectric power generator module that exploits recent advances in bandgap engineered nanostructured thermoelectric materials. Develop thick film and/or bulk materials growth processes for and demonstrate intrinsic conversion efficiency of thermoelectric materials with a thermoelectric figure-of-merit, ZT, > 2, through designed control of electronic energy band structures (Seebeck enhancement) and nanostructure (thermal conductivity reduction). Demonstrate extrinsic systems conversion efficiency through reduction of parasitics (interface and systems engineering). This technology development is directed at direct primary power generation for DoD platforms, vastly enhanced fuel efficiencies through cogeneration of electricity via waste heat utilization and auxiliary power units for DoD transport systems (ground, sea, and air), power for remote or unattended stations, energy harvesting for self-powered sensor systems, and solid-state cooling and refrigeration.

DESCRIPTION: Significant improvements in thermoelectric performance of semiconductor systems have recently been realized in thin film and bulk materials through the incorporation of nanometer scale structures that significantly increase phonon scattering, leading to record low thermal conductivities. Such performance enhancements have been demonstrated in n-type PbSeTe-based quantum dot superlattice systems prepared by molecular beam epitaxy (1,2), p-type BiTe-SbTe and n-type BiTe-BiTeSe quantum well superlattices deposited by metal-organic chemical vapor deposition (3), and bulk n- and p-type LAST (Pb-Sb-Ag-Te) chalcogenides (4). Realization of further improvements in the thermoelectric figure-of-merit, ZT, will require increases in the power factor (Seebeck coefficient and/or electrical conductivity) while maintaining low thermal conductivity. Several approaches for accomplishing this have been proposed, including, among others, quantum confinement (5), heterostructure thermionic emission (6), and diffusive electron transport (7) and experimental validation is being actively pursued.

Realization in bulk or thick film form of the performance-enhancement concepts demonstrated in thin film form and further optimization of thermoelectric performance of these thicker materials will greatly expand the technological utility, cost-effectiveness, and intrinsic efficiency of the thermoelectric materials.

To maximize system-level conversion efficiency, modules must be designed and materials selected that minimize parasitic losses and maintain mechanical robustness at operating temperature and through repeated temperature cycling.

The development of an advanced high efficiency thermoelectric power generator will require major advances in the growth of thick film and/or bulk materials incorporating advanced concepts for high efficiency thermoelectric performance and integration of high ZT thermoelectric materials (by definition resulting from enhanced power factors and reduced thermal conductivities), with advanced module engineering to optimize electrical, thermal, and mechanical properties of the interfaces and the module. This program seeks to identify new approaches to accomplish these goals.

PHASE I: Develop detailed plan for constructing prototype high efficiency (20%) 50W thermoelectric generator incorporating advanced thermoelectric materials with average ZT > 2 between 300K – 700K that derive significant enhancements in thermoelectric performance through bandgap engineering and incorporation of nanoscale elements within a semiconductor composite. Develop and demonstrate feasibility of bulk crystal growth process for advanced thermoelectric materials with average ZT > 2 between 300K – 700K that derive significant enhancements in thermoelectric performance through bandgap engineering and incorporation of nanoscale elements within a semiconductor composite. Demonstrate initial module proof-of-concept of intrinsic thermoelectric materials conversion efficiency and extrinsic low parasitics at the 100 mW-level.

PHASE II: Optimize and scale up bulk and/or thick film crystal growth process for advanced thermoelectric materials with average ZT > 2 between 300K – 700K that derive significant enhancements in thermoelectric performance through bandgap engineering and incorporation of nanoscale elements within a semiconductor composite. Fabricate and test a 100W prototype thermoelectric device incorporating the bandgap and nanoscale-enhanced thermoelectric materials to demonstrate the overall system efficiency. Analyze manufacturability, reliability, scalability, and cost issues for producing commercially viable power generation system.

PHASE III: The integration of advanced thermoelectric materials with optimized materials and module engineering that minimize parasitic losses and provide mechanical robustness will enable the development of commercially viable thermoelectric systems for power generation, waste heat recovery, and cooling.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The integration of advanced thermoelectric materials with optimized materials and module engineering that minimize parasitic losses and provide mechanical robustness will enable the development of commercially viable thermoelectric systems for power generation, waste heat recovery, and cooling.

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1. T. C. Harman, P.J. Taylor, D.L. Spears and M.P. Walsh, “Thermoelectric quantum-dot superlattices with high ZT”, J. Electron Mater. Lett. 29, L1-4 (2000).

2. R. Venkatasubramanian, E. Siivola, T. Colpitts and B. O’Quinn, “Thin-film thermoelectric devices with high room-temperature figures of merit”, Nature 413, 597-602 (2001).

3. W. Kim, J. Zide, A. Gossard, D. Klenov, S. Stemmer, A. Shakouri, A. Majumdar, “Thermal Conductivity Reduction and Thermoelectric Figure of Merit Increase by Embedding Nanoparticles in Crystalline Semiconductors,” Phys. Rev. Lett. 96, 045901 (2006).

4. M.G. Kanatzidis, K.-F. Hsu, J. Do, T.P. Hogan, F. Guo, S. Loo, “Thermoelectric Properties of Cubic AgPbnSbTe2+n”, Abstract S6.3, Fall 2003 Materials Research Society Meeting, Boston, MA (Dec. 2003).

5. L.D. Hicks and M.S. Dresselhaus, “Effect of quantum-well structures on the thermoelectric figure of merit,” Phys. Rev. B47, 12727-31 (1993).

6. D. Vashaee and A. Shakouri, “Improved Thermoelectric Power Factor in Metal-Based Superlattices,” Phys. Rev. Lett. 92, 106103 (2004).

7. T.E. Humphrey and H. Linke, “Reversible Thermoelectric Materials,” Phys. Rev. Lett. 94, 096601 (2004).

KEYWORDS: Thermoelectrics, bandgap engineering, Seebeck, nanostructures, power generator

N07-087 TITLE: Computational Models for Effects Based Operations in Special Forces Teams

TECHNOLOGY AREAS: Information Systems, Human Systems

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

OBJECTIVE: Apply computational modeling technology to aid in multicultural team function allocation, knowledge interoperability and optimal team organization to improve team training and performance.

DESCRIPTION: Defense Transformation and Network-Centric Operations has created the requirement for highly responsive, networked teams. The new focus on Coalition Operations has also driven the need for agile, multicultural teams to respond quickly to asymmetric threats. The QDR has directed a significant expansion in Special Operation Forces (SOF) and SEALs teams to operate in politically sensitive and denied areas. Principal objectives will be to track and disable high value targets globally. Effectiveness of Special Ops also often depends on understanding the impact of cultural factors for own team members and for prediction of adversary actions. Models that can identify optimal organizational structures, provide interactive function re-allocation and match cultural strengths with tasks can provide a warfighting advantage. Cultural data bases now exist that can quantify cultural behaviors and Influence Net models have demonstrated the ability to enable effects-based planning. Combining the features of these extant technologies can provide both operational and training benefits in the short term.

PHASE I: Develop a system design that makes use of existing cultural behavior data integrated with a modeling framework such as influence diagramming and Bayesian inference networks to evaluate "what if" implications and predict future scenarios. Propose a prototype for application in quick-reaction small team situations.

PHASE II: Develop and demonstrate a prototype system in a lab or simulation environment. Conduct testing to prove feasibility in an operational experiment or training scenario.

PHASE III: Introduce to users at Marine Systems Command, Special Operations Command or other special forces activities for usability testing or incorporate as part of the training program for special operations.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be used in a broad range of military and civilian applications where multicultural teams collaborate to select a course of action, make a decision or design a product. Could be especially useful in humanitarian aid/disaster relief situations.

REFERENCES:
1. Influence Net Modeling: http://www.inet.saic.com/inet-public/

2. Decision Support System for Coalition Operations: SSC San Diego Technical Report 1886, August 2002: www.maxwell.af.mil/au/awc/awcgate/navy/tr1886.pdf

3. Including Organizational Cultural Parameters in Work Process: CCRT(2004) www.dodccrp.org/events/2004/CCRTS_San_Diego/CD/papers/008.pdf

KEYWORDS: Multicultural, Decision Making, Teams

N07-088 TITLE: Improved Durability of Composite Propulsor Blade

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PMS 450, PMS 377

OBJECTIVE: Develop and demonstrate innovative, cost-effective solutions for improving the impact performance and resistance to cavitation erosion and/or repairability of composite materials for Naval applications.

DESCRIPTION: The use of composite materials in the development of advanced, high-speed surface platforms, such as the Littoral Combat Ship (LCS), can provide performance enhancements, as well as cost and weight reduction. The use of composite materials on propulsors can also provide the same advantages. The leading material candidates are fiber reinforced polymer (FRP) materials due to their high structural efficiency and specific properties. However, the relatively small, lightweight, high-speed ships are routinely subjected to heavy abrasion and impact with adjacent water craft, floating debris, sea floor. Propulsors are subject to cavitation erosion and impact damage due to the ingestion of foreign objects and solid particles. Unfortunately, the use of FRP materials leads, in general, to a reduction in impact performance and cavitation erosion resistance due to their stiff, strain-rate limited material characteristics.

This topic seeks innovative solutions to improve the impact performance and cavitation erosion resistance of FRP materials for Naval applications, including composite propellers and ship structures. Solutions should, at a minimum, address improving the elastic impact response (i.e., no resulting material damage). This may be accomplished through various means, including the development and/or use of new constituent materials (e.g., fiber and matrix), laminate architectures, and fabrication methods or combination of these. The development and demonstration of novel impact response improvements will also be considered including composite self-healing techniques and the use of shape memory polymers to enable shape recovery of impact damage. Solutions must be:

- Cost effective
- Compatible with the marine environment
- Scalable to large-scale manufacturing
- Possess structural properties consistent with the service loads
- Applicable to curvilinear surfaces and joints

PHASE I: Demonstrate through erosion and impact testing the feasibility of using advanced structural FRP and shape memory materials to improve the impact performance and/or impact recovery of propeller and lift fan blades and high-speed, light-weight ships operating in a harsh marine environment. Identify new and existing materials and/or fabrication techniques for further investigation. Identify and implement preliminary sub-scale test methods for assessing resistance to impact and cavitation erosion. Perform trade-off analyses considering cost, mass, structural properties, and cavitation performance to downselect to several candidate materials to be considered for Phase II effort.

PHASE II: Qualify candidate materials for Navy applications through extensive testing including impact performance, abrasion, cavitation erosion, water absorption, and other environmental effects. Demonstrate affordable manufacturability for large-scale applications.

PHASE III: Working with Navy and/or industry, as applicable, to develop and demonstrate material concept(s) in "mid-scale" trials. The trials should include a controlled demonstration with hardware of a nominally 4-5 ft diameter composite propeller and/or lift fans, installed and demonstrated on a surface ship as main propulsion, or on an LCAC as a lift fan or thruster.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The advanced materials developed would have direct application for commercial manned and unmanned surface vessels used in oceanographic surveying, off-shore oil exploration and on salvage ships. Additionally, high-performance marine composite materials have nearly unlimited applications in shipbuilding.

REFERENCES:
1. Rathnam, K.V., and Peel, L.D., "Impact Resistant Fiber Reinforced Elastomer Composite Materials," Proceedings of the SAMPE 2004 Conference, Long Beach, CA, May 2004.

2. Gall, K., et al, "Shape Memory Polymers for Microelectromechanical Systems," Journal of Intelligent Material Systems and Structures, Vol. 14, pp 623-632, 2003.

KEYWORDS: Composite materials, impact, shape memory polymers, composite self-healing, composite marine structures, composite propeller, low cost.

N07-089 TITLE: Information Visualization for Distributed Collaborative Environments

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: To develop technologies and tools to enable collaborative visualization of complex data, information, and knowledge in a distributed decision-making environment.

DESCRIPTION: Visualization is becoming increasingly important in analyzing scientific data, as it allows insight and understanding of information in a way not afforded by purely analytical means. Computing power and storage capacity has increased significantly over the past years, so massive amounts of data are available to the decision-maker. Despite the increase in visualization capability, little work has been done in the area of collaborative visualization. The state of the art in this area is equivalent to one analyst looking over the shoulder of another analyst. With the increasing emphasis upon collaboration in decision-making, improved capability for collaborative visualization is very desirable, especially in a distributed environment. The objective of this topic is to develop techniques, methods, and tools for collaborative visualization of data, information, and knowledge, with the goal of enabling rapid and informed decision-making in a distributed environment.

Some suggested research and technology issues that can be addressed include, but are not limited to, the following:

- Processes for visualizing metadata (data about the data) and pedigree (data quality)
- Interaction technologies and methods that enable the user to intuitively understand complex data from multiple sources
- Methods and tools that allow the user to adaptively explore the data and obtain new informative views
- Techniques that work in real-time on a wide range of display devices (e.g., portable devices, desktops, shared displays)
- Techniques that allow the user to store the insights obtained during an analytical session and the steps that were used to obtain these insights

The proposed solution may include software or software and hardware. While specific applications may be discussed in a proposal, the developed system should be extensible and therefore applicable to a variety of domain areas.

PHASE I: Develop methods that demonstrate the power of the proposed scientific visualization techniques in a distributed collaborative environment. The product from this phase will be a feasibility study for the proposed technology.

PHASE II: Implement and demonstrate the utility of the system developed in Phase I. The output from this phase will be a prototype demonstration.

PHASE III: Further develop and validate a product-level tool suite for delivery to the Navy or DoD. Convert the visualization system into a commercially viable product.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Visualization has taken on increasing importance in many private sector application areas. These areas include finance, automotive engineering, aerospace, remote sensing, medicine, and geophysics. Significant advances in collaborative visualization are likely to find a market in one or more of these domain areas.

REFERENCES:
1. J. Thomas and K. Cook, Illuminating the Path: The Research and Development Agenda for Visual Analytics, IEEE Press, 2000. http://nvac.pnl.gov/agenda.stm

2. H. G. Pagendarm and B. Walter, “A Prototype of a Cooperative Visualization Workplace for the Aerodynnamicist”, Computer Graphics Forum, 12(3), EG 93 Conference Issue, pp 485-496, 1993.

3. J. D. Wood, H. Wright, K. W. Brodlie, “CSCV- Computer Supported Collaborative Visualization” in proceedings BCS Displays Group International Conference on Visualization and Modelling, Leeds, 1995.

4. B. C. Wallet, R. L. Wentland, J. Mokhtar, “Visualization of Massive Volumetric Data Sets” in Computer Science and Statistics 34, Fairfax, 2002.

5. E. J. Wegman, ”Visual data mining,” Statistics in Medicine, 22, pp 1383-1397, 2003.

KEYWORDS: Scientific Visualization, Exploratory Data Analysis, Collaborative Graphics, Human Factors, Collaborative Environments, and Decision-making.

N07-090 TITLE: <u>Aircraft instruments for measuring the solar and infrared irradiance in the atmosphere</u>

TECHNOLOGY AREAS: Air Platform, Battlespace

ACQUISITION PROGRAM: SPAWAR PMW-180 Operational Effects Program (OEP)

OBJECTIVE: Develop instruments that accurately measure the total solar and total infrared (IR) broadband irradiance from an aircraft.

DESCRIPTION: In order to understand the effects of clouds and aerosol particles on the radiative balance of the atmosphere, and hence on the weather and climate, accurate measurements throughout the atmospheric column are required of the amount of sunlight downwelling through the atmosphere or reflected up from the surface below, combined with the amount of infrared radiation being emitted from the surface and atmosphere. These fundamental quantities are required in all radiative balance studies of the atmosphere but the instrumentation presently available does not have the needed accuracy to move these fields forward. Currently, almost all of the instruments (both surface and airborne) used to measure the total solar or total IR broadband irradiance utilize thermopile detectors. This technology is plagued by slow response times and sensitivity to variations in the temperature of the instrument itself that limit the accuracy of the measurements. While these flaws are not necessarily fatal for surface-based instruments, they are problematic for airborne measurements.

There is therefore a critical need for fast response time instruments that will accurately measure the total solar or total IR broadband irradiance from an aircraft and that are insensitive to rapid temperature and pressure variations.

The instruments should have a flat, uniform wavelength response over the solar or IR bandpass and a cosine angular response.

The solar/IR irradiance instruments should be transferable onto a variety of aircraft. Power for the instrumentation will be provided from the aircraft's 28V DC generators, and some data from the instruments should be passed to the aircraft's data system. Consideration should be given to minimizing both size and power requirements.

PHASE I: Design a prototype system that measures the total solar and total infrared broadband irradiance at a rate of 1 Hz or better and is able to accurately perform in the variable and rapidly changing temperature and pressure environment of a noisy, vibrating aircraft that flies from low to high altitudes.

PHASE II: Develop and demonstrate fully capable solar and infrared irradiance instruments for use on a research aircraft. Develop a commercialization plan, including descriptions of potential customers, missions, demonstrations and transition efforts to be performed.

PHASE III: Transition the system into operational solar and infrared irradiance instruments to include documentation, calibration and other tools and spare parts. Support solar/IR irradiance instruments integration for government customer-specified platforms. Finalize requirements for a solar/IR irradiance system that would allow its utilization by various research facilities on a variety of platforms, including aircraft, ships or ground based operations.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The possibility of commercialization is tied to the lack of accurate and fast solar and IR irradiance instruments that are insensitive to changes in temperature and pressure. The demand for such instruments is expected to be quite large due to the wide range of interest in such fundamental measurements. For example, the climate community and scientists studying the radiative effects of clouds and aerosols in the atmosphere all require accurate measurements of the solar and IR irradiance. In particular, surface based atmospheric observation networks presently use solar and IR irradiance instruments that are affected by changes in temperature.

REFERENCES:
1. Asano, S., A. Uchiyarna, Y. Mano, M. Murakarni, and Y. Takayama, No evidence for solar absorption anomaly by marine water clouds through collocated aircraft radiation measurements, J. Geophys. Res., 105 (D11), 14761-14,775 (2000).

2. Ji, Q., S.C. Tsay, On the Dome Effect of Eppley Pyrgeometers and Pyranometers, Geophys. Res. Lett., 27, no. 7, 971-974 33 (2000).

KEYWORDS: Solar irradiance; Infrared irradiance; Radiometry; Real-time Data Collection; Atmospheric radiation

N07-091 TITLE: Risk and Uncertainty Management for Multidisciplinary System Design and Optimization

TECHNOLOGY AREAS: Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: PEO-SUB PMS-404, Undersea Weapons Program Office, Next Gen Torpedo

OBJECTIVE: Develop an innovative statistical process for managing risk and uncertainty during multidisciplinary system design and optimization (MSDO). The process involves a network of probabilistic metamodels to estimate the performance and uncertainty of the cumulative subsystems and their models.

DESCRIPTION: Managing the development of a new system requires more than just estimating the performance of the system given the integrated performance of its subsystem components. It also requires managing the uncertainty in those estimates and ultimately managing the risk that may exist in using the current set of technologies and design tools [1].

Current system uncertainty assessment methods are either potentially inaccurate or computationally expensive. Differential analysis methods entail simplifying the system by linearizing its response about the design point, which can result in significant errors in estimating the tails of the resulting distribution. Monte Carlo methods are more accurate but require significantly more samples to estimate the resulting probability distributions [2].

An alternative to these two methods is to create probabilistic metamodels, such as Gaussian process models that provide good approximation to the performance of each subsystem. Also, the process models quantify the uncertainty introduced by using the metamodel as an approximation [3]. Due to the computational efficiency of the metamodel, it is possible to use Monte Carlo methods to accurately estimate the resulting system uncertainty in real-time. Hence, allowing the system designers to interactively investigate the design space and to make decisions on the best approach for the final design.

PHASE I: Develop a preliminary design framework with models to deal with design uncertainties and risk management. The efforts will include metamodels, computational methods and visual interfaces.

PHASE II: Implement and demonstrate the risk and uncertainty management design tools developed from Phase I. The tools will be applied to current undersea weapon system or sea vehicle.

PHASE III: Extend the Phase II effort to incorporate risk and uncertainty management on future undersea weapons and sea vehicles. Collaborate with Navy laboratory and industry to transition the risk and uncertainty management design tools to naval systems and other non-military applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The risk and uncertainty management methods developed in this research will have direct application to any system design program. This includes commercial sea vessels, ground transportation systems, and air vehicles.

REFERENCES:
1. Lewis, K. and Mistree, F., "The Other Side of Multidisciplinary Design Optimization: Accommodating a Multiobjective, Uncertain and Non-deterministic World," Engineering Optimization, Vol. 31, 1998, pp. 161-189.

2. Saltelli, A., Chan, K., and Scott, E.M., Mathematical and Statistical Methods: Sensitivity Analysis, Wiley Series in Probability and Statistics, John Wiley & Sons Ltd., Chichester, England, 2000.

3. Martin, J.D. and Simpson, T.W., "A Methodology to Manage Uncertainty During System-Level Conceptual Design," ASME 2005 International Design Engineering Technical Conference, DETC2005-84984, Long Beach, CA, 2005.

KEYWORDS: Risk Management; Uncertainty Design; Design and Optimization Process; Undersea Weapons and Sea Vehicles; Design Tools; Metamodel

N07-092 TITLE: Miniaturized, Vibration Hardened Drive Electronics For Compressors

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Radio Frequency Antennas & Topside Program PMW 180

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

OBJECTIVE: Development of a robust, compact set of drive electronics for medium power (300W-900W) compressors.

DESCRIPTION: Compressors are needed in many naval systems, especially where the working fluid is used for many cycles. Medium power compressors in the 300 to 900 Watt range are especially required for driving the closed cycle coolers needed for the power amplifiers of single antenna RF transmitters and directly digitizing, cryogenic receivers. The cold heads of the latter are being developed from space qualified designs to insure long lives with zero maintenance. But the compressor control electronics clearly needs to be reworked as the space community's extreme concern with the export of vibration and radiation hardness and tolerance of > $100K costs are not shared by the tactical community which is more concerned by the deleterious effect of imported vibration and environmental temperature swings. In most cases, the power wave form required is a sine wave of frequency less than 100 Hz. System sensors and on-board calibration tables should dynamically adjust the output amplitude and phase and confirm the continued health of the attached cooler. Where 2 linear motors are mounted with oppositely directed strokes to minimize the production of vibration, slightly different settings for each are sometimes desirable. Power efficiency is very important and in the past has been thought to require the use of Pulse Width Modulation (PWM) drive technology. Switching amps, say of SiC, might also be considered. It is desirable for the final package to fit on a single circuit card and cost < $300 if purchased in volumes of 1000 copies per year. The system must be able to tolerate widely varying supply voltages, power quality, and ambient temperatures. Whether the use of MIL-SPEC compliant or redundant components would guarantee 100% availability under tactical vibration and shock loading should be evaluated.

PHASE I: Phase I should produce a detailed design of the electronics package including simulated performance of an attached compressor. The compressor/system model can be obtained by teaming with an established cryocooler company or by consulting the extensive literature in the subject, such as the Proceedings of the biennial Cryogenic Engineering Conference (CEC).

PHASE II: Phase II should result in a completed prototype with sufficient laboratory testing to establish applicability to a compressor or cryocooler system as well as compliance with relevant vibration standards.

PHASE III: In Phase III, the small business is expected to transition the prototype to a full development phase with production plans corresponding to one or more specific military systems employing compressors and/or cryocoolers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Wireless communications base stations already use cryo-cooled filters and further advances toward direct reception are anticipated. In addition, the high power dissipation densities of modern high speed digital electronics and power amplifiers are making cooling fans insufficient for thermal management. Active, closed cycle cooling is the next step.

REFERENCES:
1. R.J. Glaser, J.A. Garba, M.W. Obal, “STRV-1B Cryocooler Vibration Suppression”, 36th AIAA, SDM, New Orleans , LA, 1995;

2. Kuo,C.P., “Coldfinger Motion Suppression Using A Ceramic Applique,” Proceeding of SPIE’ Smart Structures and Materials Conference ’93, Jan31-Feb4,1993, Albuquerque;

3. Olsen, H.F. “Electronic Control of Noise, Vibration, and Reverberation”, Journal Acoustical Society, Vol. 28, Sept. 1956, pp 966-972

4. A. Syed, E. Ahmed, and D. Maksimovic, “Digital Pulse Width Modulator Architectures,” 35th Annual IEEE Power Electronics Specialists Conference, Aachen, Germany, 2004, pp. 4689 ff. (http://ece-www.colorado.edu/~pwrelect/pubarch/01354828.pdf)

KEYWORDS: compressors, cryocooler; drive electronics; vibration control; pulse-width modulation; sine wave generation

N07-093 TITLE: Littoral Environment Visualization Tool

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: Oceanographer of the Navy, NSW, Mine Warfare, Space and Naval Warfare

OBJECTIVE: Develop realistic computer-generated animations of the littoral environment, including nearshore waves, riverine and estuarine flows, to provide the warfighter, planner, teacher, and student the means to manipulate such environmental variables as wave height or sea state and to see the effect in near real time.

DESCRIPTION: We seek innovative approaches to providing realistic computer-generated animations of the dynamic littoral environment. It is well known that even subtle changes in environmental conditions, for example, a wind shift or change in wave height, period, or direction, can have a disproportionate impact on the visual appearance of the littoral region. Direct visualization of the environment communicates critical information to the operator/planner and significantly enhances interpretation of static mapping products.

The film industry has developed the capability to produce realistic animations of fluid motion, and scientific studies have produced robust predictions of waves, currents, breaker type, surf zone width, and other features of the littoral environment. However, robust methods to render realistic animations spanning the full range of littoral environmental conditions in near-real-time are not available to the warfighter or mission planner. Developing such a capability will require significant innovation, yet is within reach and logically extends existing technologies. Animations would be used to familiarize operators with the predicted littoral environment and simulate performance of littoral operations; importantly, the animations will also allow the operator to appreciate the potential effect of prediction uncertainties. Although realistic animations are necessarily based on state-of-the-art computational fluid and solid dynamics, the emphasis of this tool is on production-quality animations, rather than on strict physical accuracy.

Environmental variables to be simulated and visualized include but are not limited to waves, currents, bathymetry, obstacles, sediment, and visibility. Inputs to the tool would be standard oceanographic/meteorological products, such as are available from Navy, for example, forecasts from the SWAN coastal wave model. The simulation should permit operator-selected viewpoints from above the water surface or below it.

PHASE I: Determine the feasibility of the animation approach using operational forecast products including wave height, period, direction, and breaking, wind speed and direction, and current speed and direction. Compare the tradeoff between visualization detail and realism with computational effort. Evaluate compatibility of approach with available environmental forecast products. Quantify degree of realism of the animation. Specifically, quantify the approach’s likelihood to represent a realistic picture of the littoral environment over a range of wave, current, and wind conditions. Indicate how the rendered animation might impact an operator, who may be interested in,for example, detection of floating or submerged objects.

PHASE II: Develop a prototype system and test its performance against direct imagery of a littoral environement. Verify expected visualization detail and expected computational effort. Verify compatibility with available forecast products. Verify the realism of the animations. Demonstrate visualization of simulated littoral operations over a range of littoral conditions including large and small waves, strong and weak currents, and strong and weak wind speeds. Demonstrate that subtle changes in environmental conditions are rendered with appropriate and not always subtle changes in visual appearance.

PHASE III: Develop an operational system capable of testing during a Naval exercise. Demonstrate successful integration with available environmental forecast products. Demonstrate reasonable computational time expenditure for generation of environmental animation. Evaluate operational suitability. Provide documentation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A capability to provide realistic visualizations of the littoral environment would have wide application for coastal, riverine and estuarine operations, including lifesaving, commercial and private boating near the shoreline and harbors, and as well as supporting a variety of recreational activities. Realistic visual simulations of physical processes, including waves, fluid flows, and weather phenomena are of significant interest to the computer game, motion picture, television, advertising, and marketing industries, and have tremendous potential for on-line educational programs.

REFERENCES:

1. Foster N. and R. Fedkiw. Practical animation of liquids: International Conference on Computer Graphics and Interactive Techniques archive Proceedings of the 28th annual conference on Computer graphics and interactive techniques, p. 23-30, 2001.

2. Enright D, Marschner S, Fedkiw R. Animation and rendering of complex water surfaces: ACM TRANSACTIONS ON GRAPHICS 21 (3), p. 736-744, 2002

3. Booij N, Ris RC, Holthuijsen LH. A third-generation wave model for coastal regions - 1. Model description and validation: Journal of Geophysical Research-Oceans 104 (C4), p. 7649-7666, 1999.

KEYWORDS: surf; very shallow water; animation; computational fluid dynamics; waves; riverine

N07-094 TITLE: RF Guidance Sensor Windows for High-Speed and Hypersonic Air Vehicles

TECHNOLOGY AREAS: Air Platform, Weapons

ACQUISITION PROGRAM: PEO(W) Strike Weapons and Unmanned Aviation (pre-milestone A, ACAT TBD)

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

OBJECTIVE: Design and develop low-cost electromagnetic window/radome concepts that are capable of protecting guidance sensors at speeds of Mach 4 to Mach 6 at altitudes above 40 kft at cruise for 15 minutes.

DESCRIPTION: The heating effects of a high-speed/hypersonic vehicle (stagnation temperatures up to 2,700oF) associated with high-speed/hypersonic flight pose a difficult environment for sensors. The interface surface or window material must be able to withstand the high temperatures while affording transparency in the sensor's electromagnetic spectrum of operation. Furthermore, the window may need to offer the sensor thermal insulation, cooling or protection from the vehicle's external environment. Lastly, terminal homing seekers tend to have a forward-looking field-of-view, requiring an ogive-shaped window or radome that must endure the high stagnation temperature of these speeds, and the high dynamic pressures (2000-12000 lbs/sq ft).

Given the altitudes and speeds that hypersonic vehicles encounter, RF sensors are deemed the most reasonable to perform as guidance sensors. There are 3 RF spectra of interest for high-speed/hypersonic vehicle guidance: Ka- through W-band for precision terminal homing, S- through Ku-Band for near-terminal guidance, and L-band for midcourse GPS navigation and guidance.

The intent of this SIBIR is to have window materials and designs identified and tested which can be considered for use with RF guidance sensors in high-speed/hypersonic flight vehicles. For any of the spectra of interest, the window must:

- Consider vehicle integration (thermal /structural/attachment) issues
- Meet aero thermal and pressure loading conditions for vehicle flight profiles
- Survive rain field conditions for vehicle low-altitude terminal guidance
- Accommodate both flat and non-flat (conformal, ogive, faceted) surface shapes to match vehicle aerodynamic design
- Maintain electromagnetic and thermo-mechanical properties associated with the intended guidance sensor

PHASE I: Determine the feasibility of candidate materials for window application through material properties testing (transmissivity, structural strength, and thermal properties). Show how a high-speed/hypersonic guidance sensor window can be constructed, given the candidate material properties.

PHASE II: Demonstrate fabrication techniques for the window materials in Phase I. Construct and evaluate through coupon testing, the performance and survivability endurance of a candidate window, in a relevant, supersonic/hypersonic environment. Consider multiple window fabrication and evaluation to cover some or all of the RF spectra listed above.

PHASE III: Demonstrate commercial production capability for producing full-scale windows/radomes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High endurance windows can support both land and airborne vehicles needing GPS guidance, or RF altimetry, or collision avoidance sensing.

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1. Krell A., Blank, P., Ma, H., Hutzler, T., Van Bruggen, M. P. B., and Apetz, R. “Transparent Sintered Corundum with High Hardness and Strength.” J. Am. Ceram. Soc., 86, 2003, pp. 12-18.

2. Krell A., Blank, P., Ma, H., Hutzler, T., and Nebelung, M. “Processing of High-Density Submicrometer Al2O3for New Applications.” J. Am. Ceram. Soc., 86, 2003, pp. 546-553.

3. Krell, A., Baur, G., and Dähne, C. “Transparent Sintered Sub-µm Al2O3 with IR Transmissivity Equal to Sapphire.” Proc. SPIE, Volume 5078, 2003.

4. NAWCWD TP 6750-46, Vol 2, “Hypersonic Guidance”, 2001

5. NAWCWD TP 6750-47, Vol 2, “Hypersonic Guidance”, Apr 2002

KEYWORDS: Missile Dome; RF Dome; Hypersonic Missile; Ceramics; Ceramic Fabrication; SRBSN, Silicon Nitride, Seekers, Materials

N07-095 TITLE: Alternative Flight Control Methods for Supersonic/Hypersonic Cruise Missiles

TECHNOLOGY AREAS: Air Platform, Weapons

ACQUISITION PROGRAM: PEO(W) Strike Weapons and Unmanned Aviation (pre-milestone A, ACAT TBD)

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

OBJECTIVE: Develop, design and demonstrate alternative flight control systems that can reduce or eliminate the need for fins or wings on high supersonic cruise missiles (Mach = 4 to 5).

DESCRIPTION: Control surfaces for high speed vehicles greatly complicate the design of a high speed vehicle, due to conflicting design requirements that significantly impact vehicle performance.. At lower speeds, large control surfaces are required to maintain control authority, while at higher speeds control surface effectiveness decreases, so large surfaces are still required. However at high speeds the control surfaces must also be thin to minimize drag. Structurally, this presents a series of challenges as the large thin control surfaces are under significant aerodynamic and heating loads during high speed flight operations and contribute a significant amount of drag to the overall system. Additionally, for tactical missiles, control surfaces often need to be folded or retracted in some manner in order to facilitate integration onto the launch platform (aircraft or launch cell on a ship or submarine).

All of these problems demonstrate the need to develop alternative control systems that can be as effective as typical aerodynamic control systems, but do not over-burden the vehicle in other areas. There are many factors that must be considered in order to develop a useful method for controlling high speed vehicles:

• Often high speed vehicles must have controllability at subsonic speeds during take-off or launch and during acceleration to high speed. An alternative control system must maintain sufficient control authority of a wide speed range (sufficient control authority over a speed range from Mach 0.5 to Mach 4.5 for a representative axi-symmetric missile body with a center-of-gravity at x/L = 0.6).

• Controls for maneuvering and trimming the vehicle need to be considered to make an alternative control system viable.

• The cost to the vehicle system must be considered when developing an alternative control system since most applications will be in expendable vehicles.

• The goal is to have the same or less impact on weight, drag and power required as a conventional fin control system with equivalent control authority.

• Because any reduction in control surface size may assist in the design of a high speed missile (particularly for the volume and weight limited cases), systems that augment conventional aero control surfaces may be applicable if there is benefit to the vehicle as a whole (such as reduced complexity, weight, etc.).

PHASE I: Develop a concept for an alternative control system that demonstrates control authority at Mach 4 to Mach 5 and over a wide range of speed regimes, from Mach 0.5 to 4.5

PHASE II: Develop and demonstrate a prototype system that demonstrates desired control authority with reasonable system attributes such that the control system could be integrated into a missile sized vehicle at similar cost to conventional controls (size, weight, power requirements, etc.) at Mach 4 to Mach 5, and over a Mach range from M = 0.5 – M = 4.5.

PHASE III: Insert the product into a candidate high-speed missile airframe.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be applied to any private/commercial subsonic air vehicle or to subsonic/ supersonic unmanned air vehicles. In addition, the same methods of flow control could be applied to several other types of flows such as internal engine flow control, thrust vectoring, or other non-intrusive applications.

REFERENCES:
1. Rattlrs program fact sheet, http://www.onr.navy.mil/media/extra/fact_sheets/rattlrs.pdf

2. Signal magazine, May 2006, "Missiles Aim for Mach Four Capability"

3. Massey, K, Silton, S., “Testing the Maneuvering Performance of a Mach 4 Projectile.” AIAA-2006-3649, 24th AIAA Applied Aerodynamics Conference, San Francisco, California, June 5-8, 2006

4. Patel, M, Prince, T, Carver, R, DiCocco, J, and Lisy, F, “Deployable Flow Effectors for Phantom Yaw Control of Missiles at High Alpha.” AIAA-2002-2827, 1st Flow Control Conference, St. Louis, Missouri, June 24-26, 2002

5. Patel, M, Sowle, Z, Ng, T, Toledo, W, “Hingeless Flight Control of a Smart Projectile Using Miniature Actuators.” AIAA-2005-5258, 35th AIAA Fluid Dynamics Conference and Exhibit, Toronto, Ontario, June 6-9, 2005

KEYWORDS: controls; flight control system (FCS); flow control; unconventional controls; alternative flight controls

N07-096 TITLE: Autonomous, Cooperative Behavior Amongst Unmanned Surface Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS501-Littoral Combat Ship, ACAT I

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

OBJECTIVE: Develop an autonomous control system that implements cooperative behavior amongst several Unmanned Surface Vehicles (USVs).

DESCRIPTION: Unmanned Surface Vehicles (USVs) are being considered by the US Navy for various missions. The ability of several USVs to carry out a mission, with individual USVs capable of autonomously replanning their mission based on the sensor inputs and situational awareness of the other USVs, would be of great value because this would result in reduced operator workload. Inclusion of Unmanned Aerial Vehicles (UAVs) in the system would further enhance mission capability. For the purposes of this topic, the USVs should be equipped with: 1) sensors for situational awareness, and monitoring of their mechanical systems, 2) the USVs should be equipped with a sensor or sensors that will allow them to search an operator-defined region and 3) the USVs should be equipped with additional sensors that will provide for inspection of an object of interest when it is detected. For this topic, the emphasis should be on integration of relatively inexpensive, off-the-shelf sensors and vehicles to demonstrate proof-of-concept of autonomous cooperative behavior amongst several USVs. A description of one possible approach to cooperating unmanned vehicles is found in Reference 2.

This topic seeks a capability in which the USVs can 1) autonomously and cooperatively search an operator-defined area, 2) have one USV break away from the search and inspect an object or craft of interest once it is located and 3) the remaining USVs continue the search, readjusting their search pattern to compensate for the loss of one USV from the group. Additionally, the group of USVs should be able to autonomously reconfigure their search pattern if one USV experiences a mechanical breakdown. In addition to the autonomous control of the USVs, particular attention should be paid to the challenges of the marine environment, the challenges of communication between the USVs and the human interface.

PHASE I: Develop a design concept for an automated control system that will provide for cooperative behavior, as described above, amongst a group of Unmanned Surface Vehicles (USVs).

PHASE II: Fabricate one prototype system designed in Phase I and install on a small boat. Through in-water testing, validate the properties of the system, in response to inputs from other, simulated Unmanned Surface Vehicles (USVs).

PHASE III: Demonstrate prototype system fabricated in Phase II on more than one Unmanned Surface Vehicles (USV). Provide at-sea demonstration of ability of prototype system to provide autonomous cooperative behavior amongst several USVs. Provide detailed drawings and specifications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Small boat-builders and machinery automation industries will benefit from this topic. Commercial applications include use on oceanographic survey vessels, off-shore oil exploration and salvage ships.

REFERENCES:
1. "SPARTAN Unmanned Surface Vehicle Extends the USW Battlespace-SPARTAN Concept", Naval Forces, Special Issue 2001, p. 18.

2. D. Scheidt et al., “Cooperating Unmanned Vehicles”, IEEE, July 2005.

KEYWORDS: Unmanned Surface Vehicles (USV); Autonomy, Cooperative Behavior

N07-097 TITLE: Erosion Resistance Coatings for Composite Propulsor/Fan Blades

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PMS 450, PMS 377

OBJECTIVE: Develop cost effective coatings on composite materials for insertion into naval propulsion (in air and in water) and lift fan systems that improve durability by enabling the composite blades to become highly resistant to erosion from cavitation, sand, mist, rain, or sea-water spray while providing compatibility with geometry and ease of installation.

DESCRIPTION: The use of composite materials for underwater propulsors (ships and subs) and propulsion and lift fans (for air-cushion vehicles such as LCACs) has the potential to greatly improve various metrics, including: stringent fabrication tolerance at reduced procurement cost, hydrodynamic efficiency leading to reduced life-cycle costs, cavitation, radiated noise and weight. Recent efforts have demonstrated improvements in the cavitation erosion resistance of fiber-reinforced polymers (FRP), although their improved performance still remains well below traditional metallic materials. A multifunctional composite material that provides both good structural properties and high resistance to erosion from a multiple of sources is desired. Cavitation, characterized by the sudden formation and collapse of low-pressure bubbles as the liquid pressure is reduced to the vapor pressure, subjects adjacent structural materials to repeated and concentrated shock and microjet impact loading. This dynamic loading can have an even more profound effect on strain-rate sensitive materials such as FRP. Indeed, traditional lightweight materials such as aluminum or FRPs do not perform well in a cavitating environment.

This topic seeks innovative coating solutions that address the resistance to cavitation erosion, and impact due to sand, mist, rain, or sea-water spray of FRP materials. Desired coating material attributes include:

o Erosion resistance in excess of or equivalent to traditional metallic materials (e.g., 316 SS, Nickel-Aluminum-Bronze, high-strength aluminum, etc.)
o Low cost
o Structural properties consistent with service loads
o Scalable manufacturing
o Compatible with the marine environment
o Conformable to the target application's geometry

PHASE I: Establish geometry, operating conditions, and material requirements relevant to Navy applications. Conduct survey of new and existing materials for further consideration. Identify and implement preliminary sub-scale test methods for assessing erosion resistance to cavitation and impact due to sand, mist, rain, and/or sea-water spray. Perform trade-off analysis considering cost, mass, structural properties, and erosion resistance to downselect to several candidate materials to be considered for Phase II effort.

PHASE II: Qualify candidate materials for Navy applications through extensive testing including cavitation erosion performance, abrasion, impact, water absorption, and other environmental effects. Demonstrate affordable manufacturability for large-scale applications.

PHASE III: Working with Navy and/or industry, as applicable, to develop and demonstrate material concept(s) in "mid-scale" trials. The trials should include a controlled demonstration with hardware of a nominally 4-5 ft diameter composite propeller and/or lift fans, installed and demonstrated on a surface ship as main propulsion, or on an LCAC as a lift fan or thruster.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The advanced coating materials developed would have direct application for commercial manned and unmanned surface vessels used in oceanographic surveying, off-shore oil exploration and on salvage ships. Additionally, high-performance marine composite materials have nearly unlimited applications in shipbuilding.

REFERENCES:
1. Rathnam, K.V. and Peel, L.D., "Impact Resistant Fiber Reinforced Elastomer Composite Materials," Proceedings of the SAMPE 2004 Conference, May 2004, Long Beach, CA.

2. Kendrick, L.H., and Caccese, V., “Development of a Cavitation Erosion Resistant Advanced Material System,” ADA441468.

3. Bhagat, R.B., “Cavitation Erosion of Composites – A Materials Perspective,” Journal of Materials Science Letters, 6(12), 1987, pp1473-1475.

KEYWORDS: Composite materials, coatings, erosion, cavitation, marine structures, composite propeller, low cost

N07-098 TITLE: Fire Integrity in Advanced Ship Structures

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: ACAT I - DDX Program, PEO SHIPS/PMS500

OBJECTIVE: Revolutionary new ship concepts now in the design phase are making increased use of unconventional materials such as composites or aluminum, in order to reduce weight, improve stealth, allow better reconfigurability, decrease maintenance, increase payload capability or speed, or improve fuel efficiency. However, one serious concern is the reliability of these new uses of the materials under operating conditions such as fire. This program seeks to improve the ability to predict the residual structural integrity of structures using these non-traditional materials during and after a damaging fire.

DESCRIPTION: This solicitation is calling for software to improve prediction capability in one, or several, of the following areas, or in their integration:

1. Integration of fire growth, persistence, and spread, including flame, smoke, thermal initiation, propagation, and extinction, with structural properties,
2. Structural integrity during and after fire, including strength reduction, loss of stiffness due to softening, and failures due to strain and fracture,
3. Material properties, including effects of chemical interactions, variation of thermal properties, charring, and off-gassing.

PHASE I: Based on experiment and analysis, develop the algorithms to be used, demonstrate them in a research code, prepare a software development plan, identify experimental data required to complete model development

PHASE II: Develop a software tool to model residual structural integrity of structures during and after a fire. This could include the entire event, or some aspect thereof, including fire growth and spread, convection, thermal conduction through the structure, the resulting changes in material properties, burning and off-gassing of the structure, softening, fracture, creep, charring. Particular interest is in composite materials, aluminum, and hybrid steel/composite structures. Acquire an initial data base. Evaluate the software tool against small and mid-scale data to be supplied by the government.

PHASE III: Prepare a user-friendly package with technical manuals that can be used by engineers in the naval, automotive, and aerospace industries. Expand the experimental data base. Complete validation for the specific sponsor area of interest.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The end product will be of value in commercial construction planning, for example analysis of stairwell placement to maximize escape time. There is also interest on behalf of commercial shipping.

REFERENCES:
1. Lattimer, B. Y. et. al.,"Thermal Properties of Composites for Heat Transfer Modeling During Fires," proceedings of SAMPE 04, 2004.

2. Asaro, R. J. et.al., "Rate Dependent Constitutive Modeling of Laminated FRP Composites Degraded by Fire," Composite Structures 68, no. 4 (May 2005)

3. “Modeling of Naval Composite Structures in Fire”, L. Couchman and A.P. Mouritz, editors, July, 2006

KEYWORDS: modeling and simulation, fire damage, composite structures, aluminum structures, structural integrity

N07-099 TITLE: Virtual Reality Training System Development Guidance Tool for Multimodal Information Fidelity Level Selection

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Deployable Virtual Training Environment (DVTE),

OBJECTIVE: To develop and validate a tool that guides virtual environment training system designers and integrators in the selection of the multimodal technology and fidelity level required to support training requirements.

DESCRIPTION: Virtual Environment (VE) Systems are becoming more and more prevalent in training both military and nonmilitary related tasks. Virtual training systems can be an effective means to train tasks that could prove to be too dangerous or costly to train in the real world, such as military operations or complex medical procedures. Despite this, there is a lack of guidance on how to build environments that best support training specific tasks. This results in an ever-increasing challenge for training designers to navigate the selection of technology components to provide visual, auditory, and haptic sensory cues. Technology selection is nontrivial, as empirical evidence indicates that the fidelity of these multimodal sensory cues has a significant impact on trainee performance and transfer of training (Stanney, Samman, Reeves, Hale, Buff, Bowers, Goldiez, Nicholson, & Lackey, 2003). For example, the fidelity of visual display systems may range from desktop monitor systems to fully immerse, high resolution head-mounted display (HMD) systems, all with varying degrees of impact on training. The level of audio fidelity that is to be integrated into a system could vary from no audio to the use of complex individually measured head-related transfer functions (HRTF) models to present 3D audio. Research suggests that spatialized audio can impact the sense of presence in the virtual environment (Hendrix, 1996, Blauert, 1997). It has also been shown that the quality of auditory display can have an effect the perceived quality of visual displays (Storms, 1998). Inclusion of haptic interaction with a visual display has shown improved individual task performance for object interaction (Richard, Burdea, Gomez, & Coiffet, 1994) and wayfinding (Insko, Meehan, Whitton, & Brooks, 2001), as well as enhanced performance in a shared VE (Basdogan, Ho, Srinivasan, & Slater, 2000). Feygin, Keehner and Tendick (2002) showed that haptic guidance improved timing performance regardless of whether or not vision was available during task performance. Haptics may also increase the fidelity of a VE system, which can enhance training transfer (Swezey & Llaneras, 1997).

While these findings suggest that it is critical to ensure training needs are supported with environmental cues and necessary fidelity levels (Milham, Hale, Stanney, Cohn, Darken, & Sullivan, 2004) there is often a tradeoff associated with doing so. As the fidelity of presentation increases, so do the cost, technical expertise required to run and support the system, development and configuration time, and the footprint required to accommodate the system hardware. For this reason, it is important that VE training system implementers integrate system components at the level of fidelity that gives them the most value for the task that they are training. To accomplish this, there is a need for a tool to guide designers on the fidelity level requirements and present trade-offs based on the task that is being trained and the requirements thereof.

PHASE I: Conduct initial research, develop guidelines, and design a methodology for choosing the optimal fidelity levels for each sensory modality of information presented in VE systems based on cost / benefit analysis (e. g., including training requirements, technology cost, training effectiveness ratio). This tradeoff matrix should be based on comprehensive review of DoD wide training system effectiveness as well as state of the art assessment.

PHASE II: Develop a prototype interactive computer-based system to drive the design of training systems based on the guidelines established in Phase I. Software architecture should enable users to enter desired parameters and view selection of recommended technology components together with predicted impact on critical performance parameters. Validate the prototype through empirical assessments with targeted user community.

PHASE III: Produce the final version of the tool and use it to evaluate a current military VR system and guide the design of a VE training system. Market the use of the tool to other sectors that use VE training.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system will have widespread applications to military, government, and private sector organizations in that it will support the development of VE training systems with reduced development lifecycle time/costs. This could be applied to VE training systems used by law enforcement, fire fighting, medical responders, etc.

REFERENCES:
1. Basdogan, C., Ho, C, Srinivasan, M.A., & Slater, M. (2000). An experimental study on the role of touch in shared virtual environments. ACM Transactions on Computer-Human Interaction, 7(4), 443-460.

2. Blauert, J. (1997). Spatial Hearing: The Psychoacoustics of Human Sound Localization. MIT Press, revised ed., 1997.

3. Feygin, D., Keehner, M., & Tendick, F. (2002). Haptic guidance: experimental evaluation of a haptic training method for a perceptual motor skill. Proceedings of the 10th International Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (Haptics 2002), Orlando, FL, 40-47, March 2002.

4. Hendrix, C. and Barfield, W. (1996). "The sense of presence in auditory virtual environments." Presence 5(3): 290-301.

5. Insko, B., Meehan, M., Whitton, M., & Brooks Jr., F.P. (2001). Passive Haptics Significantly Enhances Virtual Environments. Presence Workshop 2001.

6. Richard, P., Burdea, G., Gomez, D., & Coiffet, P. (1994). A comparison of haptic, visual and auditive force feedback for deformable virtual objects. In Proceedings of ICAT'94 Conference (pp. 49-62). Tokyo, Japan.

7. Storms, R. L. (1998). Auditory-visual cross-modal perception phenomena. Unpublished doctoral dissertation, Naval Post- graduate School, Monterey, California.

8. Swezey, R. W., and Llaneras, R. E. (1997). Models in training and instruction. In G. Salvendy (Ed.), Handbook of Human Factors and Ergonomics (2nd edition, pp. 514-577). New York: Wiley.

KEYWORDS: VE training system, development lifecycle, system design and development, human system integration (HSI)

N07-100 TITLE: Shipboard Laser Detection

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS 480 Anti-Terrorism Afloat

OBJECTIVE: Establish approaches to provide a laser warning sensor using atmospheric scattering for shipboard self-protection with broad wavelength coverage and reduced size and weight to existing systems.

DESCRIPTION: Naval vessels in port or operating close to shore can be threatened by rocket propelled munitions, mortars, or artillery systems that incorporate laser targeting systems (or target designators). The use of laser warning receivers (LWR) which can provide precise pointing to the illuminating laser source can enable valuable situation awareness and targeting for counterfire to protect the threatened platform. Traditional pulsed LWR systems rely on main beam or port scatter from the laser source. Large ships or groups of ships would require numerous such LWR sensors for full ship or group coverage. The feasibility of using atmospheric scattering of lasers as a detection signature has been demonstrated by the Office of Naval Research (ONR) to provide pointing directions back to the laser source. The use of atmospheric scattering minimizes the necessity of multiple sensors for full ship or group coverage. The current system design, however, is too large and bulky (> 1 cubic foot and 50 pounds per 90-degree sensor unit) to be useful on small platforms and has wavelength coverage only into the near infrared (to around 1.1 micrometers), which excludes current eye-safe laser rangefinders operating in the short-wave infrared (around 1.55 micrometers). Investigations of new technologies that could reduce the size and weight of the system and extend the wavelength coverage would significantly enhance shipboard self defense capabilities. Responders shall propose to develop and demonstrate a sensor system that will detect the atmospheric scattering of laser radiation over a field-of-view (FOV) of at least 90-degrees, expandable to full 360-degree coverage. The proposed system shall be sensitive to lasers operating at visible, near infrared, and shortwave infrared wavelengths out to at least 1.6 micrometers and be able to determine the azimuth angle of the laser source to 3-degrees accuracy or better. The proposed system should meet the requirements for a laser warning receiver, as outlined above, suitable for use in a shipboard environment. Performance, false alarm mitigation, ruggedization, and cost should be addressed.

PHASE I: Investigate candidate technologies and explore concepts to reduce the size/weight and extend wavelength coverage to include eye-safe rangefinders for laser warning systems using atmospheric scattering. Trade-off studies will outline technologies, capabilities and design approaches. Development of a technical plan will be developed recommending specific design approaches.

PHASE II: Optimization of Phase I design selected. Construct a prototype to prove feasibility. Perform laboratory and possible Government-sponsored field tests to demonstrate the effectiveness of the prototype. The final system evaluation report should address deficiencies and recommendations to further improve performance and size reduction. Note: the Phase II development plan will be reviewed to determine if it is necessary to classify certain operational or performance specifications of the developed system.

PHASE III: Optimize Phase II design and implement in prototype. Demonstrate the optimized system by participating in military and commercial field tests. Use successful demonstration test data to define the requirements for future implementation of this technology. Formulate plan for the engineering development of the concept, including integration with existing and new naval platforms. Note: the Phase III development plan will be reviewed to determine if it is necessary to classify certain operational or performance specifications of the developed system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial benefits of the technologies may include commercial shipping protection as well as harbor defense and port security. The development of high sensitivity laser sensing technologies would also benefit open-air laser-based communications systems that can operate at much higher bit rates and over much broader bandwidths than conventional radio-frequency (RF)-based systems, but are currently limited to strictly line-of-sight installations.

REFERENCES:
1. The ONR funded Shipboard Laser Acquisition System (SBLAS) project demonstrated the ability to detect emissions from typical tactical military laser designators and rangefinders using atmospheric scattering in a maritime environment and localize the bearing angle to the laser source to within a few degrees accuracy. While some details of this project and the performance of the demonstration system are classified, the general statement of work and overall goals of the effort can be obtained by referencing Contract N66001-99-C-0031 awarded by the Space and Naval Warfare (SPAWAR) Systems Center, San Diego, in 1999 to Goodrich Corporation, Optical and Space Systems Division, Danbury, CT.

2. A very good technical overview of laser warning systems, including the relative contributions from direct and scattered radiation, can be found in "The Infrared and Electro-Optical Systems Handbook, Volume 7 - Countermeasure Systems," David H. Pollock (editor), SPIE Optical Engineering Press 1993, pp. 109-148.

KEYWORDS: laser warning, atmospheric scattering, optical sensors, optical sources

N07-101 TITLE: <u>Microfabricated Circuits for Sheet Electron Beam Amplifiers in the Upper Millimeter-Wave Spectrum</u>

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Compact radio frequency (RF) power generation in the upper millimeter-wave spectrum (140 – 300 GHz) can support transformational military capabilities including secure high-data-rate communication links, high-resolution radar, electronic attack, pass-through imaging, and chemical/biological detection.   Vacuum electronic amplifiers based on sheet electron beam (or planar multiple-beam) technology have the potential to generate the RF power (up to tens of watts continuous-wave) necessary to meet the needs of these applications. The goal of this research program is to (i) develop electrodynamic circuit designs that can stably and efficiently interact with sheet electron beams; (ii) explore techniques to produce precision structures in quantity with high-yield and low-cost; and (iii) demonstrate the effectiveness of the manufactured circuits through cold-test measurements.

DESCRIPTION: The principal goals of the project are the design of novel slow-wave electrodynamic structures capable of efficient beam-wave interaction with sheet electron beams (or a planar array of multiple round-beams) and the development and demonstration of high-yield fabrication techniques to produce these structures. Both narrowband (1-2% 1-dB bandwidth) and broadband (>6% 1-dB bandwidth) circuits should be investigated. Potential circuit topologies include (but are not limited to) topologies that could support standing waves and/or traveling waves. Successful designs should operate in the 200 – 300 GHz frequency range and be capable generating up to 10 Watts (CW) of RF power. Fundamental-frequency as well as frequency-multiplying concepts are of interest. Circuit fabrication techniques should take advantage of recent advances in micro-fabrication technology that lend themselves to mass production, high yield, and low cost. These techniques include (but are not limited to) electric discharge machining (EDM), deep reactive ion etching (DRIE), Micro-Electro-Mechanical Systems (MEMS) processing, and LIGA (lithography, electroplating, and molding), as well as selected meso-fabrication techniques (high-speed spindle Computer Numerical Control (CNC) machining, wafer slitting sawing, laser machining). Successful circuit designs will be manufactured using the appropriate micro-fabrication method and experimentally demonstrated through electromagnetic cold-test measurements.

PHASE I: Complete initial electromagnetic designs of sheet beam (or planar multiple-beam) compatible circuits. A variety of electrodynamic structure designs that explore the gain-bandwidth parameter space should be investigated. Identify potential fabrication techniques/manufacturers and develop fabrication plans for the different circuits.

PHASE II: Using the results of Phase I, develop detailed structure designs for fabrication and testing. Designs should maximize the interaction impedance and address issues of mode competition; the stability of the designs with regard to excitation by parasitic modes should also be investigated. Fabricate the candidate interaction circuits, working with outside vendors to develop new or modified processes as necessary. Develop electromagnetic cold-test techniques and diagnostics to experimentally validate the fabricated structures.

PHASE III: Using the results of Phase II, develop designs for a complete vacuum electronic sheet beam amplifier. Develop plans for high-yield, cost-effective production systems for the proposed applications. Transition to commercial markets and non-SBIR funded programs through the sale of derivative proof of concept units to private corporations and government agencies who own, operate or maintain the system for the proposed application.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications of this technology include medical imaging, analytic spectroscopy, and remote sensing.

REFERENCES:
1. Glenn R. Schetrum "Microfabricated MVED", in Modern Microwave and Millimeter-Wave Power Electronics, Edited by Robert Barker, John Booske, Neville Luhmann, Jr., Gregory Nusinovich, IEEE Press, Wiley-Interscience, 2005

2. James Dayton and G.T. Mearini, "Diamond-Based Sub Millimeter Backward Wave Oscillator", 5th IEEE Int. Vacuum Electronics Conference, April 27-29, 2004, Monterey, CA

3. R. Lawrence Ives "Microfabrication of High-Frequency Vacuum Electron Devices", IEEE Transactions on Plasma Science, 33, #3, pp. 1277, 2004

KEYWORDS: Sheet electron beam, planar multiple electron beams, micro-fabrication, meso-fabrication, micro-fabricated planar circuit, THz vacuum electronics.

N07-102 TITLE: Finding Repetitive Crime Supporting Structures (Building Intent)

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: Intelligence Analysis System, ACAT IV, PM Intel, Marine Corps Systems Comma

OBJECTIVE: The building intent topic will develop an analysis capability to generate inferences concerning the location of man-made structures that support the continuation of serial crime in an area. Inference development will use available data on the locations of past events, geographic information and any additional available data about facilities in the area of interest. Predictions will be based on decision models that assume that the criminal is optimizing a utility function when selecting both supporting facilities and attack locations. The capability to be developed is relevant to the Global War on Terror (finding safe houses, weapons caches, etc.) as well as to serial crime such as drug dealing.

DESCRIPTION: In support of repetitive crime, such as the insurgent attacks associated with the war on terror, responsible hostile actors need to leverage supporting facilities. To sustain their hostile behavior bad actors (insurgents, serial killers, drug dealers, etc.) need places from which they can train, plan, store material or simply sleep. The urban clutter affords considerable concealment for the actors that we must be capture. The ease with which their supporting facilities can blend into the clutter further complicates the task of finding civilian distributed hostile networks. Novel capabilities are needed to aggregate and classify facilities, develop facility network diagrams and ontologies that relate details about a facility (e.g. location, size, floor plans, intended use, references in human intelligence or open source data, etc.) to hostile actions via the decision preference factors of the hostile actors. A facility network diagram, for example, would connect facilities used to plan with facilities used to store to facilities used for temporary housing. Facility classification should be based on both geographic profiling and a developed understanding of what building features make the best supporting facilities to a reasoning hostile actor. The analysis engine that results from this effort will be dynamic, allowing new data sources to be continuously used to improve predictions and detect changes in past patterns. The Building Intent project will provide near real time data prediction tools that will aid in shutting down facilities that support repetitive hostile action.

The challenges in this project revolve around the following:

- Formulating a group of topographically specific data sets that will be required for geographical profiling within various urban environments.
- Formulating data layers on other facility characteristics of interest (e.g. size, floor plan, intended use, references in human intelligence or open source data etc.)
- Developing facility aggregation and classification algorithms
- Developing a capability to derive facility network diagrams
- Development of an ontology based decision model that enables the locations of supporting facilities to be inferred based on a causal understanding.
- Defining a method for assigning a measure of strength for all predictions.
- Creating algorithms that can learn form previous predictions and/or regional differences in insurgent tactics, techniques and procedures

PHASE I: Conduct research to evaluate the viability of finding facilities that support repeated hostile action in an urban environment. Identify good data sets that can be used for algorithm verification. Develop algorithms that can predict the location of supporting facilities from observations of hostile actions, detailed geographic data and detailed information about facilities in the area of interest. Develop an approach to handle regional differences and dynamic predictive model updates. Submit a report covering the approach, design and results.

PHASE II: Develop a working prototype for the phase 1 capability and demonstrate its capability against a relevant data set. Extend the capability of the prototype to include the generation of a causal ontology and network facility diagrams. Deliver and demonstrate the working prototype. Deliver a final report documenting the performance and capability.

PHASE III: Demonstrate that the products developed under phase I and II can be applied to civilian serial crime. Provide Building Intent documents and prototypes to many DoD and contractor test facilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Topic has direct relevance to civilian law enforcement in that it will develop a more accurate serial crime prediction capability. The offeror will fuse geographic profiling with other available information to increase the accuracy in the resulting prediction.

REFERENCES:

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http://72.14.203.104/search?q=cache:8tmS4lqhY3YJ:les.man.ac.uk/dass/hfc/NCIS/krossmo.doc+Kim+Rossmo&hl=en&gl=us&ct=clnk&cd=4

KEYWORDS: Profiling, Insurgents, IED, Networking, Space-time predictive analysis, geographic profiling

N07-103 TITLE: Submarine UHF SATCOM (25 kHz CPM) Narrowband Interference and Multipath Mitigation with Nonlinear Adaptive Filtering

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

ACQUISITION PROGRAM: PMW 770 - Common Submarine Room, ACAT II

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OBJECTIVE: Develop nonlinear adaptive filtering to mitigate effects of narrowband interference and multipath to increase the effective number of available UHF SATCOM channels available to warfighters and maximize the data rate achieved in real-life environmental conditions.

DESCRIPTION: UHF SATCOM links are vulnerable due to narrowband interference and there is a critical need to develop capabilities to mitigate interference from the UHF communications channels due to distortion of the communication signals of interest. In addition to narrowband interference, submarines, Unmanned Undersea Vehicles (UUVs), and other platforms experience high degrees of multipath distortion when using UHF SATCOM due to the effects of the ocean's surface. For example, with Submarine UHF SATCOM, 56 kbps is the objective Submarine UHF requirement for MIL-STD 188-181B (CPM) waveform specification, but this objective is not typically achievable due to the combined effects of interference and distortion. Initial success has been achieved with the use of nonlinear adaptive filtering algorithms for CW interference contaminated 5 kHz DAMA modes. This development needs to continue for the higher data rate 25 kHz CPM CW waveforms, and the capability needs to be fielded in hardware that can interface with Navy radio rooms, both afloat and submarine. Although UHF SATCOM is a high priority communications system, note that the development of CW narrowband interference and multipath mitigation is scalable to all SATCOM frequencies, waveforms, and radios of interest.

PHASE I: Develop and demonstrate prototype nonlinear adaptive filtering algorithms for 25 kHz CPM MIL-STD 188-181B signals that are contaminated with CW and narrowband interference and multipath distortion.

PHASE II: Develop and fabricate prototype hardware that can interface with current Navy radio rooms. Demonstrate performance improvements in the SPAWAR JCIF laboratory for realistic test signals. Extend interference mitigation capabilities to time varying interference classes such as an FM chirped interference.

PHASE III: Transition this filter technology to a hardware configuration that is suitable for permanent integration in Navy radio rooms and evaluate performance of the Engineering Development Model hardware in an operational environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This nonlinear filtering hardware would be useful for commercial SATCOM applications also.

REFERENCES:
1. J.C. Allen, R.E. Goshorn,,B,J. Zeidler, and A.A. Beex, “Sea Surface Specular Multipath for Surface-Level Antennas: Phase 1”, SSC San Diego Technical Report 1924, June 2005.

2. A. A. (Louis) Beex and J. R. Zeidler, Steady-State Dynamic Weight Behavior in (N) LMS Adaptive Filters, pp. 335-444. New York, NY: John Wiley, 2003. Eds. S. Haykin and B. Widrow. (ISBN: 0-471-21570-8).

KEYWORDS: Satellite Communications, CW Narrowband Interference, Interference Mitigation, Multipath Distortion, Channel Equalization, Tactical Communications

N07-104 TITLE: Advanced Materials for Submarine Antenna Radomes

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: ACAT III Submarine High Data Rate Antenna or OE-538

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

OBJECTIVE: The objective is to investigate advanced materials for submarine antenna radomes with high reliability, and favorable mechanical and electrical properties that may allow thinner diameter, low cost, and low weight radome development.

DESCRIPTION: The undersea submarine environment is harsh, subjecting antenna radomes to significant pressure, hydrodynamic and corrosive forces and elements. The development of advanced materials for radomes that would allow the following characteristics would be useful:

(1) thinner diameter thereby allowing optimization of maximum antenna aperture
(2) mechanically strong to withstand the forces listed above
(3) electrically optimized such that attenuation of RF energy is minimized
(4) allow for embedded sensors/systems such as frequency selected surfaces and/or conformal antennas
(5) optimized shaping for hydrodynamics, minimizing mast wake.
(6) design should minimize RCS, IR and visual signatures.

PHASE I: Investigate advanced materials that are suitable for submarine applications. Demonstrate potential effectiveness of candidate technologies through modeling and analysis. Demonstration shall be performed for a specified mast application.

PHASE II: Fabricate material samples and demonstrate performance of candidate materials through test and evaluation in a laboratory environment.

PHASE III: Fabricate a submarine mast mock-up with the advanced materials for test and evaluation at electromagnetic ranges and dynamic/hydrodynamic facilities. Testing of the product will be conducted and benefit will be proven on both existing submarine masts and on future conceptual submarine mast mock ups

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The main commercial potential for this development will be for the sale and implementation to the U.S. Navy submarine fleet with potential for military sales to U.S. allied foreign Navies. There may also be potential for applications across other DoD activities such as Air Force where many of the desired attributes listed above would be useful.

REFERENCES:

1. The Handbook of Antenna Design, Vol. 2. A. W. Rudge (Editor), A. David Olver (Editor), K. Milne (Editor), P. Knight (Editor). Institution of Electrical Engineers.

2. Antenna Engineering Handbook. Richard C. Johnson, Henry Jasik (Editor) McGraw-Hill Companies, The.

KEYWORDS: Submarine; Advanced Materials; Signature Reduction; InfraRed; Visual Suppression; Stealth Technology; Radar Cross Section

N07-105 TITLE: Multi-Enclave Federation and Management of Universal Description Discovery and Integration (UDDI) Service Registry

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Integrated Shipboard Networking Systems (ISNS) ACAT I

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

OBJECTIVE: Develop enhancements to existing UDDI V3 standards and/or extensions to COTs products to support the Navy’s requirement to federate multiple registries in its unique low bandwidth and disconnected environment.

DESCRIPTION: Current COTS UDDI vendors do not support Dynamic Federation of Registries in the Navy’s unique distributed, disconnected, and low limit bandwidth environment. Furthermore, there is also a need for SOA Policy Enforcement and Policy Administration Management Services across the federated UDDI registries, to fulfill governance, security and information assurance requirements.

PHASE I: Investigate the feasibility to enhance the current UDDI V3 standards, architectural recommendations, and/or extensions to existing UDDI products and SOA Policy Management Services to support federation requirements between afloat and ashore networks

PHASE II: Develop, integrate and test a prototype system based on the recommendation provided in Phase I. Provide Technology Demonstration of the prototype system

PHASE III: Products/Capabilities derived as a result of positive Phase II demonstration, will be incorporated as capabilities into the CANES Increment 1 (ISNS Increment III) POR. These capabilities will be documented incorporated in the CANES Increment 1 CPD and other relevant acquisition documents, in support of development, integration, testing, deployment and support.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Enhanced next generation UDDI standard to include the Dynamic Federation capability and disconnect/low bandwidth strategies.

REFERENCES:

1. UDDI Registry Version 3.0

2. All other relevant Industry Standards referenced in the Net-Centric Enterprise Solutions for Interoperability (NESI) Guidance.

KEYWORDS: Discovery; Federation; UDDI; Policy Mgt; Enforcement; Disconnect Operations

N07-106 TITLE: A Reconfigurable Wireless Ad Hoc Networks Architecture for Quality of Service Support

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: FORCEnet: Spans several programs within FORCEnet.

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

OBJECTIVE: This project proposes to develop a novel self-reconfigurable MANET architecture that will provide QoS-based support for C2 missions. For this purpose, research will be pursued for designing an intelligent mobile agent technology capable of supporting efficient network resource management and adaptive routing protocols.

DESCRIPTION: Design and develop a highly configurable and scalable mobile ad hoc networking (MANET) architecture that will support end-to-end quality-of-service (QoS) based multimedia information flow including voice, video, images and text data. The proposed architecture will support guaranteed QoS in the presence of multiple network constraints such as reliability, bandwidth, mobility and limited battery power. The agent-based technology can provide efficient and real-time support through network programmability, a feature needed for managing complex configuration of MANET. A prototype will be developed to carry out detailed performance and trade off analysis.

PHASE I: Develop a highly adaptive mobility-based framework to support self-configurability and QoS-based routing for MANET, addressing the multiple routing strategies needed to act cooperatively in the network. However, this raises the question as to what those strategies should be, and how to effectively toggle among them.
In particular, specific technical objectives for Phase I are as follows:

1. Develop an agent-based high level models that incorporate E2E QoS requirements for missions critical applications.
2. Develop efficient distributed algorithms for discovery and clustering of network nodes and servers that can collectively provide an adaptive and reconfigurable architecture to ensure E2E QoS guarantees. The key criteria for clustering is based on the task to be performed and the underlying QoS-aware routing protocol. Such a protocol will use key link-state information; specification for the use of state augmentation techniques for handling nomadicity of users and devices as seamlessly as possible;
3. Define performance metrics and develop a prototype (optional) to analyze the trade-off among aforementioned protocols. The prototype will be built upon the PlanetLab kernel [Pla], a tool that provides powerful capabilities for emulating large scale network systems, including MANETs.

PHASE II: The proposed PHASE I will be developed into extensive MANET architecture. The development of that MANET architecture makes up the proposed work in Phase II. The prototype will allow automated dependency and dynamic execution analysis between a MANET architecture and numerous other QoS-based defense applications. In particular, agent-based programmable technology can be used to re-specify, re-generate, re-evaluate, re-verify, and re-test the MANET architecture with other GIG components as needed. Currently, such updates require significant cost and effort to make the overall specification of C2 mission models consistent.

Conduct detailed experimental evaluation of multi-agent technology for numerous C2 scenarios to provide a comprehensive understanding of the technical for supporting E2E QoS guarantees in a MANET environment. In particular, investigate the scalability of the research to understand the effectiveness of MANET architecture for C2 missions in regions with varying sizes and terrains.

PHASE III: Once the MANET architecture is prototyped in Phase II it will be deployed for mission oriented applications. In particular it will be integrated within GIG architecture. The agent technology developed at the highest level will provide implementation support for a range of mission oriented applications within the GIG framework.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: With the growing capabilities of PDAs (such as the upcoming Microsoft's Portable Media Centers that can play video, music and photos) and the proliferation of mobile Web services, deployment of agent-based mobile ad hoc network is expected to be the next wave of networking revolution. An efficient and cost-effective wireless alternate for high-speed network has long been an elusive goal. Although service provider usage for back haul applications has increased over time, high product and operational costs, coupled with limited interoperability, have impeded the growth of fixed broadband networking technology in local-loop and last mile applications. However, interest in alternate technology for reaching businesses and consumers remains strong. The mobile ad hoc networking technology is expected fulfill this goal.

In addition to defense applications, HASI has identified several other key sectors that provide tremendous opportunities for ad hoc networking technology solutions developed in this project. The notable sectors include mobile health care systems, mobile workforce and enterprises, intelligent transportation systems networks developed for regional Departments of Transportation. Another key market is homeland security that is happening right now.

In addition, techniques developed in this project will be presented at different forums, including the Wi-Fi/WiMAX Forum promoting the IEEE 802.16 series of standards for broadband wireless.

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4. [Baq96a] S. Baqai, M. Woo, and A. Ghafoor, "Network Resource Management for Enterprise-Wide Multimedia Services", IEEE Communication. Magazine., Jan 1996, pp. 78-85.

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KEYWORDS: MANET;Mobile;Network;Architecture;Ad-Hoc;GIG

N07-107 TITLE: HSI Issues in Composable Information & Service Environments

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: ACAT-N/A

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

OBJECTIVE: The objective of this effort is to improve the utility and usability of available information and services via compensability of user interface/displays. Cognitive and situational factors, affecting the user’s operational situation, will drive open, standards-based implementation technologies in accordance with defined composability guidelines in either a manual (adaptable) or automated (adaptive) fashion

DESCRIPTION: Network-centric applications such as the GIG, NCES, and FORCEnet, proved DOD with an opportunity to improve speed of command and mission effectiveness by increasing access to information via adaptive, web-enabled technologies. Systems such as TFW/NMCP, GCCS enhancements and Sea Warrior/NKO accelerate warfighters’ access to an increasingly wide range of information. Moreover, these technologies are evolving toward composable displays that give users the flexibility to configure their information environment in virtually limitless ways to suit their needs.

While this flexibility and range can provide substantial help for operational users, the Human Systems Integration (HSI) effects of composability are not yet well understood. In some cases, composability may be necessary for the operational situation and can be employed effectively by the users. In other cases, however, composability may become a source of confusion and frustration, causing users to abandon the system and revert to previous ways of accessing information. To a large degree, the difference between successful and unsuccessful implementation depends on how well cognitive and situational factors are integrated with technical capabilities. For example, TTP's, default settings, portal templates, and job aids have been used to help busy or novice users find an appropriate way to structure their information environment.

HSI related research and development is needed in order to identify design guidelines for interface composability and to drive the implementation technologies necessary for deployment in open, industry-standard ways. This is a time-critical need that will provide substantial benefit to network centric warfare and homeland security system developers and to operational users as a way to optimize the interface design of web-enabled technologies.

Composability may be defined as the capability to select and assemble information components (services and sources) in various combinations to form unique knowledge management systems and combinations to satisfy specific user requirements. Composability may be horizontal or vertical. Horizontal composability involves the combination of various information sources that are considered relevant to a particular task or problem. Vertical composability involves the abstraction of information for aggregation/disaggregation as necessary to communicate across multiple echelons. Petty (Petty, M.D., 2004) notes the distinction between syntactic and semantic forms of composability. Syntactic composability deals with the technical aspects of enabling information components to work together. Semantic composability concerns the degree to which the combined information is meaningful and useful. These latter issues interact most directly with HSI.

Cognitive and situational factors determine the extent to which the users' composable information environment should be structured or flexible. "Operational Focus" factors range from tactical to operational to strategic. Greater interface flexibility is needed at the strategic end because of the broader scope inherent. "Nature of Work" factors consider how structured or predictable the situation is. Highly structured tasks, such as strike planning, are well-understood and often specified in doctrine or SOPs. Unstructured tasks, such as responses to potential terrostit activities are more unique, requiring substantial flexibility. "Workload/Time Stress" factors range from high to low. Under high workload, human operators and decision makers need a much simpler and constrained information environment than when they are less stressed and have time to explore options. Other factors include the size of the team and the extent to which they are involved in a collaborative task, the level of experience.

By understanding the cognitive and situational factors, and interactions between the various factors, the appropriate properties of the composable information environment can be defined.

This effort should be built upon the human factors and computer science technical literature as well as related developments by others in order to produce a model and design guidelines. Specific solutions will be developed and tested with selected GIG-NCES-FORCEnet systems. This will provide a validated design guideline with specific examples that can be used by all network-centric warfare and homeland security program offices. HSI related design derived from potential benefits and drawbacks of composable information environments will need to be identified, investigated, and resolved.

In developing an appropriate level of composability, a range of interface design options should be addressed. At the most constrained level, users would have a fixed, structured, information environment. At the other extreme, users would be able to construct their unique information environment—much like building a website. In between these extremes, users would be able to select among several display templates, to customize the arrangement of information on their displays, and to tailor their information environment to the task demands.

Various techniques (such as net flow analysis and task decomposition/analysis), should be investigated to monitor and analyze the dynamics of task and situation. Web service-centric models (such as, the Web Services Experience Language (WSXL) and associated components) with a focus on providing a user experience across the network for representing data, presentation, and control, defining and executing user interface behavior and navigation, and modifying, adapting, coordinating, or integrating the user's experiences and control should be thoroughly explored and incorporated in the system's design.

PHASE I: • Review human-computer interface and computer science literature to identify key issues, design approaches, and tradeoff functions concerning composable information environments.

• Develop a model of composable information environments based on cognitive and situational factors. Develop a range of composable interfaces in accordance with the model

• Develop “best-fit” and “worst-fit” designs of composable information environments for a selected GIG-NCES-FORCEnet system. Collect utility and usability data from operational users to determine the impact of HSI guidelines.

PHASE II: • Develop and implement an appropriate composable information environment for a selected GIG-NCES-FORCEnet system. Conduct research to collect outcome measures (mission effectiveness, human performance) in a controlled exercise environment.

• Explore technical approaches for adaptive composability that alter the interface properties based on dynamic conditions of task and situation

• Develop and implement adaptive information environments for horizontal composability as a method for accessing task-relevant information

PHASE III: • Develop and implement multi-echelon (vertical) composability as a method for transferring commander’s guidance and status reports.

• Test composable information environments with selected GCCS-NCES-FORCEnet systems in an exercise environment

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Composability and its effect upon the human as defined here for the net-centric warfighter, is of equal concern to the net-centric first responder and the net-centric enterprise. Today’s public safety, emergency management and homeland security professionals as well as Fortune 1000 companies increasingly deal with information overload, new types of threats/competition and complex fields of engagement/markets while attempting to achieve a shared situational awareness/understanding while making critical decisions under a high degree of uncertainty.

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KEYWORDS: human systems engineering, human factors, services oriented architecture, semantic integration

N07-108 TITLE: Prognostics and Health Management (PHM) for Afloat Information Technology (IT) and Network Services

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Electronics

ACQUISITION PROGRAM: PEO C4I & Space (PMW 160) - Integrated Shipboard Network System

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OBJECTIVE: Develop and demonstrate advanced PHM capabilities for enterprise afloat IT/networks.

DESCRIPTION: Key to accomplishing PHM for IT/networks is being able to understand fault-to-failure progression characteristics for the component and/or subsystems and having realistic and verifiable prognostic capabilities in critical network components. This effort will develop, demonstrate, and apply advanced PHM capabilities in support of afloat IT/networks and their component elements and services. This is a difficult task because of the large amount and variability of IT/network/services components, multiple sustainment provider organizations and the plethora of individual networks and systems in operation; thus innovative approaches, models, and methodologies will be required.

The afloat IT/networks services environment needs a robust, comprehensive, and highly integrated PHM capability across all networks/systems. This enterprise remote/automated 3M/ILS/LCS support concept, which we have initially termed PAMS or Predictive and Automated Maintenance System, would provide PHM status assessments, diagnostics and contingency planning information for networks, systems and subsystem operating in dynamic operating environments. These tools sets and associated techniques would provide on-line, real-time health status assessments and diagnostic fault detect/fault isolation capabilities. These dynamic capabilities, techniques and tools sets should also be able to relate to and enhance maintenance decision support, configuration management and contingency planning concepts.

PHASE I: Determine the feasibility of structuring an innovative and advanced PHM maintenance support concept supported by additional tool sets for 3M/ILS/LCS capabilities. Assess and evaluate the various commercial PHM best practices to migrate enterprise best value capabilities therein to the military network services environment using these advanced capabilities, tool sets, techniques, methodologies, and approaches. Develop a strategy for integrating the advanced capabilities, tool sets, and PHM components into the general afloat IT/network environment and specifically the ISNS/CANES programs architecture (leveraging the PAMS concept).

PHASE II: Develop, validate, and deliver a complete set of PHM applications and techniques to be used on different networks/systems and components therein. Provide software programs, tools, and procedures for integrating these capabilities within the general afloat IT/network environment and specifically the ISNS/CANES programs.

PHASE III: Integrate these capabilities within a comprehensive program for certification, verification and validation of all PHM system capabilities for the ISNS/CANES application.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Any results (understanding) gained from applying these PHM techniques and would provide a significant crossover benefit to other similar commercial or military applications.

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2. NDIA Electronics Prognostics White paper.

3. Draft CANES CPD (Consolidated Afloat Networks and Enterprise Services)

KEYWORDS: Prognostics; Health Management; CBM; R-TOC; FORCEnet; Maintenance

N07-109 TITLE: <u>Interpolation Techniques with Minimal Data Density Analysis for Seafloor and Sub-seafloor Characteristics</u>

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

ACQUISITION PROGRAM: PEOC4I&Space PMW180 Littoral Battlespace Sensing, Fusion & Integration ACAT

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

OBJECTIVE: Develop minimum data density technique and interpolation algorithms that will provide the fleet with high quality seafloor and sub-seafloor information without having to obtain unrealistic percentages of data coverage in the areas of interest. Integrate the techniques and algorithms into a system that would automatically analysis, and interpolate a huge volume of Geospatial Information & Services (GI&S) survey data from in-situ sensors of various types into a coherent picture of the battlespace seafloor and sub-seafloor properties for real-time to near-real-time use by decision makers and tactical decision aids.

DESCRIPTION: Driven by national security interests, our Navy needs to operate in littoral regions around the world through the foreseeable future. Because of this, there is a need for Intelligence Preparation of the Environment (IPE) over littoral operating areas that can extend to hundreds of square nautical miles. To this end, the Navy has created the Littoral Battlespace Sensing, Fusion, and Integration (LBSF&I) program to acquire data in these regions of tactical interest.

Key properties of the environment in these regions that impacts the performance of acoustic systems, which are used in Anti-submarine and Mine warfare in remote littoral regions, are associated with the seafloor and sub-seafloor. The primary measurement and interpretation problem is to provide accurate information on properties such as geoacoustic and seabed roughness over large areas with minimum survey time. This would permit the Oceanographer of the Navy with a means to adequately characterize the environment with less than 100% data coverage using the available survey assets.   To implement this strategy, an accurate data interpolation and analysis scheme is required so that the principal character of the seafloor and/or sub-seafloor is well predicted in the data spare regions. One must optimize the survey strategy to seek satisfactorily low error on the interpolation for the least investment of resources.

The conditional simulation method provides an excellent example of a framework from which to consider the optimization problem. It seeks to interpolate data in such a way as to maintain the statistical fabric of the true structure. Such interpolations look very realistic - which is their strength - but can, in the absence of sufficient data conditions, be largely fictitious and unconstrained. For example, different simulations using the same data conditions but with different random number initial conditions can produce quite divergent results. However, a great advantage of maintaining true statistical character is that robust error analysis can be performed. In particular, error can be estimated at every location of the interpolation simply by generating a number of Monte Carlo conditional simulations and computing the standard deviation of the results. Errors may also be estimated through more sophisticated analytic methods. If the statistical structure of the bottom is well established, one can generate cost versus error trade-off curves using simulation methods. This value may provide our best trade-off between resources invested and interpolation error.

This approach is only provided as one of many possible ways to approach the problem. It has been provided as a means to demonstrate the characteristics desired in the analysis and interpolation system.

PHASE I: Propose a conceptual design, based a three dimension interpolation scheme that minimizes data sampling and work well with a mix of dense and spare data sets. This architecture must take into account the various confidence levels, the distribution characteristics of sampled data and provide for methodologies to develop advanced interpolation schemes and analysis methods to estimate errors in data spare regions for use by the Naval METOC Production Centers and forward deployed METOC elements that acquired seafloor information using tactical sensor systems.

PHASE II: Build and test the prototype data analysis and interpolation system. The critical initial step is to ascertain the statistical structure of the seafloor characteristic to be interpolated.   This should require the characterization of the covariance structure (or, equivalently, the power spectrum or variogram) in two dimensions, and the univariate probability density function. The test and evaluation phase of the effort should use appropriate datasets that reflect a two-stage field strategy: 1) first, a reconnaissance survey, using a small fraction of the available resources, to explore the structure of the data at the largest applicable scales and to estimate statistical properties, and then a comprehensive survey at the optimal data geometry, as established using a simulation strategy. Knowledge about the asymmetry of the statistical properties should be a significant factor in optimizing survey geometries. The prototype planning system must include Navy human system interface (HSI) considerations and contain easily readable/interpretable displays that facilitate the quality control process. Demonstrate the value of the proposed system with the use of performance metrics – e.g. the Interpolation and analysis process must be completed within tactical time constraints. Work with the METOC Production Centers to develop an acceptable concept of operation (CONOPS) for the interpolation capability and define logical needs within the constraints provided by the CONOPS and system requirements.

PHASE III: The Phase II prototype capability will be transitioned and integrated into the MIW Post mission Analysis System, LBSF&I program of record or provided to the Naval Oceanographic Office to support Reach-back Concept of Operations.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial potential of this SBIR effort is extensive. Some applications include commercial marine survey interpolation for use in commercial seafloor mapping, sub-seafloor interpolation of acoustic sub-bottom profiler data used in geotechnical studies and the oil industry.

REFERENCES:
1. Naval Transformation Roadmap 2003

2. "Geostatistics Modeling Spatial Uncertainty" by Jean-Paul Chiles and Pierre Delfiner 1999 Publ: John Wiley & Sons

3. "Simulation of Stratigraphic Architecture from Statistical and Geometrical Characterizations" by J. A. Goff in Mathematical Geology Vol. 32 No. 7 2000

KEYWORDS: Three Dimensional Data Interpolation, Error analysis, Seafloor, Sub-seafloor characteristics, statistical structure

N07-110 TITLE: Shipboard Wideband Collection Systems Using All-Digital State of the Art Receivers and Technology

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: PMW-180 / Ships Signal Exploitation Equipment Increment F / ACAT II

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

OBJECTIVE: To apply state-of-the-art cutting-edge digital technologies to improve shipboard wide-band receiver systems performances in high EMI (electromagnetic interference) environments.

DESCRIPTION: The current electromagnetic environment of Naval platforms is cluttered with transmitters that cover large portions of the EM (electromagnetic) spectrum. The large number of transmitters coupled with the high power levels cause harsh EMI that severely limits wide-band receiver systems operations without proper mitigation. The current state of the EMIenvironment pushes the limits of conventional technologies. These technologies, although adequate in the past, are quickly becoming limiting factors. As a result, critical shipboard functions such as signal acquisition and real-time direction finding (DF) are degraded well below specified requirements.

Advances in state-of-the-art digital technologies promise to provide fully operational shipboard ultrawideband receiver systems, not limited by EMI. These advances such as direct digital conversion have extended the ranges of key performance parameters (power tolerance, dynamic range, sensitivity, sample rates, etc) beyond conventional limits.

Current conventional wideband receiver systems employ multiple analog-to-digital converter (ADC) cards. Current state-of-the-art ADC cards require down conversion, which limits dynamic range and in current configuration require coherent coupling, which increases system complexity.

The goal of this work is to build a single unit multi-channel phase-coherent all-digital receiver system. This receiver will provide direct digitization of the RF spectrum to increase system dynamic range and to increase access to more of the RF spectrum. Reduction from the current multiple ADC system to a single unit all-digital receiver will not only save space but also improve performance and cost. As an integral part of the Naval platform wideband receiver system, the all-digital receiver will be NESI compliant and will interface to the required data formats.

PHASE I: Provide specifications and initial design for a single unit multi-channel phase-coherent directional all-digital receiver. The receiver will meet and exceed existing and future requirements of Naval platform wide-band receiver systems.

PHASE II: Build and deliver a prototype system outlined in Phase I. Perform laboratory and field testing. Field testing will be performed in an environment simulating conditions aboard Naval platforms including use of state-of-the art antennas.

PHASE III: Provide modifications to an existing wide-band receiver system for incorporation of the new multi-channel phase-coherent all-digital receiver. Provide continued testing in an actual platform environment using current and state-of-the-art antennas (such as the Tapered Slot Antenna (TSA) array). Provide plan for transition of technology into Naval operations.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: As wireless technology becomes more prevalent in society, directional accuracy will become more and more valued. Many devices in small areas will begin to demand distinction with the techniques expected to evolve here.

REFERENCES:
1. O.A. Mukanhov et al, "Superconducting Analog-to Digital Converters", Proc. IEEE, 92(10) pp. 1564-5.

2. J. Rosa, "Direct Digitization Using Superconducting Data Converters”, RF Design, March 2005, pp. 40-46.

KEYWORDS: high dynamic range; digital down conversion; DF accuracy; phase-coherent; wideband

N07-111 TITLE: Global Information Grid (GIG) Tactical Edge Networks (TEN)

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Integrated Shipboard Network System, Afloat Digital Network System ACAT IIs

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

OBJECTIVE: Expand the GIG TEN service efforts to improve situational awareness and Joint connectivity in the battlefield.

DESCRIPTION: Achieving a decisive military advantage through end-to-end communications and universal situational awareness is the idea behind net-centric operations. The Department of Defense's (DoDs) vision is to connect everyone in the field, from the commander to the warfighter, who operates along the "Tactical Edge." Achieving net-centricity depends on the supporting infrastructure of the DoD's GIG.

The GIG is a network of networks—a complex system that links hundreds of information system elements to enable the rapid exchange of information among the U.S. services, the Intelligence Community (IC), and multinational allies. The GIG involves more than just technology. Rather, it is a globally connected, end-to-end set of information capabilities, associated processes, and personnel for collecting, processing, storing, disseminating, and managing information on demand. It comprises most of the DoD's information systems, software, and services, and supports the DoD and IC in peace time and during conflicts.

With the abundance of non-compatible legacy radio systems, waveforms, and networking protocols in use, another major challenge in this environment is available bandwidth. In an office, workstations are supported with various Local Area Networks (LANs) (e.g., Ethernet) that connect to the Internet through high speed connections. Data rates are not a major issue. In the mobile environment, however, all communications require mobile wireless connections. Current DoD radios provide only limited data rates on the order of dial-up connections in the 1970s and 1980s—much less than in today's office environment. It's one thing to receive a text message—and even that is not guaranteed on the battlefield—but downloading photographs and maps cannot be accomplished in a reasonable time period. Additionally, as vehicles maneuver on the battlefield, wireless connections are continuously broken and re-established. This results in a very difficult application environment on the "Tactical Edge." Improved mechanisms and applications are required to better share and re-use available network connections.

TEN are a collection of communications nodes that provide direct connectivity for users executing tactical missions while also reaching back from the "Tactical Edge" into services that are provided by the rest of the GIG. TEN are envisioned to provide networked capabilities over the battlespace, to support a Mobile Ad Hoc Network (MANET) that enables Just In Time (JIT), netted connectivity with highly mobile and disadvantaged users; and to support a high bandwidth backbone service to interconnect larger Command and Control (C2) and Intelligence, Surveillance and Reconnaissance (ISR) nodes in the battlespace.

This solicitation seeks innovative software applications that will provide expansion of the GIG TEN services efforts to improve the Joint connectivity in the battlefield. The proposed product will shorten the kill chain, improve the Common Operational and Tactical Picture (COTP), and enhance decision making speed and quality.

This application must support one of the three proposed network types:

1. TEN-A
Very stable, low (tens of Kbps), medium (hundreds of Kpbs) and high data rate (up to hundreds of Mbps) Radio Frequency (RF) links based on very long duration (weeks, months) communications relays, including tactical intra-theater Satellite Communication (SATCOM).

2. TEN-B (backbone)
Stable, medium and high data rate RF links based on medium duration (hours, days) communications relays, including Line Of Sight (LOS) relays involving manned and unmanned aerial platforms.

3. TEN-M (MANET)
Rapidly changing low, medium, and high data rate RF links based on direct platform-to-platform communications, where both the physical proximity and composition of platforms in the network varies over time scales of minutes.

PHASE I: Investigate the feasibility of developing new applications and/or protocols to integrate data and voice sensors to align with the expansion of the GIG TEN services efforts, by improving Joint connectivity in the battlefield, improving the Common Operational Tactical Picture (COTP) and enhancing the speed and quality of these services for the Warfighter and Decision Makers. Develop a prototype of a web-based knowledge management technology for maintaining common situational awareness that instantiateds and demonstrates these technologies. Develop and write the initial Feasibility study.

PHASE II: Develop and demonstrate a prototype software application or protocol to integrate voice and data sensors into simulated U.S. Navy operational networks using either a TEN-A, TEN-B, or TEN-M network type. Define a design and demonstrate a simple prototype of the application with a simulated field unit and internet-connected client. Develop a functioning, web-based experimentation testbed of the technology for Joint Force mission planning and execution. Perform a Certification Test and Evaluation of the application in a laboratory environment.

PHASE III: Install and implement the application and/or protocol to integrate voice and data sensors into existing U.S. Navy operational networks using either a TEN-A, TEN-B, or TEN-M network types. Perform a Security Test and Evaluation (ST&E) of the functionality of voice and data sensors of the TEN network type into an existing Navy operational network. Transition the technology product developed in Phase III into an existing Navy Program of Record (PoR) system, e.g., Integrated Shipboard Network System (ISNS), Afloat Digital Network System (ADNS), or the Consolidated Afloat Network Enterprise Services (CANES).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology product could be applied to any Transport Control Protocol (TCP)/Internet Protocol (IP) network and significantly enhance the civil sector's emergency response to disasters.

REFERENCES:
1. "Tactical Edge Perspective"; Brian Clingerman, OPNAV N6FT

2. "Navy Transition: IPv6"; Mark Evans, Office of the Chief Engineer (SPAWAR San Diego), 20 October 2005

3. "How the Global Information Grid is Transforming Communications for the Warfighter"; Marc Richard and Dave Roth; MITRE publications. Fall 2005.

KEYWORDS: MANET, network, interoperability, GIG, net-centric, backbone, common operational picture, legacy radio, bandwidth, connectivity, COTP, ISNS, ANDS, CANES

N07-112 TITLE: Modeling and Simulation for Higher Fidelity of Commercial SATCOM Capability as a Design Aid to the Planning and Decision Making Process.

TECHNOLOGY AREAS: Information Systems, Battlespace

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

OBJECTIVE: To develop a toolset to model the effects of time-driven, scenario-specific deployment considerations of Satellite Communications (SATCOM) systems. The core of the model is to provide the military SATCOM community with the ability to examine the performance of a broad range of deployment options with respect to maximum achievable data rates for a given set of SATCOM terminals and show the effects of these SATCOM systems in the context of a warfighting scenario.

DESCRIPTION: The model must be capable of assessing the bandwidth performance of given sets of SATCOM terminals, or Terminal Fielding Plans, within different SATCOM resource allocation scenarios. Therefore the model must be able to simulate the performance of a variety of SATCOM terminals and satellite transponders under a number of different constraints, including power amplifier, antenna and modem parameters, as well as other considerations faced by the commercial sector.

The model must be linked to, and capable of maintaining a commercial database of available SATCOM resources. This includes available SATCOM terminals, the platforms on which terminals are deployed, available modems, available antennas, existing and proposed satellites, and the satellite payloads.

The SATCOM bandwidth model must interface directly with a mission/campaign level warfighting model that is capable of explicitly modeling communications and can show traceability of bandwidth constraints and bottlenecks to mission timelines overall warfighting effectiveness such as BLUE side platform losses and the rate of attrition of

RED side forces. The model interface must make use of open source input and output data formats such as the extensible markup language (XML).

The model toolset must have the capability to perform statistically significant bandwidth assessments of maximum achievable data rates for a given field plan under different system design configurations and must be able to run these in warfighting scenarios for Major Combat Operations (MCO).
The toolset must have a graphical user interface (GUI) to allow an analyst the capability of configuring terminal fielding plans, satellite configurations, and resource allocations.

PHASE I: Will include researching potential SATCOM bandwidth computational models and DoD approved warfighting models with a SATCOM component. The results of the research will be analyzed to determine a development approach for building a SATCOM bandwidth performance assessment model. The development approach will include a plan to integrate SATCOM bandwidth modeling capabilities with existing warfighting models.

PHASE II: Includes the development of a prototype system. The prototype will demonstrate system feasibility, sound conceptual design, database design, interface capability, and a practical implementation approach.

PHASE III: Will include the development of a modular, scalable, and reusable system. The main features of the system will include: a database of available SATCOM equipment and resources, the ability to quickly assess differing SATCOM scenarios, visualization of dynamic scenarios, automation capability, the ability to integrate with existing industry and military standard models, and an intuitive GUI interface. The system will be expandable to allow for easy integration of new features.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The resulting product would provide a valuable enhancement to several modeling and simulation environments for private defense industry, and other private sector companies whose products must show the value added of SATCOM networks.

REFERENCES:
1. CJCSI 3170.01E

2. SECNAVINST 5000.2C JCIDS

KEYWORDS: modeling; commercial; satellite; SATCOM; network; stochastic

N07-113 TITLE: <u>On the Edge: Hybridized Distributed Storage</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: DRPM & SPAWAR 05-5

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

OBJECTIVE: In order to efficiently use existing computer workstation storage hardware, and safely store data, a system must be devised for storing that data. As a proof of concept, this project aims to sketch such a system. The basic project would be to choose a method for redundantly storing the data, implement it, and implement a method for distributing and retrieving data. In essence, the objective here is to develop a hybridized client-server based distributed storage system, leveraging the vast research & myriad techniques developed for Peer-to-Peer (P2P) environments.

There are a number of key elements needed. One of the most important design issues is the method used for resource location of distributed on diverse peer workstations, & capable of adapting to a changing network topology.

This recognizes the futility of massive efforts to eliminate all but one copy of any given document & acknowledging the fruitfulness of the same document distributed naturally throughout the network, by the everyday workings of users on that network. But, what of the locations of these randomly scattered documents? We need here a technique for the retrieval from one's nearest neighbor (that is one of many that stores any given document). This requires that each document, or storage element, contain routing information in its' unique identifier (i.e. see Pastry), & then asking which route is the shortest. Secondly, the need to index the content of documents scattered throughout the network requires massive storage, in addition to associated meta-data (i.e. literally, data about data; the main purpose of metadata to speed up and enrich searching for resources). The challenge here is which is more efficient, centralized storage of this data, or, as with the Web, distributed through out the network. Lastly, there are several other issues that must be squarely addressed: (1) the need to largely automate the now human-intensive task of managing large storage systems; & (2) the cultural issues of privacy and anonymity in the context of distributed storage.

DESCRIPTION: In the recent years, Peer-to-Peer system research has grown significantly. According to Using a large scale distributed network of machines has become an important element of distributed computing due to the phenomenal popularity of Peer-to-Peer (P2P) services like Napster, Gnutella, Kazaa and Morpheus. “Using a large scale distributed network of machines has become an important element of distributed computing due to (their) phenomenal popularity…(offering) a decentralized, self-sustained, scalable, fault tolerant & symmetric network of machines providing an effective balancing of storage and bandwidth resources” - From "A Survey of Peer-to-Peer Storage Techniques for Distributed File Systems" by Hasan, Anwar, Yurcik, Brumbaugh & Campbell, National Center for Supercomputing Applications, Department of Computer Science, University of Illinois at Urbana Champaign.

The builders of distributed storage systems face many architectural decisions, the most basic of these is the question, “How do we leverage the vast research & myriad techniques developed for P2P distribution of storage to existing client-server storage”? While the traditional evaluation metrics for centralized storage systems remain focused on cost, persistence, bandwidth, & latency, in terms of decentralized, distributed storage we must consider a fresh set of neo-metrics – shared coherent access, availability, survivability, security, interoperability, search, caching, load balancing, and scale. Both the traditional metrics & the neo-metrics have to be brought to the table in evaluating such hybrid storage system.

“The similarities of P2P & Client-Server approaches to storage are subtle. Hierarchical approaches, including the new trend toward storage virtualization, use layers of control and abstraction to stitch together distributed and disparate storage providers into a single virtual whole. In the peer-to-peer approach, the clients themselves provide storage for everyone. There is no need for any server in the traditional sense. In the ideal case, such systems are fully symmetrical with no fixed central leader. The server-to-server approach is related to peer-to-peer, but here many servers work together in a symmetrical way to provide storage services; clients need not install any new software to consume basic storage services. This broad categorization includes much work in the established field of distributed file systems - P. Yianilos & S. Sobti, published, IEEE, 2001.

In a Princeton University article on Distributed Storage by P. Yianilos & S. Sobti, published by the IEEE in 2001, They readily admit that “the Web’s fragility and operational semantics prevent it from addressing the storage problems of mainstream data processing – error messages or suspended display is common when a network or system component fails somewhere, making a page or one of its elements inaccessible…&, informal caching on the Web makes it hard to be certain that you’re viewing current information.” A simple form of distributed file storage is widespread now, as many of us routinely and transparently access files stored somewhere else on a local area network. It is “between LANs and the World Wide Web lies the domain of distributed enterprise wide storage, an area that industry is now actively developing.”

To compare & contrast current storage developments to that of distributed storage efforts, P. Yianilos & S. Sobti, 2001, point out that “hierarchical approaches, including the new trend toward storage virtualization, use layers of control and abstraction to stitch together distributed and disparate storage providers into a single virtual whole…(whereas) in the Peer-to-Peer approach, the clients themselves provide storage for everyone.” In this approach there is no need for a server or servers, & they are “fully symmetrical with no fixed central leader.” They also note that “…the server-to-server approach is related to Peer-to-Peer, but here many servers work together in a symmetrical way to provide storage services; (in the Peer-to-Peer) clients need not install any new software to consume basic storage services."

Replication-Based Data Archives, such as Past (using Pastry for routing), Intermemory, & Farsite are but a few of the distributed data storage services:

(1) Past, a global utility, in development at Microsoft Research, Cambridge, UK, names files with random-looking bit strings that are cryptographically tied to their immutable content, while replicas of files are placed on a diverse set of nodes by a fault-tolerant and self-organizing routing and location infrastructure called Pastry (P. Yianilos & S. Sobti, 2001). (See also, "PAST: A Large-Scale, Persistent Peer-to-Peer Storage Utility", P. Druschel, Rice University, Houston, TX & A. Rowstron, Microsoft Research, Cambridge, UK' as well as, "Pastry: Scalable, decentralized object location and routing for large-scale peer-to-peer systems?", A. Rowstron & P. Druschel, Microsoft Research Ltd, Cambridge, UK.)

(2) Intermemory addresses the issue of long-term preservation of information in the context of digital libraries, envisioned as either peer-to-peer or server-to-server, where libraries & institutions cooperate to create a robust storage substrate for their collective holdings (P. Yianilos & S. Sobti, 2001).

(3) Farsite is a replication-based distributed file system where clients contribute storage resources in exchange for a highly available and reliable file system service. Logically, a single hierarchical file system is visible from all access points, but underneath files are replicated and distributed among the client machines. There is no central authority that administers the system. The system does not assume mutual trust among the client machines. Write access to files is controlled using digital signatures. All files are encrypted before storage using a technique called convergent encryption, which allows files with identical content to be detected even if they have different names and are encrypted using different keys. Files with identical content are coalesced to save space. Also to save space, files are compressed at write time, and decompressed when read. A distributed directory dynamically keeps track of replica and file version locations (P. Yianilos & S. Sobti, 2001).

The research on the Client-server side of distributed storage is rather sparse, but certainly DISP, the Distributed Information Storage Protocol, that. according to D. Ellard from Sun Microsystems & J. Megquier from /etc consulting, "manages the storage of immutable data objects by distributing the responsibility for storing each object among a set of autonomous and independently functioning servers", appears quite seminal (Reference available on request). Also, FREELOADER, the "Scavenging Desktop Storage Resources for Scientific Data" by Sudharshan S. Vazhkudaio & team, based on the work on PAST, seems hopeful. See also, An Automatically Reconfigurable Distributed Data Storage System for High Data Availability" by Gwang S. Jung, Department of Mathemathics and Computer Science, Lehman College, The City University of New York, & Qutaibah M. Malluhi & Farida Chowdary. Department of Computer Science, Jackson State University, Jackson, MS (Reference available on request).

PHASE I: Survey existing methods for: (1) redundant storage, resource location of distributed on diverse peer workstations; (2) document location, routing & retrieval, capable of adapting to a changing network topology; (3) the storage of massive meta-data, either centralized; & a unique identifier for each document, or storage element, to contain routing information.

PHASE II: Using the result of the survey in Phase I, identify potential solutions and improvements to document storage and handling methods applicable to the Navy's primary networks (NMCI, One Net and IT 21), and develop a limited number of initiatives, prototype, then test them in the Navy environments."

PHASE III: Implement solutions and improvements proven by the prototypes in phase II in to the Navy infrastructure

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In this increasingly complex and demanding world of distributed storage the demand for storage systems of truly immense proportions shows no sign of abating satisfying our increased appetite for storage. This research carves a new path for storage systems which can enhance existing storage service systems. Moreover, this effort points toward a solution for the need to largely automate the now human-intensive task of managing large storage systems.

REFERENCES:
1. "Evolving Field of Distributed Storage", P. Yianilos & S. Sobti, Princeton University, IEEE, 2001.

2. "FreeLoader: Scavenging Desktop Storage Resources for Scientific Data", Sudharshan S. Vazhkudai, Xiaosong Ma, Vincent W. Freeh, Jonathan W. Strickland, Nandan Tammineedi & Stephen L. Scott, Computer Science and Mathematics Division, Oak Ridge National Laboratory, Department of Computer Science, North Carolina State University, Association for Computing Machinery, 2005.

3. "PAST: A large-scale, persistent peer-to-peer storage utility", Peter Druschel
Rice University, Houston, TX 77005, USA & Antony Rowstron, Microsoft Research, Cambridge, CB2 3NH, UK.

4. "Pastry: Scalable, decentralized object location and routing for large-scale peer-to-peer systems?", Antony Rowstron and Peter Druschel, Microsoft Research Ltd, St. George House, 1 Guildhall Street, Cambridge, CB2 3NH, UK.

5. "A Survey of Peer-to-Peer Storage Techniques for Distributed File Systems Ragib Hasan, Zahid Anwar, William Yurcik, Larry Brumbaugh &Roy Campbell, National Center for Supercomputing Applications, Department of Computer Science, University of Illinois at Urbana Champaign.

KEYWORDS: Distributed; Decentralized; Symmetry; Scalability; Load Balancing; Location & Access Mechanisms