# NAVY
# STTR 09.A PROPOSAL SUBMISSION INSTRUCTIONS

## INTRODUCTION:

The responsibility for the implementation, administration and management of the Navy STTR Program is with the Office of Naval Research (ONR). The Navy STTR Program Manager is Mr. Steve Sullivan. If you have questions of a general nature regarding the Navy's STTR Program, contact Mr. Sullivan (steven.sullivan@navy.mil). For inquiries or problems with electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8:00 am to 5:00 pm ET). For technical questions about a topic, you may contact the Topic Authors listed under each topic before **24 February 2009**. Beginning **24 February**, for technical questions you must use the SITIS system **www.dodsbir.net/sitis** or go to the DoD Web site at **http://www.acq.osd.mil/sadbu/sbir** for more information.

The Navy's STTR 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 STTR Program can be found on the Navy STTR Web site at **http://www.onr.navy.mil/sbir.** Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the Web site at **http://www.navy.mil.**

## PHASE I PROPOSAL SUBMISSION:

Read the DoD front section of this solicitation for detailed instructions on proposal format, submission instructions and program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000. The technical period of performance for the Phase I base should be 7 months and will commence on or about 01 July 2009. The Phase I option should be 3 months and address the transition into the Phase II effort. Phase I options are typically only funded after the decision to fund the Phase II has been made. Phase I technical proposals, including the option, have a 25-page limit (see section 3.4). The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award.

All proposal submissions to the Navy STTR Program must be submitted electronically. It is mandatory that the **entire** technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR/STTR Submission Web site at **http://www.dodsbir.net/submission**. This site will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents is submitted separately through the Web site. To verify that your technical proposal has been received, click on the "Check Upload" icon to view your uploaded technical proposal. If you have any questions or problems with the electronic submission contact the DoD SBIR Help Desk at 1-866-724-7457 (8:00 am to 5:00 pm ET). Your proposal **must** be submitted via the submission site before **6:00 am ET, Wednesday, 25 March 2009**. An electronic signature is not required when you submit your proposal over the Internet.

Within one week of the Solicitation closing, you will receive notification via e-mail that your proposal has been received and processed for evaluation by the Navy. Please make sure that your e-mail address is entered correctly on your proposal coversheet or you will not receive a notification.

**PHASE I ELECTRONIC 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/STTR Web site. It must not exceed 700 words and should include potential applications and benefits. 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.

**PHASE II PROPOSAL SUBMISSION:**

Phase II proposal submission is by invitation only. Only those Phase I awardees who achieved success in Phase I, measuring the results achieved against the criteria contained in section 4.3, will be invited to submit a Phase II proposal. If you have been invited to participate, follow the instructions provided in the invitation. The Navy will evaluate and select Phase II proposals using the evaluation criteria in the DoD solicitation. All Phase II proposals must be submitted electronically through the DoD SBIR/STTR Submission Web site.

Under the new OSD (AT&L) directed Commercialization Pilot Program (CPP), the Navy SBIR/STTR 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 $250,000 to $1 million 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 $750,000 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 during 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/STTR Web site at the end of their Phase II.

**PHASE II ENHANCEMENT:**

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy STTR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy may provide a one-to-four match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in additional STTR funds for $1 million match of acquisition program funding can be provided, as long as the Phase III is awarded and funded during the Phase II.

**ADDITIONAL NOTES:**

**1.** The Naval Academy, the Naval Postgraduate School and other military academies are government organizations and therefore do not qualify as partnering research institutions or subcontractors. In the special case of an otherwise qualifying proposal, if there is a compelling need for participation by such an institution, a request for a waiver of this regulation will be sent to the Small Business Administration (SBA); and the contract award will be contingent on the receipt of this waiver.

2. The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR Web site at **http://www.onr.navy.mil/sbir**. A Navy success story is any follow-on funding that a firm has received based on technology developed from a Navy SBIR or STTR Phase II award. The success stories should be included as appendices to the proposal. These pages **will not** be counted towards the 25-page limit. The success story information will be used as part of the evaluation of the third criteria, Commercial Potential (listed in Section 4.2 of this solicitation) which includes the Company's Commercialization Report and the strategy described to commercialize the technology discussed in the proposal. The Navy is very interested in companies that transition SBIR/STTR efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR/STTR Phase II it will not count against them.

3. Any contractor proposing research that requires human, animal and recombinant DNA use is advised to view requirements at Web site **http://www.onr.navy.mil/sci_tech/ahd_usage.asp**. This Web site 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 complete STTR Phase I proposal (coversheet, technical proposal, cost proposal, and DoD Company Commercialization Report) has been submitted electronically through the DoD submission site by 6:00 am ET, Wednesday, 25 March 2009.**

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

**____4. Make sure the Phase I proposed cost for the base effort does not exceed $70,000, and the Phase I Option proposed cost does not exceed $30,000. 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 STTR 09A Topic Descriptions

N09-T001 TITLE: Autonomous Launch, Recovery and Turn-Around Systems for Small UAVs

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

OBJECTIVE: To develop a system whereby small UAVs can be retrieved, serviced, and launched without attending personnel.

DESCRIPTION: While UAVs typically operate autonomously while in flight, and even during launch and retrieval, they continue to require manual handling during turnaround. Elimination of post-deployment manual handling would permit more flexible basing, including the potential for operation from unattended sites. Such a concept would allow forward basing of the UAV, while reducing risk to personnel. Concepts suitable for practical fully-automated launch, recovery and turnaround must be developed and demonstrated for small-scale UAVs. Of particular interest is the development of technologies that contribute to autonomous launch/recovery/turnaround of small UAVs in confined areas, remote sites and on-board at-sea vessels and platforms.

Proposed system should support UAVs with the following characteristics:
1. Gross weight class of up to 100 lbs.
2. Flight endurance greater than 24 hours.

Proposed solutions should consist of a ground support system that would capture, secure, stow, shelter, refuel and/or recharge, release and launch the UAV. The ground support system concept should be compact enough to be delivered and deployed with a high mobility military vehicle (HMMV), small truck or air transported with a helicopter. Future applications/enhancements of this system may be deployment of UAVs by unmanned ground vehicles.

PHASE I: Demonstrate technical feasibility for fully-automated retrieval, service, and launch of small UAVs in practical operating conditions, including hardware demonstration at the component level.

PHASE II: Develop and test prototype systems, including flight demonstration of fully automated turnaround. The concept can be demonstrated with any type or size of vehicle, so long as the concept can be shown scale-able to a UAV with the performance characteristics of the aforementioned class air-vehicles.

PHASE III: Fully develop and demonstrate a functional prototype launch/recovery/servicing apparatus.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Fully-automated turnaround would improve the economics and viability of emerging civil applications for small UAVs, such as forest-fire and disaster monitoring, environmental reconnaissance, border patrol, and search and rescue.

REFERENCES:
1. Olivier Doucy, Nicolas Cellier and Philippe Corrignan. Recent developments in shipborne automatic homing and recovery of unmanned vehicles . UAV Systems International Conference & Exhibition, Paris, June 2007.

2. Mullens, Burmeister, Wills, Stroumtsos, Denewiler, Thomas, Stancliff. Automated Launch, Recovery, and Refueling for Small Unmanned Aerial Vehicles. SPAWAR, SAIC, Carnegie Mellon University, 2006.

KEYWORDS: UAV; UAS; Servicing; Autonomous; Unmanned; Automated

N09-T002 TITLE: Nonlinear Interaction of Impulsive Acoustic/Hydrodynamic Sources and Natural Ocean Inhomogeneities

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace

OBJECTIVE: Develop a physics-based model describing the generation of remotely-detectable small-scale ocean surface roughness anomalies caused by nonlinear interactions between impulsive acoustic/hydrodynamic sources and background ocean inhomogeneities.

DESCRIPTION: Wind and current variations at the mean surface can give rise to a modulation of the ocean surface roughness and thus can become visible in optical and radar images. For example, the capacity of optical and radar sensors to image bathymetry features in tidally dominated coastal areas is well established. Although microwave radiation cannot penetrate the ocean by more than a few millimeters, underwater features appear clearly as bright and/or dark patterns in radar images. In fact, there are many ocean phenomena that can generate detectable alterations in radar imagery. Among them are ocean swells, oil slicks, wind slicks, currents, internal waves, eddies, and ship wakes.

Investigation is needed in the interaction of weak natural and man-made sources of impulsive acoustic/hydrodynamic energy with a marginally stable ocean background environment in a nonlinear fashion to produce small-scale ocean surface roughness changes of sufficient amplitude and spatial extent to be visible optically and by microwave radar. A physical understanding of the signature generation mechanism along with the spatial and temporal characteristics of the surface roughness modulation is sought. The ability to discriminate between the signature of interest and signatures of other oceanic and atmospheric phenomena is critical.

PHASE I: Provide and justify the taxonomy for the nonlinear interaction between impulsive acoustic/hydrodynamic sources and background ocean inhomogeneities.

PHASE II: Develop analytical and computational models and perform simulations that might lead to an understanding of the important phenomena and interactions from Phase I. Provide a plan for further analytical investigation of key issues and a plan for the experiments that will provide data for these issues. Develop test specifications for equipments, sites, and environmental needs, and develop hypothetical test plans for measurements required to validate the simulations of merit.

PHASE III: Continue the development of the analytical and computational model and perform the validation experiments and analyses. Working with sensor system OEMs, develop real-time detection algorithms suitable for evaluation in an operationally representative test environment. A sensor system utilizing proven detection algorithms could be utilized in applications of interest to the Navy as well as civilian environmental applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential dual use applications include ocean environmental assessments, physical oceanography, biological and chemical oceanography, ocean modeling and prediction, tactical environmental support, and marine meteorology.

REFERENCES:
1. Clemente-Colon, P.; Xiao-Hai Yan, “Observations of East Coast upwelling conditions in synthetic aperture radar imagery,” Geoscience and Remote Sensing, IEEE Transactions on, Volume 37, Issue 5, Sep 1999 Page(s):2239-2248.

2. Dennis B. Trizna, David J. Carlson, “Studies Of Dual Polarized Low Grazing Angle Radar Sea Scatter In Nearshore Regions,” IEEE Transactions On Geoscience And Remote Sensing, Vol. 34, No. 3, May 1996, Page(s): 747-757.

3. T. F. N. Kanaa, G. Mercier, E. Tonye, Sea Surface Slicks Characterization in SAR Images, Oceans - Europe 2005, 20-23 June 2005, Page(s): 686-691.

KEYWORDS: Nonlinear Interaction; Impulsive Acoustic/Hydrodynamic Sources; Natural Ocean Inhomogenities; Ocean Modeling and Prediction; Marine Science; Oceanography

N09-T003 TITLE: Store/Aircraft Interface Force Measurement System

TECHNOLOGY AREAS: Air Platform, Sensors, Weapons

OBJECTIVE: Develop a low-cost force measurement system that will provide high quality information on the interface forces and moments between a weapon and its carriage platform.

DESCRIPTION: Dynamic environments (shock and vibration) experienced by stores during captive carriage on an aircraft, are currently expressed in terms of acceleration response of the store at selected measurement points within the store. Response acceleration can seldom be used to determine the input forces (and moments) to the store at the interface between store and platform. For assurance of store system integrity under dynamic loading, knowledge of interface forces and moments is essential. Accurate measurement of these interface loads in the field will allow accurate input of these loads in the laboratory, thereby satisfying the store boundary condition at the interface. In addition, direct knowledge of the interface forces and moments is essential for material fatigue considerations.

In the past, use of strain gauges on carefully modeled (e.g., detailed finite element models) interface components, such as store hangers, has largely been unsuccessful because of the nonlinear relationship between measured strain on an interface component and the distributed force/moment configuration over the component's interface points. Likewise it has been demonstrated that the use of "contributing" or "dynamic modal mass" to establish loads at the interface utilizing force as the product of mass and acceleration has been unreliable.

A low-cost measurement system to provide information on the resultant interface forces and moments between a weapon and its carriage platform is sought. Proposed systems will need to make simultaneous measurements along at least two principal axes (preferably along all three axes) with an orthogonal orientation. On occasion multiple measurements in one axis may be desirable in order to estimate the distribution of the force over the component interface surface. The measurements should provide analog or digital outputs available for on-board signal conditioning and recording. At least sixteen bits of dynamic range should be available for recording. Target bandwidth of the measurement system should be from DC to 2500 Hz for laboratory dynamic testing however, a bandwidth to 500 Hz will be sufficient to support material fatigue concerns. Any analog-to-digital sampling should assume a 10:1 oversample ratio providing at least ten digital values for the highest frequency of interest. In addition, video confirmation of store movement under dynamic loading is desired. All measurements in the selected axis system must be of the same bandwidth and phase correlated for multi-axis processing. Typical stores range in weight from 10 to 2000 pounds and may be subject to dynamic loading exceeding 1000 g's acceleration for smaller stores to 20 g's acceleration for stores above 1000 pounds weight. Typical stores may be carried externally on aircraft pylons or internally on weapon racks. Resultant force and moment measurements will be used in design and design modification of weapon/platform interfaces and in support of the force input to the overall weapons system for dynamic laboratory testing and interface material fatigue purposes. Measurement system application must be in accordance with flight safety standards for military aircraft with captive carry stores.

PHASE I: Determine the feasibility of developing a force/moment measurement system and the ability to creatively apply such technology in a general manner to simple configurations e.g., store hanger and rail.

PHASE II: Design, develop and demonstrate a prototype force/moment measurement system on a typical store/platform interface configuration. A typical store hanger and rail may be provided for demonstration of the technology. Developed systems may be subject to (1) static load/moment test in the laboratory (simulating interface component material fatigue) and (2) dynamic vibration/shock loading on an exciter with the launcher attached to the exciter and a store measurement acceleration profile as controlled input under Time Waveform Replication.

PHASE III: Finalize design and manufacture the interface force/moment measurement system. Provide documentation on installation and measurement system capabilities and limitations. Transition technology to interested parties.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The measurement technology industry e.g., those involved in manufacture of accelerometers, pressure gages, force gages, etc., will benefit through extension of their technology base.

REFERENCES:

1. "Harris' Shock and Vibration Handbook", 5th Edition, Cyril M.Harris and Allan G. Piersol editors, McGraw-Hill, New York, 2002.

2. "Vibration Fundamentals and Practice", 2nd Edition, Clarence W. de Silva, CRC Taylor and Francis, Boca Raton, 2007.

3. "Department of Defense Design Criteria Standard, Airborne Stores, Suspension Equipment and Aircraft-Store Interface (Carriage Phase)", MIL-STD-8591, 12 Dec 2005.

4. "Service Fatigue Loads Monitoring, Simulation, and Analysis", ASTM Special Publication 671, American Society for Testing and Materials, Philadelphia, PA, 1979.

KEYWORDS: Measurement; Force and Moment Loads; Signal Conditioning; Instrumentation; Fatigue; Store Interface

N09-T004 TITLE: Innovative Approaches to the Development of Zinc-Oxide (ZnO) Nanowire Technologies for Advancing Full-Spectrum Photonic Sensing

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

OBJECTIVE: Design, develop, and demonstrate the ability to fabricate ZnO nanowires and to integrate the ZnO nanowires into an array configuration.

DESCRIPTION: Key functions of a hostile fire indication system are to detect threatening energetic events and to locate their origin. Advances in sensor technology are needed to measure the energetic event, determine line of bearing, line of sight angle, and in some cases, range and range rate. Passive sensors may then hand-off threat data such as ultra-violet/infrared (UV/IR) radiance in multiple bands, target images in several dimensions, and dynamics of the event(s).

One of the leading and most promising nanomaterials for optoelectronic sensors is ZnO because of its piezoelectronic properties and its band gap of ~3.4eV and an exciton binding energy of 60meV. Zno nanowire response to photons of light at greater distances than current UV and IR sensors. Successful fabrication and integration of this technology should reduce size, weight and power requirements from current UV and IR sensor systems which require complex cooling systems. To date, a repeatable synthesis process that yields a consistent ZnO wire alignment on a substrate does not exist. Current ZnO synthesis techniques do not consistently align the nanowires into useable, deliberate arrays.

Innovative growth/synthesis processes are sought to fabricate deliberate arrays of ZnO nanowires. Proposed processes must be repeatable, of reliable quality, and align the nanostructure for optimum photonic detection. Developed ZnO nanowire/nanobelts technologies are to include advanced passive photonic sensors and sensor components. The major focus is to integrate the developed ZnO nanowires/nanobelts in order to achieve open architecture, compact, lightweight, high performance, uncooled, full-spectrum (ultra-violet (UV) through infra-red (IR)) photonic sensors.

Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been be implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor may be required to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this may be a requirement. The selected company may be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a ZnO nanowire growth/synthesis process that is repeatable and of reliable quality that aligns the nanostructure into a deliberate array for optimum photonic detection. Determine the feasibility of the ZnO array's ability to detect photons, providing data through an electronics display.

PHASE II: Design, develop, and characterize a prototype of a ZnO-based photonic sensor with minimal photon sensing limitations and spectral sensing parameters/capabilities. This phase should provide insight into the concepts of nano-based, multi-array photonic sensors that employ various spectrum-sensing nano-materials into one lightweight array, effectively providing for UV through IR sensing.

PHASE III: Develop and execute a plan to manufacture the sensor system, or component(s) developed in Phase II. Assist in integration and testing into existing or future HFI/photonic-sensing systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed technology may be used in potential commercial applications such as law enforcement, rescue and recovery operations, maritime and aviation collision avoidance sensors, medical uses and homeland defense applications.

REFERENCES:
1. William Mathers, "Down to the Nanowire, Supersensitive material may Help Detect Snipers", C4ISR Journal, July 2008.

2. J. L. Miller, Principles of Infrared Technology, Chapman & Hall, 1994.

3. A. V. Jelalian, Laser Radar Systems, Artech House, Inc., 1992.

4. J.S.Acceta and D.L. Shumaker, "The infrared and electro-optical systems handbook", SPIE Optical Engineering Press, Bellingham, Washington, 1993.

5. Sood, A. K., et. al., "Design and development of multicolor detector arrays," Proc. SPIE, Vol. 5564, p. 27-33.

6. Lao, Chang, et al, Giant Enhancement in UV response of ZnO Nanoblets by Polymer Surface-Functionalization", from an abstract at https://www,stormingmedia.us.

KEYWORDS: Zinc Oxide (ZnO) Nanowire; Remote Sensing; Multispectral Imaging; Discrimination; IR Detector; Hostile Fire Indication; Spectral Characteristics of Materials

N09-T005 TITLE: <u>Realtime Determination and Prediction of Aircraft Trajectories Using Limited Sensor Data</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

OBJECTIVE: Develop and demonstrate innovative methods for determining and predicting the four-dimensional trajectory of an aircraft given limited sensor data.

DESCRIPTION: Naval Safety Center accident data indicate that mid-air collisions remain in the top-five causal factors for Class-A accidents in Naval Aviation. In addition, numerous organizations are struggling to introduce Unmanned Aerial Systems (UAS) into the National Air Space (NAS) for reconnaissance, patrol, and other security and law enforcement missions. The integration of UAS into the NAS is being met with resistance from the Federal Aviation Administration (FAA) due, in part, to the lack of a "sense and avoid" capability in the UAS – a means of being aware of the airspace around the UAS and the ability to avoid conflict with other air vehicles.

A solution revolves around knowing where the "threat" is and being able to predict the trajectory of that "threat" in realtime. The threat may be anything from a data-link equipped military aircraft capable of transmitting a near-complete picture of its aircraft state (position, velocity, acceleration, etc.) to a general aviation aircraft incapable of providing any state information beyond its position. Position information may be available from on-board radar, FAA ground-based surveillance radar via Automatic Dependent Surveillance-Broadcast (ADS-B), or on-board Mode-S transponders, for example. Development of advanced trajectory prediction algorithms utilizing limited sensor data will be critical to increasing UAS mission capability as general aviation aircraft state information is normally only available from aircraft or ground-based radars.

In order for proposed solutions to be effective, the errors associated with such a prediction must be understood and the error budgets incorporated into the prediction allowing for intelligent determination of the probability of imminent mid-air collision. For example, large potential errors increase the range at which a collision avoidance warning must be issued to be effective and not nuisance-prone. Such errors may include effects from aircraft sensors and radar, ground-based radar, communication latencies, aircraft maneuvering capabilities, and pilot intention based upon recent trajectory history.

PHASE I: Develop the concept for a realtime predictive methodology and demonstrate the scientific merit and feasibility of the approach when given near-complete aircraft state data and when given position only. Identify the conditions under which the effectiveness of proposed predictive methods would be affected (i.e., range, closure rate, level of maneuvering, etc.).

PHASE II: Fully develop the methodology demonstrated under Phase I into a usable predictive tool. Evaluate the accuracy of predicted trajectories against provided threat data. Identify the conditions (i.e., range, closure rate, etc.) under which the errors cause the prediction to fail leading to erroneous collision warnings. Determine the accuracy of the trajectory predictions against the actual trajectories. Modify prediction algorithms to allow for multiple data sets to include steady-state flight, general aviation-like maneuvering flight and high performance flight.

PHASE III: Refine and deliver algorithms for threat prediction for numerous data sets and sources. Transition the technology to various defense platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Improved capability in mid-air collision predictions leading to fewer nuisance warnings, increased user acceptance, and integration of unmanned aerial systems into the National Airspace.

REFERENCES:
1. Naval Safety Center Class “A” Mishap Data, 1997-2004.

2. "New algorithms for aircraft intent inference and trajectory prediction", YEPES Javier Lovera, HWANG Inseok, ROTEA Mario, Purdue University, AIAA Journal of Guidance, Control, and Dynamics, 2008

3. "Performance Evaluation of a Novel 4D Trajectory Prediction Model for Civil Aircraft", Marco Porretta, Marie-Dominique Dupuy, Wolfgang Schustera, Arnab Majumdara and Washington Ochieng, Journal of Navigation, Cambridge University Press, 2008.

KEYWORDS: Mid-Air Collision Avoidance Systems; Sense and Avoid; Detect and Avoid; Unmanned Aerial Systems; Trajectories; Sensors

N09-T006 TITLE: <u>Wavelength Agile, High Energy, High Repetition Rate Blue Laser for Oceanographic LIDAR Purposes</u>

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Develop a wavelength agile (tunable), high energy per pulse, high repetition rate, blue laser for airborne oceanographic LIDAR systems.

DESCRIPTION: A wavelength agile, high energy per pulse, high repetition rate blue fly-able laser for oceanographic LIDAR systems is sought. While current state of the art technologies (including Optical Parametric Oscillators (OPOs), wavelength doubling of Ti:Sapphire based lasers, doubling and tripling of other laser hosts, and blue laser diodes), meet a few of the required characteristics, there are none that meet all of the requirements to support our objectives. Our system requires all of the design thresholds in order to be effective. Additionally, currently funded SBIR projects for developing blue laser technologies can not be leveraged due to design constraints limiting those efforts to a fixed, single wavelength and lower energies than required.

The desired laser should have the following characteristics (in order of priority but all are required to be met simultaneously):

1. Wavelength agile (tunable) blue laser output (Threshold: tunable through 460-485nanometer; Objective: tunable through 450-490nanometer, both with suitable power and repetition rate in a range listed in objectives 2 and 3). Laser wavelength needs to be agile after construction: i.e. wavelength needs to be user tunable, not fixed after design implementation.
2. High energy per pulse (Threshold: at least 10 milli joule per pulse @1KHz rep rate, Objective: at least 15 milli joule per pulse@1 KHz rep rate)
3. High repetition rate (Threshold: >750 hertz, Objective 1000 hertz)
4. Short nanosecond pulse width, Threshold: 30 nanosecond pulse width (FWHM), Objective: 10 nanosecond pulse width (FWHM)
5. Beam Quality: Threshold: M2 < 1.5 symmetric, Objective: M2 < 1.1 symmetric
6. Line width of: Threshold: <0.1nanometer, Objective: <0.01nanometer
7. Divergence: Threshold: 5 milli radian, Objective: 1 milli radian

PHASE I: Determine feasibility of producing a laser with the characteristics listed above. The final product must meet ALL of the above requirements. However, emphasis during Phase I should be placed on meeting characteristics 1, 2 and 3 with a clear path to implementing a design that meets all of the above specs during Phase II.

PHASE II: Build a bread board, laboratory laser based on the method from Phase I which exhibits all characteristics listed above. Test and fully characterize the system operation in the laboratory.

PHASE III: Build a ruggedized brass board system for operation by NAVAIR employees proficient in laser systems operation in aircraft environments and obtain certification for flight on a NAVAIR aircraft to be determined. Provide support to NAVAIR during test and evaluation flights.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High energy per pulse lasers have applications in manufacturing and lithography. Oceanographic bathymetry systems for survey and exploration work would benefit greatly from this laser. Higher repetition rate versions of this laser could have applications to underwater communications systems.

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KEYWORDS: Wavelength Agile; Tunable; Blue Laser; High Power; High Energy Per Pulse; High Repetition Rate; Oceanographic Lidar

N09-T007 TITLE: Tailoring Training for Disparately Skilled Participants in Large Scale Training Exercises

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop tools for instructors and facilitators of large-scale training exercises that can be used to provide skill-appropriate training objectives for individual, team, and unit level participants, while maintaining the overall integrity and realism of the mission.

DESCRIPTION: Large-scale training exercises are among the most logistically challenging training evolutions. Due to range costs, Temporary Active Duty (TAD) costs, conflicting unit schedules and other logistical factors, it is imperative to maximize the return on training investment while an exercise is underway.

Disparities in knowledge, skill level, or expertise, either within or between teams, often compromise the effectiveness of the large scale training exercise. If the training requirements are too challenging for the less experienced participants, they are not likely to benefit, while conversely if the requirements are targeted to less experienced participants, the more experienced participants will not receive maximum training benefit and become bored.

Innovative approaches to this problem might be modeled after strategy games such as “Go” (Hasan and Crawford, 2006) which simulate contexts requiring complex collaborative activity by teams, providing a medium for research and training in the area of networkcentrism. Grunhdstein and Rosenthal-Sabroux (2005) noted the tendency to view knowledge as an object, and by doing so, disregard the importance of people. Their proposed empirical model emphasized the link between knowing and acting, with regard to the constraints of the socio-technical environment. Taking an entirely different tact, Hussain and Ferguson (2005) demonstrated that it is feasible to perform large-scale military training exercise using a commercial off-the-shelf game with low development time and high re-use of training content.

Regardless of the approach, innovative tools for tailoring training for disparately skilled participants that identify and accommodate skill level, performance, and individual differences are needed. These tools should provide the individual, team or unit with challenging training objectives while providing the instructors with an assessment of performance relative to initial skill levels.

PHASE I: Define and develop a methodology for identifying useful algorithms for the classification of task specific skill levels of individuals, teams and units engaged in a large scale exercise. Propose initial concept of operations for development in Phase II.

PHASE II: Produce a prototype of the proposed tool(s), to include details of the data that will be required for the tools, how the data will be collected and inputted, and how the tools shall function. Develop and demonstrate empirically validated fully functional prototype tools incorporating the algorithms and methodology generated in Phase I.

PHASE III: Finalize design developed in Phase II and transition to interested parties.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential non-military application opportunities exist for law enforcement and first-responder training.

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KEYWORDS: Large-Scale Training Exercises; Skill Acquisition; Team Training; Tailored Training; Live, Virtual & Constructive Training; Distributed Mission Training

N09-T008 TITLE: Large Eddy Simulations of Hot Supersonic Jets for Aeroacoustics

TECHNOLOGY AREAS: Air Platform, Weapons

OBJECTIVE: Define new approaches to the design and performance analysis of nozzle components that attenuate the exhaust jet noise of the powerplants of modern tactical aircraft. Analysis may be done by current state-of-the-art computational fluid dynamics (CFD) modeling and simulation methodologies.

DESCRIPTION: The noise from the turbulent, hot, supersonic jets at take-offs and landings as well as high-Mach cruise at altitude dominates noise emanating from other powerplant components (e.g., fan, combustor) and has significant safety implications for launch personnel as well as environmental impacts of noise pollution around military installation. Noise generation mechanisms of supersonic jets are quite complex and different than those of subsonic jets typically encountered in the exhausts of high-bypass ratio transport aircraft powerplants. Both subsonic and supersonic jets contain small and large-scale turbulence structures. While small-scale turbulence structures are the dominant mechanism of subsonic jets, the large-scale turbulence structures are dominant in supersonic jets. Intense Eddy Mach wave radiation from regions along the jet shear layer is produced by the large-scale turbulence structures convected supersonically relative to the ambient medium. Additionally, oblique shock cell quasi-periodic structures, the result of imperfectly expanded supersonic jets, are noise radiation sources and contribute to discrete tone screech and broadband frequency noise.

New innovative approaches are sought to aid in the design and engineering of nozzle components that attenuate the exhaust jet noise of the low-bypass ratio powerplants of modern tactical aircraft. New, quieter nozzles should be optimized for performance at take-offs and landings as well as at high-Mach cruise at altitude. Furthermore, efficient integration of the nozzles with airframe is also critical since forward flight modifies exhaust jet noise and the optimization of the quiet nozzle designs needs to be achieved both at the component and system level.

Critical to this effort is the improved prediction and understanding of the turbulent mixing of hot supersonic jets under pressure-matched and pressure-mismatched conditions -- which is central to improving aeroacoustic predictions of these propulsive jet flows. This breaks down to the developement of Large Eddy Simulations of hot supersonic jets issuing from propulsive nozzles, improved modeling of shock-containing jet plumes, and physics-based noise predictions for these flows which include both jet mixing noise and the shock-associated noise..

PHASE I: Demonstrate the feasibility of proposed methodologies for nozzle performance analysis on mutually-agreed government-furnished test case(s). Of primary interest is the accuracy of the methodologies compared to full scale experimental data. Of secondary interest is the practicality of simulations in terms of turn-around times and computer resources required for the simulations. Applicability of these methodologies in the design process for nozzles for tactical aircraft will also need to be demonstrated.

PHASE II: Develop design procedures employing Phase I methodologies. Further improve selected methodologies so that they can be employed/validated in ongoing DoD programs. Demonstrate accurate performance analysis of proposed nozzle concepts with quick turn-around times.

PHASE III: Transition the technology to ongoing DoD programs. Demonstrate that the transition of this innovation leads to significant cost savings in the design of nozzle components for tactical aircraft by major powerplant DoD contractors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Innovative modeling and simulation tools for aero acoustics are necessary in the design of advanced quiet nozzles for High-Speed Civil Transports (HSCT) and Supersonic Business Jets (SBJ). The successful development of technologies in this program will address jet noise, a major hurdle in the development of these next generation commercial aircraft, and will offer solutions to the newly emerging large by-pass area ratio gas turbine engines being deployed on the latest civil transport designs. Jet noise reduction will offer increase flexibility in domestic flight paths and airport locations by reducing the noise footprint typically produced by high speed aircraft.

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KEYWORDS: Nozzles; Supersonic Jet; Exhaust Jet Noise; Propulsion/Airframe Integration; Tactical Air Vehicle; Computational Fluid Dynamics; Large Eddy Simulation

N09-T009 TITLE: Rotor Wake Computations for Direct Integration with Current CFD Technology

TECHNOLOGY AREAS: Air Platform, Materials/Processes

OBJECTIVE: Develop methodology and code suitable for the integration of more accurate rotor wake computations within current unstructured CFD computations.

DESCRIPTION: Current CFD rotor computations have notoriously dissipative rotor wakes. This premature numerical dissipation disallows rotor wake surface interaction problems from being accurately computed more than a couple of rotor wake revolutions from the tip path plane. There have been projects that address this issue with full overset rotor computations. Specifically these are the Hybrid CFD code, which integrates free wake computations with overset rotor motion, and the vortex tracking project, which attaches refined grids to the overset rotor blades to minimize wake dissipation. However, full overset rotor computations are expensive and in many cases not necessary. Additionally, current research in the development and enhancement of simplified actuator disk models as a substitute for full overset rotor computations do not address the modeling or dissipation of the rotor wake.

This topic specifically addresses the issue of modeling a rotor wake with simplified rotor models. The ultimate goal is to produce a method suitable for more efficient rotor/fuselage or rotor/ship interaction problems that will preserve the rotor wake away from the rotor plane in the computational regions of interest without losing the accuracy of unstructured CFD computations of the flow around the fuselage or ship structures. Portable library formats that may be integrated with various unstructured CFD codes are preferred.

PHASE I: Determine feasibility of the proposed methodology for the rotor model through initial testing. This must include an evaluation of an initial integration with unstructured CFD computations, and must address all other areas of technical risk associated with the proposed method. Efficiency of the proposed method must also be reported. Specific requirements for the end of Phase I are a measure of how far from the rotor the wake accuracy is preserved, and how well the wake is able to conform to the solid surfaces.

PHASE II: Full coupled code development and evaluation. Demonstration of code ability compared with available test data is expected, as is a report of efficiency compared with current overset CFD and actuator disk computations.

PHASE III: Final product development into a form suitable for transition.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Rotor CFD is presently used in government, industry, and academia. This is true of both overset rotor computations, and actuator disk computations. Thus an enhancement to these methods will be useful to all three organizations. The computations themselves may be used to predict many different rotor problems that need to address rotor vortex interactions. Including isolated rotor/fuselage problems and rotor/external structure problems. The external structures may include ships, buildings, or any structure that may presently be modeled using CFD.

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KEYWORDS: Rotor; Wake; Unstructured; CFD; Ship; Fuselage; Interaction

N09-T010 TITLE: <u>Innovative Approaches for Real Time Monitoring of Full Field Strain Measurement Over a Large Area</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop a methodology for the real time monitoring of full field strain measurement.

DESCRIPTION: The development and certification of composite aircraft structure requires a building block approach that requires many thousands of coupons to validate the performance of the composite. The development of analytic tools to predict complex behavior – especially that near stress concentrations – is costly and cumbersome. Furthermore, in order to be effective, these tools must be calibrated with extensive data, and are limited in their use to specific applications. Since the predominant limitation of current methods of composite test is the ability to measure strain response in regions of concentration, the use of full-field strain measurement techniques could reduce costly experimental programs through better understanding of material behavior. Coupling full-field strain measurements with stress models will result in accurate stress-strain relations and material failure criteria. Nonlinear matrix-dominated constitutive properties could be directly measured, and not inferred from model behavior. This could enable the implementation of smaller test matrices and simpler specimen designs compared to traditional methods. By lowering the cost to validate the use of composite materials, the barriers to implementation for new materials, analysis methods, and structural concepts would all be reduced.

Proposed solutions must measure full-field strain in real time and not require significant post-test processing (as is the case today). In addition, proposed methods must demonstrate the ability to be correlated with linear and non-linear analysis tools using a variety of stress concentration types. Real time measurement capability will allow test engineers to change data acquisition rates during test and capture critical information, without current limitations of computational speed or storage space. Monitoring strain values at critical regions during test will allow for increasing frame rates prior to failure onset. Furthermore, the use of real-time data capture and analysis will allow for test control based on concentrated stress fields. This capability does not exist presently, and could provide an excellent means of dramatically reducing the need for extensive testing of stress concentrations.

PHASE I: Develop a methodology and demonstrate feasibility of the proposed approach for a full field strain measurement system.

PHASE II: Based on Phase I results, develop a methodology for assessment of stress-strain relations and failure criteria for composites through the development of software for strain control based on real-time strain measurements.

PHASE III: Complete the development of the control software as a stand-alone system for use with the full-field strain measurement system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed technology will reduce the cost of correlating analysis tools with experimental validation date. This will reduce the cost of transitioning new composite technology – especially structural composite materials with limited application. This will provide transition opportunities for this technology to both commercial as well as military aircraft and other composite material applications.

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KEYWORDS: Composite; Material Design; Strain Measurement; Stress Concentrations; Full-Field Strain; Experimental Stress Analysis; Experimental Mechanics; Composite Material Testing

N09-T011 TITLE: <u>Characterization of the High Temperature Decomposition Products of JP-10</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Space Platforms, Weapons

OBJECTIVE: Develop kinetics models for the high temperature decomposition products of JP-10 and to validate the kinetics model against experimental data over a range of temperatures, pressures and equivalence ratios relevant to ramjet and scramjet propulsion.

DESCRIPTION: JP-10 (exo-tricyclo[5.2.1.0^2,6]decane, also known simply as C10H16) is a high vapor pressure, dense hydrocarbon fuel suitable for cruise missiles and shipboard environments. The physical properties of JP-10 have been fairly well characterized, however the decomposition chemistry is poorly understood and the few kinetics models that exist are very limited in their ability to reproduce experimental data [1, 2]. The combustion chemistry of JP-10 is highly complex and involves hundreds if not thousands of individual species and thousands of chemical reactions. Numerous efforts [3-9] have been undertaken to characterize the combustion chemistry of JP-10 and develop reduced order combustion chemistry models. A detailed kinetics model capable of predicting the chemical species, transport properties and other important parameters is necessary to understand ignition, flame-holding and combustion behavior in ramjet and scramjet applications. In addition, a detailed kinetics model is necessary to build one ore more reduced-order kinetics models suited to different regions of the temperature, pressure and equivalence ratio ranges relevant to air-breathing propulsion. These models must be suited for use in combustion modeling such as computational fluid dynamics (CFD) and simpler models utilizing codes such as Chemkin and Cantera. Validation of the predictions made with the kinetics model against experimental data will be an important part of this effort.

PHASE I: Identify and define an initial kinetics model that includes transport properties for the decomposition products.

PHASE II: Develop a detailed JP-10 kinetics model that includes transport properties, which can be utilized in computational fluid dynamics (CFD) simulations or other modeling efforts that utilize codes such as Cantera and Chemkin. In addition, documentation that details the model development effort, plus extensive comparison of simulations utilizing the model to experimental data published in the literature.

PHASE III: Work with the government to incorporate the JP-10 kinetics model into new or existing DoD or NASA programs where JP-10 is used as a fuel. A robust JP-10 kinetics model would be used for assessing air-breathing propulsion flow-path performance and also would facilitate the design of combustion systems with shorter combustor lengths.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The aerospace industry will be the primary beneficiary of this STTR. An example of a potential private-sector application is the emerging UAV market. As the requirements for more sensors and other systems increase the demand for available payload space in UAV's, there will likely be a push towards higher energy density fuels to both increase range and available payload space. In addition, propulsion for space access will also benefit from a robust JP-10 kinetics model such as NASA's X37 project, which uses JP-10. It is likely there will be other propulsion systems for space access that will use JP-10 in the future.

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KEYWORDS: JP-10; Combustion; Chemical Kinetics; Transport Properties; CFD; Chemical Decomposition

N09-T012 TITLE: Acoustic Intercept Receiver for Naval Special Warfare Undersea Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics, Weapons

ACQUISITION PROGRAM: Shallow Water Combat Submersible (SWCS), PEO LMW, PMS NSW, ACAT III

OBJECTIVE: Develop and evaluate an prototype acoustic intercept receiver to detect acoustic signals capable of identifying manned or unmanned undersea vehicles.

DESCRIPTION: Underwater vehicles are susceptible to detection by active sonar systems used for surveillance of littoral areas. Such systems can operate over a range of frequencies and can ensoniify at various intervals and powers and, consequently, be effective at different ranges. The challenge is to develop a small package to intercept such emissions early enough for the underwater vehicle to avoid capture or destruction. The system needs to fit in the confines of existing and future undersea vehicles, minimize the power requirements, and, ultimately, interface with existing vehicle systems such as command and control, communications. Current intercept systems require significant space and weight of rack-mounted equipment supporting very large processing systems. The proposed system must provide sufficient source bearing accuracy and emission characteristics to allow identification and classification of the emission as a threat emission so that tactical decisions may be made. Identification and classification, while necessary to the tactical decisions, are outside the scope of this topic. (They are necessary to distinguish between threat and friendly force active sonar.) The desired system must detect a wide range of threat frequencies and should be capable of filtering out the acoustic emissions of its own platform in order to prevent false alarms. Because of the range of potential acoustic threats that need to be addressed, development of this system will not be classified.

The Navy will only fund proposals that are innovative, address Research & Development, and involve technical risk. The program office supporting this topic focuses on manned Naval Special Warfare vehicles including the Advanced SEAL Delivery System (ASDS), SEAL Delivery Vehicle (SDV). And the planned Joint Multi-Mission submersible (JMMS) and Shallow Water Combat Submersible (SWCS). However, the technology Is applicable to large diameter UUVs.

Parameters for manned underwater vehicles include:

Total sensor weight: less than 15 lbs, processor and sensor(s)
Total system power requirements: less than 25 watts
Bearing accuracy: +/- 15 degrees from emission source
Frequency sensitivity: 10 kHz to 512 kHz (Frequency range of current commercially available emitter systems)
User interface: Intuitive GUI written to operate with Microsoft Windows 2000/XP or Linux
Hardware Interfaces: USB, RS 232 or 422 serial, or Ethernet

PHASE I: Develop an innovative design to accomplish an acoustic intercept receiver. Identify expected performance enhancements to be achieved along with critical design parameters such as volume, power, cost, and technical risk.

PHASE II: Develop, demonstrate, and evaluate a prototype system in a realistic environment over extended and diverse operating conditions.

PHASE III: Produce acoustic intercept receivers for use in undersea vehicle.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of a small, advanced acoustic intercept receiver would provide government agencies, such as the Department of Homeland Security and the US Coast Guard, with detection technology that could be utilized as part of a comprehensive port & littoral protection system.

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KEYWORDS: sensor; situational awareness; stealth; sonar; undersea sensor

N09-T013 TITLE: Energy Scaling of Ultrashort Pulse (USP) High Energy Fiber Lasers Through Temporal Control

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: PMS 405 Ultrashort Pulse Laser Development. ACAT level N/A

OBJECTIVE: The goals of this STTR: (1) to develop a concept for a compact, environmentally stable approach to the temporal control of the pulse quality of USP lasers; (2) to evaluate this approach in an eye-safer 1.5 micron USP laser with greater than 1 mJ per pulse energy. Studies should include the evaluation of hardware for control and sensing, investigation of robust real time control algorithms, and testing with a compact fiber laser source with autonomous software control. Optical solutions that could be exploited for future spatial beam correction methods are preferred.

DESCRIPTION: The purpose of this topic is to innovate a compact and robust active control method to scale the energy of ultrashort pulse (USP) fiber laser sources. The results will enable solutions for applications of interest to the US Navy, including, but not limited to, directed energy weapons, ECM, and LADAR.

Fiber lasers offer many advantages for Navy applications: high efficiency, high average power and good beam quality with a small form factor. Single fiber lasers with average power up to several kilowatts have been demonstrated, and even higher power levels have been obtained from arrays of such lasers. Key advantages for fiber lasers are direct diode pump configurations as well as beneficial geometry for thermal management.

While fiber lasers easily scale to high average power, pulsed laser emission is inherently more susceptible to temporal distortions. Two main methods are commonly employed to mitigate the distortions. First, chirped pulse amplification (CPA) reduces peak power by up to three orders of magnitude. Second, much work has been done to reduce distortions by changes in the fiber geometry, primarily by deploying larger core sizes and shorter fibers with higher dopant concentration. However, both methods are ultimately limited. Longer stretched pulses require increasingly large and complex optics, and fiber geometry improvements are limited by fiber fabrication and beam quality issues.

The energy levels of USP fiber lasers could potentially be further extended by exploiting control methods in the time domain similar to those employed in correcting for spatial distortions. An example of the enabling power of such systems is the spatial control method exploited in very large terrestrial telescopes. These telescopes would not otherwise be feasible as they would be limited by atmospheric distortions. Studies and bench top experiments have shown the potential of temporal control in USP lasers. Nonetheless, due to complexity of the solutions and available lasers, these methods have not been commercialized into environmentally stable and compact lasers. Innovative approaches to this temporal control are required in order to pave the way for compact USP lasers with energies in the mj and higher range.

PHASE I: Conduct research, analysis, and studies for a compact high energy short-pulse fiber laser architecture at 1.5 micron eye-safer wavelength with active temporal control. Develop measures of performance and document results in a final report. The Phase I effort should include modeling and simulation results supporting performance claims. The effort should also produce a concept for evaluating the proposed laser architecture in the phase II effort.

PHASE II: Evaluate the concept developed in Phase I for a temporal control and sensing system with a compact 1.5 micron eye-safer USP laser with autonomous software control, to show scaling to pulse energies of 1 mJ and greater output.

PHASE III: Develop a rugged, deployable temporal correction and sensing system suitable for deployment in both civilian and military applications. Specific requirements will be based on the specific application.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: USP fiber lasers are a broadly enabling technology with a multitude of applications in the private sector, including manufacturing, medical technology, and life sciences. Temporal correction and sensing enables USP fiber lasers to reach higher peak power and pulse energy. Increased peak power and pulse energy give additional capabilities in these fields. Accordingly, it is expected that this technology will be of high value for USP laser vendors and USP laser users.

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KEYWORDS: Ultra-short pulses; Millijoule pulses; High-energy amplifiers; High peak power pulses; Compact fiber amplifiers; Eye-safer fiber amplifiers; Pulse control; Environmentally robust

N09-T014 TITLE: Advanced Hydrogen Reformate Stream Purifier for Fuel Cell Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO Ships, Electric Ship Office

OBJECTIVE: Development of a 250KW electrical-equivalent, hydrogen flow (EEHF) reformate purification system for shipboard operation.

DESCRIPTION: Fuel cells are a very attractive shipboard technology, not only for the fuel efficiency savings (est. 20% per vessel) but inherent modularity which dramatically improves the ease of shipboard installation and general maintenance. Other benefits of fuel cells include a significant reduction of heat, noise signatures and air requirements over the traditional power generation modules. However, fuel cells depend on a pure supply of hydrogen and today's reformate technology cannot deliver hydrogen in the purity and quantity required for shipboard operation.

Current hydrogen reformate technology enables the US Navy to reform logistics fuel to produce hydrogen, the preferred fuel source for high-efficiency fuel cells. However, the hydrogen stream produced by this reformation contains many compounds such as CO, $CO_2$, $H_2S$, etc. These compounds have proven to be harmful to fuel cells, leading to shortened life, and in many cases, loss of operation due to contamination. Today, there is no large-scale, economically-viable technology capable of separating hydrogen from these harmful contaminants; existing technologies require either the use of precious metals or very high pressures (over 7 atms.). As a result, the hydrogen purification process is either cost-prohibitive, or overly complex, exceeding the temperature and pressure limitations of the current, highly-efficient HTPEM-based fuel cell generator technology.

The Navy seeks to develop a robust purifier capable of continuously filtering hydrogen reformate streams in a shipboard environment, given space constraints, shock requirements and fluctuating hydrogen streams. The system should demonstrate the continuous removal of $H_2S$, CO, $CO_2$ from a reformate stream while maximizing the hydrogen output for PEM fuel cell utilization. Additional removal of $N_2$ would be advantageous, but it is not required. The solution must minimize system size, complexity, and potential fabrication costs while enabling modular packaging (modular: able to disassemble to a hatchable dimension of a 26" x 66" oval and re-assembled at point of installation; weight: maximum 500 lbs per module). The separator technology should maximize the $H_2$ output and maintain consistent product quality while meeting the following operational and performance parameters:

- Operational: System should be able to handle pressure ranges of 1-4 atms, with a pressure drop of no more than 2 atms. Desired temperature operations are within 140-180 oC range, with a system volumetric density of 250 W/L.

- Performance: Minimize all impurities within the hydrogen reformate stream, notably $H_2S$ (to < 10 ppm), CO (to < 100 ppm), and $CO_2$. Removal of $N_2$ is desirable, however should not degenerate the other performance and operational metrics. The purifier must be able to output hydrogen at a rate which allows the fuel cell to generate electricity at a cost comparable to logistics fuel ($3,000 /1500 kWh). The reformer technologies which will be supplying the hydrogen reformate stream are operating at 35-40% efficiencies; overall system efficiency is critical.

PHASE I: Demonstrate the feasibility of the development of a 250 kW EEHF reformate purifier system which meets the above listed thresholds and is capable of integrating into a shipboard fuel cell power generation unit. Evaluate the attributes of the system, including volumetric density, material characteristics, operation and performance, dynamic response, anticipated life, anticipated maintenance requirements, ability to withstand a shipboard environment, and thermal impact using detailed models or small subscale components. Submit a Phase II development approach, performance goals and schedule containing discrete milestones for product development.

PHASE II: Finalize the design concept from Phase I and fabricate a prototype 250kW separation device. In a laboratory environment, demonstrate that the prototype meets the performance goals established in Phase I. Perform a membrane material life test for a minimum of 500 hours under the specified design operating conditions.

PHASE III: Demonstrate proposed installation, maintenance, repair, and regeneration methodologies. Develop a cost/benefit analysis and perform testing and validation. Provide detailed drawings, specifications and validation data.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology is a critical enabler for fuel cell operability, allowing an on-demand, low-cost, and robust source for pure hydrogen fuel. The technology can be easily extended to the semi-conductor and chemicals industry for hydrogen purification processes in their production facilities. The technology of capturing CO and CO2 may have far broader application in capturing emissions from power stations and manufacturing facilities, assisting the industries in meeting future stringent control of green house gasses.

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KEYWORDS: Fuel cell; membrane separator; reformate; modular; hydrogen; purifier

N09-T015 TITLE: <u>Affordable Unmanned Underwater Vehicle (UUV) Power System Architecture</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: PMS-408/EOD; ACAT IV and abbreviated acquisition programs

DESCRIPTION: For several years, PMS-408 (PMS-EOD), PMS403, and PMS495 have been developing unmanned underwater vehicles (UUV) to help in the location and removal of underwater mines. These complex missions involve significant variations in location, duration, deployment scenarios and environment of operations, so the vehicles used for them vary in size and capability accordingly. The vehicle sizes can range from 9 inches to 21 inches or larger in diameter, with power and energy requirements ranging from 1 to over 10 kWh. With varying size requirements and relatively low production volume on any one vehicle, the costs to develop, procure, operate and maintain the advanced batteries for these vehicles is significant. Though many of these batteries are said to be modular they can only work in the vehicle they are designed for due to differences in power levels, communication protocols, energy storage, environmental requirements and physical detentions. To compound this problem each system also has a unique battery charger. As UUV energy and power requirements grow alternate, hybrid power systems are being explored which also compounds this problem.

Clearly the current concepts for modular batteries are not working and a new innovative approach to power systems is needed. The objective of this topic is to develop a new, universal architecture for UUV power systems. Similar to Toyota’s Synergy© Drive which is used in small and large Toyota vehicles as well as competitor’s vehicles, his new power system architecture should be adaptable to any new UUV system no matter the power system used. To accomplish these objectives research in areas such as adaptive logic, new power distribution concepts, flexible packaging and others will need to be applied. Building battery modules that just plug into each other has been show to not meet this need and is therefore not acceptable for this topic. The Navy will only fund proposals that are innovative and involve technical R&D risk.

The goal of this architecture is to reduce the overall cost of operating different size UUVs, decrease the burden of logistical support of these vehicles, and increase the capability/flexibility of the UUV systems. This power architecture should be 1) Intelligent enough to be used with various energy storage media; 2) Functional in vehicles with various sizes and power requirements; 3) Modular; 4) Applicable to both free-flooded and pressure independent UUV sections; 5) Able to communicate and transmit pertinent data to the users; and 6) Minimize size and weight.

PHASE I: Develop and demonstrate innovative battery architecture concepts that address the above requirements. Reasonable weights and volumes for system components based on current technology readiness levels (TRLs) should be used. Feasibility of the proposed design and anticipated improvements during Phase II should be supported by available scientific test data. Make recommendations for a Phase II detailed design and document in a technical report.

PHASE II: Build and demonstrate the power system architecture in UUVs of 9-inch and 12.5 inch diameter sizes, suitable for advanced laboratory and supervised field testing. These prototypes should demonstrate the ability of the battery system architecture to be adapted to various energy storage types and various power demands for vehicles of different sizes. Develop and implement a test plan that addresses the requirements above. Document and provide a Safety Assessment Report for the prototype system.

PHASE III: Prepare a manufacturing plan and marketing plan to sell this product to the government as well as the private sector if deemed beneficial. Make the necessary teaming arrangements with the manufacturers of the components used in this product.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Improved power system architecture would find wide-spread use in various fields like unmanned systems, hybrid vehicles and telecommunications.

KEYWORDS: Batteries; hybrid electronics; UUV; modular; power electronics; underwater

N09-T016 TITLE: <u>Manufacturing of Physical Scale Models for Signature Reduction</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Develop a low cost enabling manufacturing technology for the production of Physical Scale Models (PSMs) for signature reduction from full-scale drawings of Navy ships. Address all technical issues related to full-scale drawing conversions, and PSM design, fabrication and testing.

DESCRIPTION: Typical models of ships and submarines focus on the aesthetic quality of the model and its ability to visually relate the major features of the vessel without regard for physics-based effects. Physical Scale Models (PSMs), on the other hand, are designed not only to accurately reproduce the form of the vessel, but also to reproduce the effects of structure and materials in response to physical stimuli [e.g. wave action, vibration, acoustic and electromagnetic (EM) propagation, etc.]. This requires the development of high fidelity reproductions of features in the model. Since the 1940's, when PSMs were first employed routinely to model electromagnetic (EM) behavior, these features have been meticulously designed and constructed by hand in model-making machine shops. While providing an accurate representation of the magnetic signature, this process has nonetheless been labor intensive, requiring many hours of skilled craftsmanship to complete a PSM. In many cases, the PSM was developed while new construction vessel designs were still being modified. Significant design changes often resulted in increased rework of the model or, more likely, fabrication of an entirely new model. The result is that, under current fabrication procedures, the manufacture of PSMs is expensive, labor intensive, and slow to respond to design changes. With today's advanced design, modeling and fabrication tools, the techniques used in developing PSMs are ripe for modernization. Rapid and efficient manufacturing techniques are needed to go from concept to design to fabrication of a physical product in a short time. New technologies such as solid freeform fabrication and direct digital manufacturing, which are suitable for “art-to-part” approaches, mass customization, flexibility in design changes, and robotic assembly, can be exploited to impact PSM development.

PHASE I: Develop proof-of-concept of a technique to design, model and manufacture PSM for EM signature reduction. The PSM can be 1/30 to 1/60 of full-scale and should have EM signature corresponding to the full-scale structure. Current PSMs use manually assembled sheet metal and manually laid degaussing coils. The proposed PSM could be made of any material or combination of materials as long as it has the desired EM signature and has a means to include coils, either in situ, or later installed. Demonstrate manufacturing cost reduction of 1/4 to 1/2 of current costs, which can be as high as $500K to $1M per PSM. Demonstrate significant reduction in product realization time, few days or few weeks. Using the developed fabrication concepts, build a simple shape, such as a cylinder, for testing and validation by the Navy. An example could be reduced scale ship steel cylinder with inserts and partitions to serve as decks or bulkheads.

PHASE II: In cooperation with the Navy, construct a PSM prototype as a testable product. The Navy will perform the signature tests and validate the model. An example could be a coast guard boat scaled to 1/48 or 1/24, whose drawings are available in autoCAD, CATIA or other forms.

PHASE III: Transition the PSM manufacturing technology to critical military use and the civilian sector. Build marketable manufacturing units and demonstrate the fabrication of a test model. For example, construct a PSM of a complex Navy ship with degaussing coils.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A successful PSM fabrication system would be useful for a variety of commercial applications. Its affordability and versatility will result in new businesses and industries, and high value jobs.

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3. ASNE Ships & Ship Systems Technology (S3T) Symposium, "The Role of Physical Scale Models in the Design of Ship Degaussing Systems in the Age of Computer Modeling" (Mr. William Gay & Mr. Robert Wingo), 13-14 November 2006.

KEYWORDS: Physical Scale Model; EM Signature; Rapid Manufacturing; Cost Reduction.

N09-T017 TITLE: <u>Development of Advanced Energetic Oxidizers for Solid Propellant Applications</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Space Platforms, Weapons

ACQUISITION PROGRAM: Dave Williams, PMA-201; Cartridge/Propellant actuated device

OBJECTIVE: Design, develop, characterize and demonstrate methods for the preparation of an advanced energetic oxidizer superior to ammonium perchlorate (AP).

DESCRIPTION: Over the past 50 years AP has been the most commonly used oxidizer for solid propellant and explosives, particularly metallized systems.

The development of a new revolutionary advanced energetic oxidizer molecule with the following general characteristics is desired:
Density > 2g/cc
Oxygen content > AP oxygen content

Melting Pt >150 C
Min. No. of Synthetic Steps
Sensitivities better than PETN
Low Hydrogen & Carbon; High Oxygen & Nitrogen content
The new molecules preferably would be prepared from CHNO content. General examples include categories like caged compounds and polyheterocycles containing NNO2, NO2, NO, O, and etc. energetic groups.

PHASE I: Design and prepare conceptual synthesis routes to new oxidizer molecules. Down select and synthesize up to 25-gm samples of these new materials after consultation with the program COTR. Provide characterization, analysis, and delivery to government laboratories for evaluation.

PHASE II: Scale-up and optimize the synthesis process to pound quantities for larger-scale evaluation. Investigate process research and establish parameters to define process for manufacturing of pure material for delivery of 2000lb. per year. Potential candidates for Phase II investment have the potential of being classified as to manufacturing process and any performance data generated in actual system hardware.

PHASE III: Transition technology to next generation propulsion and ordnance systems per appropriate PMA/PMS road maps. Provide costing and data package for pilot production of materials based on requirements and need. Examples include missile systems and new underwater explosives.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: While the principle application for AP type oxidizers would be for solid propulsion and ordnance applications, potential custom oxidizer applications in synthesis can be envisioned, particular for a stable, long-shelf life material. Other potential applications may be found with NASA.

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KEYWORDS: ammonium perchloate, AP, explosive, solid propellant, oxidizer

N09-T018 TITLE: Electromagnetic Metamaterial Films

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: CG(X) Program Office (PMS 502); Integrated Topside INP

OBJECTIVE: Using metamaterial technology, develop and demonstrate thin films in which the reflectivity and emissivity can be tailored and controlled over a large range.

DESCRIPTION: Metamaterials are engineered composites that exhibit superior properties not found in nature and not observed in the constituent materials. Electromagnetic metamaterials exhibiting negative refraction show promise for a variety of optical and microwave applications such as new types of beam steerers, modulators, band-pass filters, lenses, microwave couplers, and antenna radomes. Laboratory demonstrations of negative refraction have been limited to small areas due to laborious fabrication techniques. Practical application of metamaterials for large area coatings will require use of scalable manufacturing such as film processes. The purpose of this topic is demonstrate thin films exhibiting electromagnetic responses characteristic of metamaterials, such as negative refraction, in the visible-infrared spectral region (0.3 – 10 microns wavelength). Films can be made of any combination of constituent materials. The successful proposal will give details of the modeling, design, fabrication and testing methodologies to be used, as well as a discussion of recent scientific literature relating to these materials. The successful proposal will include at least one novel fabrication approach that holds promise for making films having an area of at least a square foot.

PHASE I: Demonstrate the feasibility of designing and fabricating a metamaterial film in which the reflectivity and emissivity can be tailored from low to high values. Determine the bandwidth, loss, and effect of angle of incidence on reflectance and transmittance. Analyze the scalability of fabrication to large areas in Phase II

PHASE II: Develop large (greater than a square foot) prototype films or coatings based on the success of the Phase I work. Develop methods to increase bandwidth. Extend fabrication to multi-layered films. Extend Phase I analysis in order to determine tradeoffs between bandwidth, loss, and angular response.

PHASE III: Develop prototype production line for the fabrication of large area metamaterial films and commercialization plans using the knowledge gained during Phases I and II.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of large area films could be used as anti-reflective coatings in numerous commercial applications.

REFERENCES:
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KEYWORDS: metamaterials, negative refraction, electromagnetic materials, thin film processing

N09-T019 TITLE: Compressive Sensing in the Tactical Underwater Environment

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

ACQUISITION PROGRAM: PEO(LMW) / PMS-495, applicable to all underwater sonars and electro-optics

OBJECTIVE: Develop compressive sensing algorithms and techniques for underwater tactical applications. The goal is to reduce the sampling requirements resulting in higher area coverage rates, reduced datasets, and / or relaxed sensing geometry requirements. Sensors of interest include synthetic aperture sonar, real aperture sonar, electro-optics, and magnetic.

DESCRIPTION: The task of sensing & recognizing objects underwater often requires large amounts of data to be sampled relative to the signal of interest (e.g., submarine detection, electro-optic mine detection, etc). In other applications highly sophisticated and computationally expensive techniques for estimating sensing geometry are required (e.g., motion compensation for synthetic aperture sonar). Compressive sensing techniques are relatively new yet they possess a rich and principled mathematical foundation. They enable the simultaneous sensing and compression of sparse signals traditionally acquired with substantial oversampling while also exploiting the potential random variations in sampling geometry. Therefore, ONR is seeking the development of compressive sensing algorithms for tactical application in the underwater environment. The proposed algorithms may work to reduce the sampling requirements or may simultaneously sense and recognize targets depending on the proposer's area of expertise. Example datasets may be provided if required.

PHASE I: Development of overall concept, detailed description of how sensing will be performed, and proof-of-concept algorithms demonstrated on test data (government provided if required).

PHASE II: Extend proof-of-concept algorithms from Phase I to robustly perform in a laboratory environment given a government provided dataset. This will require an investigation into bounds on performance (e.g., requirements on aspect / sensing geometry and sampling matrix for sufficient reconstruction or recognition).

PHASE III: Extend algorithms to be robust and fault tolerant to a full spectrum, government provided dataset. Work with government labs and other contractors to integrate into a sensing platform and participate in at-sea testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These techniques are applicable to all industries requiring underwater surveys, searches, or mapping including petroleum, utilities, and geology.

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KEYWORDS: Automatic target recognition; autonomous systems; classification; compressive sensing; compressed sensing; sampling

N09-T020 TITLE: <u>High Efficiency Stretchable (Highly Conformable) Photovoltaics for Expeditionary Forces</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: Marine Corps Science and Technology, Office of Naval Research

OBJECTIVE: Research the technologies to produce high conversion efficiency, stretchable photovoltaic modules for lightweight power generation.

DESCRIPTION: High efficiency thin film photovoltaics that can be applied to any shaped surface as a stretchable "skin" offer the potential for new mobile power generating capacity. Commercially available photovoltaics that incorporate thin semiconductor films on plastic or thin metal substrates are sufficiently flexible and lightweight to be rolled up for easy transport. Unrolled, the photovoltaic systems are planar and not highly deformable. Achieving stretchable photovoltaics that allow conformable application will require that the complete system of active and passive components be designed to accommodate a fully elastic mechanical response to deformation. Optimization of conversion efficiencies should consider a range of second- and third-generation materials, enhanced broad spectrum absorption concepts, and associated interconnect, integration, and packaging strategies. The goal of this research is to achieve lightweight stretchable (conformable) photovoltaic arrays with conversion efficiencies of >12% and specific power and reliability that compare favorably with existing flexible photovoltaic technologies.

PHASE I: Evaluate photovoltaic materials, device design, and processing technology options to achieve conversion efficiencies of >12% with elastic response to biaxial strains up to 30%. Define specifications and testing protocols for Phase II experimental prototype.

PHASE II: Apply the designs developed in Phase I to fabricate a scalable working prototype photovoltaic modules and conduct appropriate tests to demonstrate photovoltaic (electrical) and mechanical performance in a laboratory environment. Conduct detailed experimental and theoretical analysis of system performance and trade-offs. Assess process scalability and cost-effectiveness.

PHASE III: Develop a stretchable photovoltaic module for integration into expeditionary force equipment or platform. Conduct field testing to demonstrate performance and reliability.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Dual use applications would develop through scaled-up manufacture of cost-effective high efficiency, stretchable photovoltaic “skins” for portable and/or non-obtrusive conformable power generation applications, including flexible battery-charging covers for electric scooters and hybrid/all-electric vehicles, battery-charging sun-umbrellas.

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KEYWORDS: Photovoltaics, power generation, conformable

N09-T021 TITLE: Development of Low-Cost Tracking System for Infantry Training

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMTRASYS Deployable Virtual Training Environment (DVTE)

OBJECTIVE: To develop a low-cost tracking system for individuals in virtual and augmented reality training environments.

DESCRIPTION: Virtual Reality (VR) and Augmented Reality (AR) systems are rapidly evolving (Muller, Schmorrow, and Buscemi 2008). To date, the joystick, gamepad, and keyboard/mouse have been most commonly employed control interfaces for inputting locomotion and firing information into many virtual worlds. While suitable for desktop gaming, this technique has the potential to provide negative training for many tasks. It has also been noted to provide a less compelling immersive experience compared to more direct forms of interaction (Usoh et al, 1999). The need exists to move beyond basic desktop/laptop virtual environments for many military training environments. More advanced VR and AR need to accurately and inexpensively track the position of the individual and his weapon. The individual’s head, limbs, and weapons must be tracked in real time so that a virtual representation of the individual can be rendered. Such technologies exist today (inertial, optical, and magnetic tracking), but are not low-cost and/or are not robust enough to be deployed and operated by the average (non-technical) user. Many of these systems are not able to capture facial expressions and individual finger movements, which is also desirable for advanced training applications. The goals of this topic should be accomplished with minimal equipment being added to the individual being tracked. The system must be very robust, since the training environments provide the individual with significant movement and shock. The system should be able to track multiple users operating in a shared space without loss of accuracy or individual identification.

Desirable Features:
Tracking: Head & weapon with
Accuracy: Orientation - 0.05 degree or better, Location - 2.5mm or better
Latency: 10 ms or less

Sampling Frequency: 120 Hz or faster
Maximum Weight (including batteries): 6oz or less on head and rifle
Also track major body segments and weapons. Tracking of facial expressions and individual finger movements would enhance the strength of the proposal.
Primarily for use indoors, but systems capable of outdoor use would make for a stronger proposal.
Provides full room coverage
Provides seamless transition between rooms
Track at least eight people per room
Low cost on a per room basis
Portable and easy to set up

PHASE I: Develop a concept for a highly accurate and low cost tracking system for the individual.

PHASE II: Prototype the tracking system in a laboratory environment. Demonstrate that the accuracy, latency, and robustness are sufficient for training applications.

PHASE III: Produce the tracking system at low-cost and in volume.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development has the potential to revolutionize the training and gaming industries. This technology could form the next generation of the highly successful Nintendo Wii controller.

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KEYWORDS: Training; Tracking; Virtual Reality; Augmented Reality; Simulation; Low-cost

N09-T022 TITLE: <u>Fieldable Probe for Quantitative Assessment of Degree of Sensitization in Marine Aluminum Alloys</u>

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

OBJECTIVE: Develop a sensor system capable of quantitatively assessing the degree of sensitization (DoS) in 5XXX aluminum alloys allowing in-situ application on ship structure.

DESCRIPTION: In order to assist maintenance decisions and guide predictions of structural integrity in service, a fieldable probe that can quantify the DoS of 5XXX alloys of interest to DON is required. The probe should be able to differentiate the DoS over the range of 5 to 50 mg/cm2 as determined by ASTM G67. It should be able to assess an area of material between 2 and 20 cm2 in a single measurement. It should be easy to be used on-board a ship or at a vehicle without the need to remove the structure of interest. The method should be applicable to a range of 5XXX alloys including 5083, 5456, 5059, 5383, 5454, and 5086. The ability to inspect welds and nearby regions would also be beneficial as well as a build-in calibration capabilities. The scientific basis for the measurement is not limited including methods based on ultrasonic, conductivity, optical, chemical, or electrochemical approaches.

The long-term benefit of such a probe would be its aid in developing an inspection approach that ensures aluminum ship structural integrity and health monitoring.

PHASE I: Conceptualize the capability to quantitatively measure DoS in a commercial 5XXX alloy, demonstrate on a single alloy in the 5XXX class under laboratory conditions and validate by comparison of results from ASTM G67 tests. The method must be applicable to development of a fieldable probe.

PHASE II: Develop and construct a prototype system capable of measurement of DoS on several 5XXX alloys on samples that show those expected to be found in service. The prototype should be applicable to 5XXX alloys in addition to those used in Phase I, i.e., robust enough to be applied to across different manufacturing lots of materials. A successful phase II effort will include delivery of a system which successfully maps out the DoS on a large (4'x4') plate in both horizontal and vertical position in a lab setting.

PHASE III: Develop a robust portable inspection system that can quantitatively detect and assess degree of sensitization (DoS) in large area on Al ship hulls to provide improved condition-based maintenance decisions for ship structural integrity and health monitoring.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These alloys are widely used in commercial marine structures and this method would be of use in the commercial ferry industry.

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KEYWORDS: corrosion, sensitization, corrosion measurement, aluminum alloys, Condition based maintenance

N09-T023 TITLE: <u>Planar, High Frequency, Power Conversion Device Technology</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

OBJECTIVE: Design and develop high frequency, high efficiency solid state power switches

DESCRIPTION: Efficient power conversion and power conditioning devices significantly impact the mission capability and affordability of both the shipboard and airborne platforms through capacity considerations, generation cost and size and weight form factors.

The advancement of wide bandgap, planar Gallium Nitride (GaN) power device technology has demonstrated the advantage that can be gained by exploiting higher frequency in switch-mode power conversion where reduced passive element volume lead to lighter weight and reduced system costs. While significant progress has been made in normally–on devices(1), the normally-off devices preferred for many applications continue to lag in performance in planar GaN technology. An advance in normally-off planar device technology will enable simpler and more practical power systems for Navy applications.

The U.S. Navy is interested in investigating and developing planar normally-off devices that can sustain high breakdown and operating voltage (~1000 V) with at high power conversion frequencies (greater than 1MHz) and efficiency which will result in both reduced weight and volume power conversion systems and potentially enable active, dynamic, point-of-use load management power systems

The Navy will only fund proposals representing innovative R&D and involving technical risk.

PHASE I: Provide an initial development effort that demonstrates scientific merit and feasibility of an approach to achieving normally-off device operation. The effort will demonstrate a device that provides a blocking voltage of 1000 V, a threshold voltage >2.5 volts, with a specific on-resistance, RDS,ON-SP of 20 Ohm-mm. These specifications are to be achieved in a device geometry that is capable of comparable frequency response characteristics to current normally-on GaN power switching device (1).

PHASE II: Demonstrate a device with a 1 A drain current while advancing the blocking voltage to 1200 V, threshold voltage >5 V and reducing the on-resistance, RDS,ON-SP to 15 Ohm-mm. In addition the drain current collapse, RAC/RDC, at 600V, will be <3. Device yield on-wafer should be > 50%. Prototype packaged devices meeting the phase II goals will be delivered for testing and evaluation.

PHASE III: Demonstrate a device with a 5 A drain current with a blocking voltage to 1200 V, threshold voltage >5 V and reduced the on-resistance, RDS,ON-SP to 10 Ohm-mm. The reduce the drain current collapse, RAC/RDC, at 600V, to <1.5. Advance on-wafer yield to > 90%. Packaged devices meeting the phase III goals will be delivered for testing and evaluation.

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

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2. “A 120-W boost converter operation using a high-voltage GaN HEMT, W. Saito, T. Nitta, Y. Kakiuchi, Y. Saito, K. Tsuda, I. Omura, and M. Yamaguchi”, IEEE Electron Device Letters, Vol. 29, No.1, pp. 8-10, Jan 2008.


KEYWORDS: Power efficiency, Gallium Nitride, GaN

N09-T024 TITLE: <u>Affordable Undersea Vehicles Through Bio-inspired Sensing and Navigation</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: PMS 403, PMS 480

OBJECTIVE: Enable low cost AUV’s by developing new feature based navigation and sensing technologies that exploit multiple low resolution environmental cues to provide an alternative to costly AUV component systems such as IMUs (Inertial Measurement Units).

DESCRIPTION: Current AUVs employ expensive systems for navigation that substantially drive up the vehicle costs, and limit the potential of small AUVs for a variety of missions for surveillance, MCM, and harbor defense. The cost of IMU (Inertial Measurement Units) to support navigation is a substantial hurdle for acquisition and use of small AUVs for missions such as mine neutralization or multi-vehicle survey and surveillance. An alternative approach, and one used by animals, is that of feature based navigation. Animal navigation exploits fusion of multiple low resolution cues, such as geomagnetoreception of magnetic inclination and local magnetic field anomalies (sea turtles), celestial cues, including light polarization vectors, and electric fields. Moreover, there are gravitational field anomolies that can also be mapped and exploited for navigation. Recent advances in MEMs sensors allow affordable and compact sensing of navigation cues such as magenetic inclination and electric fields. Prior mapping of an area using these alternative field sensing modes can also provide a feature map that can be exploited for navigation and homing of an AUV employing a simpler imaging system.

PHASE I: Develop a design and identify system components and costs for AUV navigation that exploits fusion of multiple low resolution cues such as magnetic field inclination and local anomalies, electric field, gravity anomalies, optical or celestial cues into a feature based navigation framework. Consider the cost and performance. Identify source of sensors and perform initial sensing experiments to support feasibility of the design concept.

PHASE II: Develop, construct and test an integrated navigation system on a AUV based on the phase I design study and evaluate performance on a transit navigation task and feature based navigation to a target. Demonstrate mapping of an area using the field sensing mode(s) selected and navigation within that mapped area.

PHASE III: Produce and demonstrate an autonomous undersea vehicle the navigation system developed in phase I and II. Demonstrate performance in a range of aquatic environments and produce a production cost estimate for the navigation and sensor component systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Low cost AUVS are expected to be used in a wide variety of non military markets including: oil rig inspection, wharf and bridge pylons safety monitoring, harbor defense, port security, fishery studies, oceanography and more.

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3. S. Johnsen & K. Lohmann, “The Physics and Neurobiology of Magnetoreception” Nature Reviews Neuroscience, vo. 6, P. 703-712, 2005.

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KEYWORDS: AUV, navigation, geomagnetic, biosonar, affordability, electric field, sensors, undersea vehicles

N09-T025 TITLE: Robust Autonomous Maneuvering of Unmanned Air Systems in Challenging Environmental/Weather Conditions for Safety, Mission Effectiveness, and Endurance

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: PMA-263, PEO(U&W)

OBJECTIVE: To explore and develop autonomous control algorithms for safe, robust, and effective maneuvering of small (roughly 0.5-4 meter wingspan) unmanned air systems in challenging environmental/weather conditions. This should enable vehicles to survive and maintain some mission capability in a broader range of weather conditions as well as taking advantage of environmental conditions to increase endurance. This should be done to the greatest extent possible using existing sensors only or at most, relatively cheap, low energy, and lightweight additions.

DESCRIPTION: Current small unmanned air systems have limited ability to fly in challenging environmental/weather conditions. Environmental disturbances may lead to loss or damage to the vehicle, an unacceptably high rate of fuel/energy usage, and/or an inability to follow trajectories with sufficient accuracy to carry out mission tasking such as sensing. However, there are examples of systems that are able to operate effectively in such environments. This includes skilled piloting of manned gliders and ultra-lite aircraft, birds, and skilled control of small RC aircraft. These animal and man/machine systems are able to not only operate successfully in challenging conditions, but also to take advantage of atmospheric conditions to improve endurance. There has been some experimentation with autonomous control approaches to take advantage of atmospheric phenomena, such as increasing endurance by soaring on thermals. However, there are a much wider range of phenomena that could potentially be utilized in developing an autonomous maneuvering system including extracting energy from gusts and taking advantage of velocity gradients. Further, another important issue is avoiding loss of vehicle and limiting structural loads that might cause damage in difficult conditions.

One goal of this effort will be to minimize the sensing requirements to enable such a system including cost, weight, volume, and power. For example, control approaches could use existing parameters like energy rate and acceleration and either relate that to explicit models of atmospheric phenomena or utilize that in control approaches implicitly based on such models. Alternatively, existing sensors may be used in non-traditional ways. For example, an air vehicle with GPS data on altitude could potentially use an air data sensor to learn some knowledge about local environmental conditions. Approaches that rely on large, expensive, and power-consuming LIDAR or Doppler Radar sensors are not appropriate. Further, the goal of this effort is to develop the control algorithms and not platform or sensor hardware. Another important goal of the effort will be to ensure any approach is not a point design suitable only for a single type of configuration, but can be applied to a broad range of small unmanned air vehicles including future designs. Finally, analysis and certification techniques to ensure the approach is safe and reliable will be important, and must be considered in the design of the approach.

The Navy will only fund proposals that are innovative address R&D and involve technical risk.

PHASE I: Phase I will provide initial development of the algorithms and experimentation using a limited-fidelity simulation. The simulation should include models of the platform, the sensing approaches, and the relevant environmental phenomena at a reasonable level of complexity and uncertainty (although not necessarily a high degree of fidelity). Phase I should also develop a set of sensing requirements for the particular approach and estimate the cost, weight, volume, and power requirements of the sensing approach and of the processing power required to run all on-board algorithms. Relevant metrics for the simulation proof of concept may include the probability of upsets that could lead to loss of vehicle relative to different environmental conditions, endurance or a related metric such as average thrust required, and the accuracy of maintaining mission sensor field of regard over a desired target area and/or of following particular trajectories.

PHASE II: Phase II shall allow for further development of the algorithms and testing using a high fidelity nonlinear 6- Degree-of-Freedom aircraft model with sufficient complexity for a proof of concept. This model should exhibit both static and dynamic instabilities, relevant disturbances, sensor noise, and uncertainties in its plant dynamics. If feasible, flight test on a small unmanned vehicle may be used in conjunction with simulation. Phase II will also allow for refinement of sensing requirements.

PHASE III: Phase III will develop a software package for use by government and industry to apply the proposed algorithms to a wide range of control systems. Phase III may also allow for experimentation on a target small UAV.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would be relevant to a wide range of civilian uses of unmanned air systems including first responders, environmental monitoring, law enforcement, park service, and agriculture.

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2. Allen, M. J., “Updraft Model for Development of Autonomous Soaring Uninhabited Air Vehicles,” AIAA 2006-1510, 44th AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, 9-12 January, 2006.

3. Allen, M. J. and Lin, V., “Guidance and Control of an Autonomous Soaring Vehicle with Flight Test Results,” AIAA Aerospace Sciences Meeting and Exhibit, AIAA Paper 2007-867, American Institute of Aeronautics and Astronautics, Reno, Nevada, January 2007.

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KEYWORDS: autonomous control; unmanned air system; maneuvering; weather

N09-T026 TITLE: Exact modeling of targets in littoral environments

TECHNOLOGY AREAS: Information Systems, Battlespace, Human Systems

ACQUISITION PROGRAM: Effects of Sound on the Marine Environment (ACAT IV);

OBJECTIVE: Produce exact acoustic scattering solutions for complex natural (marine mammal) and man-made (submarines, mines) elastic objects embedded in shallow water using recent advances in finite element modeling. Reduce costs for at-sea training and environmental planning by providing a better set of synthetic training and modeling tools.

DESCRIPTION: Modeling acoustic propagation and boundary/target scattering in complex shallow water environments requires numerical modeling. To date, the models used make simplifying assumptions to handle the numerical complexities that arise. Recent advances in finite element modeling hold the promise of producing exact solutions that include the full elastic behavior of ocean seafloors, mammal skeletal structure and man-made objects. Incorporating these solutions into a modular design can improve the speed and versatility of the total model.

PHASE I: Demonstrate the capability to calculate the acoustic field propagated to, produced within, and scattered from a simple elastic object in shallow water. Finite element results must address water depths of 10 to100 meters and source to object ranges of at least 1000 acoustic wavelengths. Elasticity must be included for both the ocean seafloor and the object.

PHASE II: Couple the numerical solutions from Phase 1 to more approximate numerical codes so that scattering can be calculated for source to object ranges of at least 10000 acoustic wavelengths. This phase must include demonstration of front-end modules that allow the user to change the ocean environment and the object being examined without accessing the finite element code backend directly.

PHASE III: A successful development has the potential: to assess exposure levels within the body of a marine mammal or other objects, and to simulate active sonar for both ASW and long range mine countermeasures. SECRET clearance may be required for Phase III.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The specific application would have primary application in the military or DHS. There is some potential for the technology to spin off to scientific and fisheries applications that involve detection of fish or marine mammals.

REFERENCES:
1. M. Zampolli, A. Tesei, F. B. Jensen, N. Malm, and J. B. Blottman, “A computationally efficient finite element model with perfectly matched layers applied to scattering from axially symmetric objects,” J. Acoust. Soc. Am. 122, 1472–1485 (2007).

2. M. Zampolli, A. Tessi, G. Canepa, and O. A. Godin, J., “Computing the far field scattered or radiated by objects inside layered fluid media using approximate Green's functions,” J. Acoust. Soc. Am. 123, 4051-4058 (2008).

KEYWORDS: acoustic; scattering; active; sonar; finite-element; modeling

N09-T027 TITLE: High Sensitivity Analog to Digital Converter

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: SPAWAR PMW-180 SSEE shipboard crytographic systems

OBJECTIVE: The objective of this work is to increase the amplitude sensitivity within a receiver for improved digital representations of minimum signal(s) across a desired frequency bandwidth.

DESCRIPTION: Many naval RF receivers and commercial wireless systems have their coverage range determined by the minimum amplitude signal they can receive. Advanced space time adaptive processing (STAP) can sometimes be used to lift the signals out of the environmental noise, but quantification of the complete signal spectrum including the noise is often needed. However, many analog to digital converters set the least significant bit to be half a bit above the receiver noise temperature and do not address techniques to lower receiver noise temperature below the environmental noise temperature. This topic requests efforts to do those things to achieve sensitivities in excess of 90 dBm over at least the HF band, 0.1-30 MHz.

PHASE I: Proposal should include a design concept for a data converter and numerical techniques that would enhance minimum signal sensitivity. A numerical simulation of the entire approach should be developed and demonstrated by the close of the first phase. In addition to the modeling of the noise floor characteristics, the ADC dynamic range and spur free dynamic range should be calculated

PHASE II: Convert the design into an appropriate circuit layout for fabrication and test. Iterations to improve the size, weight, power, and especially performance of the design are expected.

PHASE III: Incorporate ADC into a high sensitivity receiver such as the Navy’s SSEE.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In sparse signal environments such as rural areas, wireless tower coverage is limited by the attenuation of the distance and maximum handset battery draw. If the towers could extend their range or hear via the diminished signals associated with multipath, there would be fewer coverage dead zones and improved service. In addition, in urban areas, all handsets could turn down their transmitter power for longer battery life.

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KEYWORDS: analog to digital converters; sparse signal environments; noise floor; non-linear amplification; thermal fluctuations; environmental noise; STAP

N09-T028 TITLE: Adaptive Training to Enhance Individual and Team Learning

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Total Ship Training System - PEO IWS 7C

OBJECTIVE: Develop an innovative adaptive training tool suite with the goal of imparting adaptive expertise to the learner -- including intuition, critical/creative thinking, decision making, problem solving, and team interaction skills -- while compressing the learning experience by optimally tailoring experiences, in real-time, to current cognitive and physiological states of the learner.

DESCRIPTION: The at-sea environment is one of the least forgiving of errors, particularly in decision making and situation awareness. Commanders and their crews must be able to adjust to unforeseen threats and make accurate and timely decisions in the face of vast streams of complex and sometimes conflicting data with varying levels of detail and reliability, while working in a distracting and crowded environment. Surface and subsurface crews in the future will be required to report onboard with a greater level of skills, rather than relying extensively on "on-the-job" training to come up to speed. Reduced manning also drives Sailors to understand and execute more than one traditional job. These challenges require a new direction in on-board and off-board training approaches.

Adaptive simulation-based training has the potential to present individual trainees and teams with the optimal mix of experiences and instruction to rapidly develop robust and effective decision making skills and other complex cognitive processes to deal with uncertain threats. However, the development of this type of training capability requires an emphasis on furthering methods and technologies for training the skill of adaptive expertise (Burke, Pierce, & Salas, 2006; Dorsey, Mueller-Hanson, & Pulakos, 2006; Holyoak, 1991; Tillson et al., 2005). Further, it requires additional technical capabilities for continuous performance measurement and assessment, and empirically validated instructional interventions. Ideally, a full spectrum measurement and diagnostic approach should be developed. A comprehensive picture of a trainee's state of knowledge, skills and abilities can only be developed through an integration of multiple sources of data. Integrating and evaluating these data also requires powerful and sophisticated models of expert performance. In order to support adaptive training systems, it is necessary to build, execute, and manipulate these models in real-time. Finally, while advanced display capabilities and intelligent agent technology, combined with the advanced performance assessment capabilities addressed above, have opened a host of possibilities for adapting training (such as real-time feedback, real-time scenario modification and automated cueing and scaffolding strategies), what is still needed is empirically based guidance to drive the optimal selection of adaptive instructional mitigation given the current context (learner's state, training domain).

PHASE I: Develop an adaptive training framework. The components in the framework should build on and extend the state-of-the-art capabilities in performance measurement (including neurophysiological indices), modeling and assessment techniques, and learning sciences. The components in the framework should work within an open systems architecture.

PHASE II: Develop a prototype suite of adaptive training tools based on the framework established in Phase I. Validate the tools through empirical evaluations with the targeted user community.

PHASE III: Produce and market the suite of adaptive training tools for integration with ship and submarine training acquisition programs including the Total Ship Training System and submarine Bridge Team Trainer.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The suite of tools will have widespread applications to military, government, and private sector organizations in which fewer personnel are required to operate the same tasks and missions without degraded performance, i.e., the training is required to be adaptive to the learner to compress learning time and increase competency levels.

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KEYWORDS: adaptive training; measurement; assessment; modeling; learning sciences; adaptive expertise

N09-T029 TITLE: Remote Release Device for Marine Mammal Electronic Tags

TECHNOLOGY AREAS: Materials/Processes, Electronics

ACQUISITION PROGRAM: N45, SPAWAR

OBJECTIVE: To develop a radio-activated, remotely triggered device that would release a tag package (archival and/or satellite-linked tags) attached to a marine mammal (or other large marine animal). The remote release device (RRD) would release the tag and enable it to be recovered without the need to recapture the tagged animal.

DESCRIPTION: Small, sensor-equipped and microcomputer-driven tags that may be attached directly to large marine animals have led to a wealth of information on the behavior and distribution of marine mammals, and investing in tag development, testing and evaluation is an important Navy S&T focus area. The Navy is required to comply with environmental legislation that protects marine mammals. Information on marine mammal distribution and behavior directly informs required environmental compliance documentation and mitigation measures for Naval training and operations. Archival tags that record behavioral and environmental variables have been the backbone of marine mammal tagging efforts since the mid-1980's. They provide detailed time series data often sampled every few seconds; however, recapture of the animal is typically necessary to recover the tag and retrieve data. Recapture of some marine mammals is not possible, only possible at certain times of year, for others it is always very difficult, all of which limits the number of animals and species that can be tagged. Further, the stress of recapture is probably better avoided. Recently, satellite-linked tags have been developed that record information on an animal's location, dive behavior and environment, summarize the data and transmit it back to researcher in near-real-time via the Argos or Iridium satellite systems without the need for recapturing the animal. However, these tags are expensive and the slow data transmission rates for satellite communication necessitate the transmission of summarized data which limit the type of questions that can be addressed. There is a need in the field for a cost-effective device that enables investigators to retrieve archival and/or satellite-linked electronic tags, which will significantly increase the numbers of animals and species that can be investigated and greatly enhance our understanding of this group of animals.

To improve the amount and quality of data recovered from marine mammal electronic tags , the U.S. Navy is interested in developing a remotely triggered self-detaching recoverable unit. Corrosive links attached to tags that are glued to animals have been used previously, but not knowing the exact time of the release is inconvenient and decreases the probability of tag recovery. A radio triggered device could be released by investigators when animals are sighted. The tag package (archival or satellite-linked tag attached to the animal by a RRD) could be released without necessitating the animal's recapture. Each recoverable tag and RRD attached to the animal should have a unique and specific radio frequency and should be activated by a small handheld transmitter with a FCC approved coded radio signal and a transmission range of 2 – 3.5 km line of sight to the tagged animal. The RRD requires a receiver with a rechargeable or replaceable battery and antennae. To survive extreme pressures and hydrodynamic drag experienced by diving animals, the RRD receiver should be a small and lightweight electronic package capable of accepting tag packages up to 370g, good to a depth of 1500-2000m, battery life good up to 1 year, and adaptable to secure to various mechanisms of attachment to the animal (glue to pelage, suction cups, more invasive).

PHASE I: Provide an initial design and development effort that demonstrates scientific merit and capabilities of the proposed components (transmitter, receiver, release platform) and manufacturing processes for making integrated radio-triggered receiver and release platform or RRD.

PHASE II: Fabricate and field test prototype RRD system including small handheld transmitter (up to 7 inches in length, 3 inches wide, 1 ½ inches thick with 7 to 10 inch antenna) powered by rechargeable battery, receiver (maximum 0.625 inches thick, 1.75 inches wide and 2.00 inches long) with antennae attached to adaptable size plate (starting size - 4 inches long, 3 inches wide) to carry tag package, and base plate (starting size - 4 inches long, 3 inches wide) that attaches to animal. Specific properties of interest include dimensions, weight, and materials that are conducive to use with marine epoxies and other current marine mammal tag attachments. Prototype unit should be field tested (leading to remotely triggered release and tag recovery) on any marine mammal with any commercially available recorder that includes at minimum time and depth, operating for a minimum of one day.

PHASE III: Based on Phase II experience modify and produce fully integrated Remote Release Device with handheld transmitter, receiver device to carry a tag package (archival and/or satellite-linked tags) that is a self-detaching recoverable unit.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of the RRD will enable investigators to apply a RRD and tag package to animals that otherwise would not be tagged due to an inability to recapture, greatly increasing the amount of data recovered from tags. The product will significantly decrease the loss of expensive satellite-linked dive recorders, and significantly increase possible numbers and species that can be tagged.

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KEYWORDS: tag, transmitter, receiver, bio-friendly materials, remotely detaching

N09-T030 TITLE: Common Optical / Radio-frequency Threat Sensor (CORTS)

TECHNOLOGY AREAS: Sensors

OBJECTIVE: This effort will develop a tactical threat warning sensor utilizing a common sensing aperture and receiver covering a broad range of the electromagnetic spectrum (EMS) encompassing both the optical and the radio frequency domains. This sensor will be capable of detecting military threats with emissions in the common radar bands (RF, 1-20 gigahertz frequency), the millimeter wave band (mmW, 20-300 gigahertz frequency), and optical bands including the ultraviolet (UV, 100-400 nanometer wavelength), visible (Vis, 400-700 nanometer wavelength), near infrared (NIR, 700-2000 nanometer wavelength), mid-wave infrared (MWIR, 2.0-5.5 micron wavelength), and long-wave infrared (LWIR, 8.0-12.0 micron wavelength). The sensor must be able to achieve background-limited performance (BLIP) for detection, identification, and determination of angle-of-arrival (AoA) of such diverse threats as radars used for target detection and missile guidance (RF and mmW), radio-frequency weapons (RF and mmW), missile exhaust plumes (UV, MWIR), hostile ground fire (UV, Vis, NIR, MWIR), lasers used for target designation and missile guidance (pulsed NIR, MWIR, LWIR), lasers used to disrupt optical systems (pulsed and continuous Vis, NIR, MWIR, LWIR), and laser weapons (pulsed and continuous Vis, NIR, MWIR, LWIR). Key innovations required for the envisioned system are apertures, detection methods, and receiver architectures that span the EMS while minimizing sensing elements and redundant processors, as well as reducing system requirements for size, weight, and available power (SWAP). An affordable and robust Common Optical / Radio-frequency Threat Sensor (CORTS) system will enhance the situational awareness of warfighters under hostile fire and improve the survivability of Navy vessels; Marine Corps and Army ground vehicles; and Navy, Marine Corps, Army, and Air Force aircraft.

DESCRIPTION: Threat warning is key to increasing the survivability of military platforms. Modern missiles and other rocket-propelled threats utilize a variety of guidance modes using both passive and active seekers operating in multiple bands of the electromagnetic spectrum. The increasing complexity and compactness of these guidance systems allow modern missiles to operate in multiple-modes, either sequentially or simultaneously, which necessitates tactical threat warning systems to operate over greater spectral (wavelength) and temporal (frequency) ranges to provide truly comprehensive situational awareness.

Simultaneous detection and identification of optical and radio-frequency threats, as well as determination of the direction of the threats to an accuracy of better than 5-degrees over a conical field of regard of at least 120-degrees, will provide significantly enhanced threat warning over current sensors that operate over a limited portion of the full EMS. All threat detections and required processing (threat declaration, ID, azimuth, and elevation) should be performed in real-time to enable cueing of external counterfire or countermeasures systems. (The specifics of these external systems are not germane to this topic, except that the sensor processing system should include the ability to generate a generic cueing signal or "trigger pulse" that can be synchronized with the time of detection to an accuracy of 10 milliseconds or better.) To facilitate tactical implementation, design considerations should include techniques to detect threats in the presence of background clutter and solar radiation; minimizing false alarms; decreasing size, weight, and exposed cross-section; and enhancing robustness against vibration, shock, and thermal variations.

PHASE I: Perform concept studies and preliminary design of the Common Optical / Radio-frequency Threat Sensor (CORTS). Explain the technical basis of the proposed broad spectrum sensing technology and the plan for maturing this technology in subsequent phases of this effort, with particular attention to assessing development risk and possible means of risk mitigation. Determine predicted performance against typical target tracking and guidance radars, missile exhaust plumes, and pulsed and continuous laser sources. Show that the sensor can be designed for operation on military tactical (jet) and assault (rotor wing) aircraft.

PHASE II: Perform detailed design of the Common Optical / Radio-frequency Threat Sensor (CORTS), including optical, mechanical, electronic and software components. Generate detailed drawings and bills of material for easy transition to Phase III production. Provide to the Navy a working prototype of the sensor and evaluate its operation against available threat hardware and simulators.

PHASE III: Perform modification of the Phase II prototype sensor for inclusion in a specific military vehicle. Work closely with a military sponsor to militarize the sensor and to provide appropriate outputs for integration into the vehicle. Modify the Phase II system design to conform to the military vehicle installation constraints.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: With the proliferation of shoulder-fired missiles, terrorist threats to commercial transportation, whether via ships, vehicles, or aircraft, have become a real concern. Development of this low-cost 360-degree field of view threat warning sensor will provide a means for Homeland Defense agencies to protect commercial transportation systems without an undue cost burden.

In addition to the threat detection application of this technology, the development of low-cost, real-time sensors with broad spectral coverage has a number of uses for machine vision and automated inspection applications. By coupling the sensor with a variety of electro-optical illuminators and RF emitters, the system could be readily adapted to surface and bulk quality inspection by identifying surface contaminants or sub-surface inclusions prior to material processing.

Examples of this application and the industries affected include:
• Airline manufactures currently have no easy reliable method to verify surface cleanliness prior to painting or sub-surface inclusions or voids that can lead to material fatigue. This technology would allow high-speed inspection of entire airframes or bulk components for surface or sub-surface irregularities that would reduce component lifetimes.
• Anti corrosion conversion coatings for maritime use require testing in salt-spray chambers to verify correct application and performance. Currently the industry has no way to quickly verify coating performance, nor inspect for inclusions of dissimilar materials that can act as corrosion sites. Adaptation of a common optical and radio-frequency sensor to determine any irregularities in the optical or RF characteristics of manufactured materials would provide manufactures a method to reduce corrosion inspection times from hours to seconds, quickly revealing areas of coating breach or material inclusions that would otherwise be invisible to the eye. This improvement in inspection capability would result in decreased manufacturing costs, increased profitability and reliability, and increased component lifetime for both the military and commercial users of these items.

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KEYWORDS: electronic warfare; threat warning; situtational awareness; radio frequency; millimeter wave; electro-optical

N09-T031 TITLE: Development of Low-Cost Augmented Reality Head Mounted Display

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PMTRASYS Deployable Virtual Training Environment (DVTE)

OBJECTIVE: To develop a low-cost see through Head Mounted Display for augmented reality training environments.

DESCRIPTION: Augmented Reality (AR) systems have the potential to provide a unique ability to train infantry skills (Muller, Schmorrow, and Buscemi 2008). However, for these systems to become a practical training methodology Augmented Reality Head Mounted Displays (HMDs) must be made that are inexpensive, battery-operated, untethered, and must provide bright, wide field of view color images. Current AR HMDs are limited along each of these dimensions, but the lack of a wide FOV is a particularly significant impediment to their use in infantry training. They should also be lightweight and in a form-factor of ballistic goggles or sunglasses. The display should permit a user to wear any corrective lenses he or she may already use. The user must be able to pass a standard eye exam (e.g. Snellen eye chart at the 20/20 level) with a real eye chart while wearing the display and the display must also have less than 1.5 arcminutes of resolution (approx. 20/30 vision) for graphical imagery within the field of view. The graphics on the display must be visible in bright sunlight, whether by increasing the display brightness or by filtering the incoming light from the real world. The color depth of the display must be at least 16 bits, and the user must further be able to discern basic shades of colors from each other reliably; a test must be designed that satisfactorily demonstrates this capability. The display must allow the wearer to adjust the inter-pupillary distance, vergence angle, and focus distance. Strong proposals will seek to develop HMDs that meet or exceed these specifications as well:

Field of View: 22 degrees vertically, 40 degrees horizontally
Resolution: 1920 x 1024
Battery life of 6 hours
Brightness: greater than 30fL.
Weight: less than 0.5 kg on head
Production cost: below $10k per unit

PHASE I: Develop a concept for a low cost, high performance see through HMD.

PHASE II: Prototype the HMD in a laboratory environment. Demonstrate that the robustness, size, weight, comfort, and power requirements are sufficient for training applications.

PHASE III: Produce the HMD system at low-cost and in volume.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development would be useful to many different training applications in a variety of industries. For example, maintenance workers could have instant access to repair manuals within their field of view. Games could be developed that combine virtual and real worlds.

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1. Muller, Schmorrow, and Buscemi, The Infantry Immersion Trainer: Today's Holodeck, Marine Corps Gazette, September 2008, p. 14-18

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KEYWORDS: Training; Tracking; Virtual Reality; Augmented Reality; Head Mounted Display; simulation

N09-T032 TITLE: Lightweight Structures Roadside Blast Protection

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO Combat Support & Combat Service Support

OBJECTIVE: Develop lightweight and volumetrically-efficient structures that can be applied to the underbody and sides of lightweight tactical vehicles that provide multifunctional structural load support and mitigation of blast impulses from roadside explosives events and buried mine blasts. The areal density of the structures must be less than 10 lb/ft2 and they must be able to reduce the level of blast energy that is transmitted to the crew compartment by at least 30% compared to a monolithic metal armor plate with the same areal density.

DESCRIPTION: The blast effects of roadside explosive events and buried mines can be eliminated by the use of thick armor and stand-off protection concepts but the resulting vehicles are then heavy, difficult too maneuver and difficult to transport by sea or airlift. New lightweight, volumetrically-efficient, structures are sought with enhanced impulse mitigation and blast energy absorption capabilities to provide protection to the occupants of lightweight tactical vehicles from road side bomb and buried mine blasts. This research would develop new lightweight structures that can used to construct, or be applied to, the underbody and sides of lightweight tactical vehicles that will provide load bearing properties and blast mitigation capabilities from roadside bombs and buried mine blasts. The areal density of these new structures must be less than 10 lb/ft2 and they must be able to reduce the level of blast impulse that is transmitted to the crew compartment by at least 30% compared to a monolithic metallic armor plate with the same areal density. The improved performance must be demonstrated experimentally in controlled blast experiments.

Progress has been made in the development of metallic sandwich panels with cellular cores. The benefits of these structures in water blast have been demonstrated and rationalized by the dynamic response of the core and face sheets[1,2]. Because of their tailorability, these structures offer a wide range of topological options for integrating blast protection in passive systems [3]. New multilayered structures made from high specific strength metals and ballistic fiber structures infused with impact resistant epoxy polymer systems are beginning to be realized [4]. Recent measurements on panels with square honeycomb and pyramidal lattice topologies have demonstrated that composite cores can be designed to realize strengths about an order of magnitude greater than their steel counterparts [5].

PHASE I: The successful contractor will develop and test the required number of proposed structures to meet the stated objectives of this STTR topic. The dimensions of the structures to be tested should be at least 2 feet by 2 feet with the minimum thickness dictated by the impulse transfer requirements. In addition, an technical cost model for the large scale manufacturing of the proposed structure should be provided.

PHASE II: Design, build, and evaluate the blast resistance of a prototype structure for a specific lightweight tactical vehicle such as the High Mobility Multipurpose Wheeled Vehicle (HMMWV) or Mine-Resistant Ambush Vehicle (MRAP). The performance of the prototype should meet or exceed the stated objectives of the SBIR.

PHASE III: Design build test and evaluate ballistic response of blast resistant structures.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: N/A

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KEYWORDS: Road side bomb, mine blast, impulse mitigation, blast protection, blast, armor, tactical vehicle, blast mitigation, lightweight tactical vehicle, manufacturing technology.

N09-T033 TITLE: Novel Antibacterial Agents

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Novel approaches and novel antibacterial agents are sought for the treatment of bacterial pathogens that are problematic for military personnel.

DESCRIPTION: The discovery of greater than 100 antibiotics from the 1940s-1970s suggested that infectious diseases could be easily cured, and the possibility that many infectious diseases might even be eliminated. However, bacteria quickly learned to withstand the effects of antibiotics and today bacterial infections that are resistant to all conventional antibiotics are common in hospital and military settings.1 New antibacterial agents are needed that are based on novel approaches that will combat antibiotic resistance.2 Offerors are asked to focus their efforts on a military relevant pathogen (e.g. Acinetobacter baumannii (wound infections)3,4, community acquired methicillin resistant Staphylococcus aureus5,6, Coxiella burnetti (causative agent of “Q fever”)7,8 diarrheagenic Eschericia coli9, or Pseudomonas aeruginosa.10). Systemic, topical, and prophylactic measures are sought.

PHASE I: Identify lead compounds that function as novel antibacterials.

PHASE II: Subject promising antibacterial candidates to initial testing for efficacy and toxicology in laboratory animals.

PHASE III: Continue the program forward and address Food and Drug Administration regulatory matters to reach full drug development.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: New antibacterial agents would have applicability in military and civilian medical care.

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KEYWORDS: antibacterials; antibiotics; antibiotic resistance; antimicrobials; multi-drug resistance; infectious disease

N09-T034 TITLE: Biofuels Production From Nonedible Bio-oils

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO (T), PEO(A), PEO (JSF), PEO(W)

OBJECTIVE: Explore and develop processing methods to produce biofuels from nonedible bio¬oils for naval applications.

DESCRIPTION: Fuel costs from petroleum based feedstocks have risen at a phenomenal rate due to increased demand worldwide, uncertainties and insufficiency on supply side, and geopolitical instabilities. Jet and diesel fuel prices have more than doubled in the past four years; consequently, the Navy fuel cost has also doubled during this time. Biofuels such as biojet and biodiesel derived from domestic and renewable resources have the potential to alleviate excessive fuel cost burden for the Navy.

Conventional methods of such as transesterification of triglycerides or esterification of fatty acids produce biofuels that suffers from poor fuel characteristics like high cloud point and low oxidation stability which compromise the performance and shelf life of the biofuels. Because global energy conversion and delivery systems have considerable inertia, it is essential that alternative biofuels must be suitable for use in current propulsion systems and requires no design changes to the engines. Novel fuel processing methods must produce biofuels with properties and performance comparable to their petroleum fuel counterparts.

The alternative biofuels conversion methods must not use food crop feedstocks (palm, soybean, rapeseed, etc.) or nonrenewable petroleum based feedstocks (coal, oil, natural gas etc.) Desirable feedstocks for biofuels production should come from renewable resources such as nonedible bio¬oils and cellulosic plant matters.

The desired biofuel processing methods must not be feedstock specific and must be capable of converting a wide range of feedstocks into direct production of biojet and biodiesel to meet the Navy needs. Conventional conversion method using Fischer Tropsch chemistry can involve many unit operation steps which are expected to be very cost intensive. The desired biofuels conversion methods need to have consolidation of unit operation and should leverage existing fuel processing technologies and infrastructure to be cost effective.

PHASE I: Conduct feasibility analysis on process concepts to produce cost effective biojet and biodiesel from cellulosic biomass and nonedible bio-oils feedstocks.

PHASE II: Design and run pilot plant tests to experimentally demonstrate process concepts to produce one liter of biofuels for testing.

PHASE III: Address scale up issues for commercial scale demonstration unit. Build and test demonstration unit.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of the biofuels program for the Navy will also have significant impact for the commercial aviation industry and commercial trucking industry as the rising jet and diesel fuel prices has hindered their profitability and competitiveness. Successful development of cost effective biofuels have the potential to reduce inflation concern resulting from rising fuel prices.

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34796, "Biomass Oil Analysis: Research Needs and Recommendations".

KEYWORDS: Bio jet Fuel, Bio diesel fuel, non edible bio oils, cellulosic biomass, renewable energy, sustainable energy.

N09-T035 TITLE: Development of Novel Phase Shifterless RF Phase Array Antenna Systems

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

ACQUISITION PROGRAM: PMW 120 / Service Cryptologic Carry-on 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: Utilize advanced technology and design concepts with nonlinear dynamics to develop a Phase-Shifterless RF Phase Array Antenna systems. We plan to use novel coupled Voltage-Controlled Oscillator (VCO) Networks to realize small and phase-shifterless efficient phase arrays antennas capable of supporting wideband software-defined radio communication systems.

DESCRIPTION: The concept of phase-array antennas has been around for several decades [1-2]. Various active antenna array systems have been used in Department of Defense (DoD) applications with digital signal processing to improve signal reception and anti-jamming properties (i.e., smart-antenna systems [2]). Those RF systems are high cost and mostly bulky and complicated in control electronics and matching, making them very difficult to be miniaturized for commercial applications. However, due to the recent technological advancement, there has been a strong interest to integrate phase-array networks in a 'system-on-chip (SoC)' fashion for use in S, C, and X bands [2-3]. This is because the integration level of RF Integrated Circuits (ICs) has exhibited dramatic progress during the last decade. Furthermore, it has become increasingly clear that areas as diverse as signal processing, communication, sensors, lasers, and biomedical anomalies such as epilepsy have a common underlying thread: the dynamics that governs these systems are inherently nonlinear. However, while significant progress in the theory of nonlinear phenomena have been made, there exist comparatively few commercial or military devices that actually designed to take advantage of this nonlinear dynamics. For example, there have been virtually no publications on RF performance-compliance active antenna using nonlinear dynamics for any wireless standard today, either for military or for commercial use [4,5]. Our research therefore targets to advance nonlinear dynamics knowledge for realizing state-of-the-art active antenna systems for DoD applications. This research program is to provide a proof-of-concept for the operation of phase-shiferless active antenna arrays that exploit nonlinear system dynamics using coupled VCO arrays for wideband transmit and/or receive phase array antenna systems. This technology has a great potential to enhanced affordability related to acquisition, performance and maintenance of a warfighting system.

PHASE I: Identify near-term and long-term innovative fully-monolithic coupled-VCO array design approaches for the development of an efficient phase-shifterless active antenna arrays that exploit nonlinear system dynamics by using coupled VCO arrays. Demonstrate the feasibility by SPICE simulation of a unit cell design of such active antenna can be formed by using a nonlinear VCO integrated circuit (IC) to drive a passive antenna element. Demonstrate the feasibility of an active phase array antenna can be formed by using a nonlinear 1-Dimensional (1-D) coupled-VCO array to drive a 1-D passive antenna network. A coupled on-chip variable resistive network as a switching network will be introduced in this design to attain element-to-element phase variation without the need for phase shifters according to realistic SPICE simulation data. Demonstrate the capability of beam-steering range of over +/-60° from broad-side by modeling and simulation analysis without the bulky phase-shifters. Develop preliminary design complete with documentation that will provide proof-of-functionality.

PHASE II: Validate by testing the coupled-VCO array design through development, fabrication and test of a prototype that functionally meets the performance objectives and requirements of a scanning range of +/-60° from broad-side for phase-shifterless phase-array antenna systems. Provide measured electrical RF performance to include the frequency ranges, scanning angles, power consumption, coupling-strengths, gain, etc. Make required changes to the design if required. One goal is to transition and commercialize this technology by developing working relationships with the relevant electronic warfare systems and contractors.

NOTE: We think that it is possible, not probable, that the RF IC capabilities could be classified in Phase II.

PHASE III: Validate the phase-shifterless phase array antenna design through development, fabrication and test of a prototype that functionally meets the performance objectives and requirements. Provide electrical RF performance to include scanning range, frequency range, VSWR, gain, radiation patterns, and power handling. Demonstrate that the mechanical and physical design approach will be suitable for DoD applications. Make required changes to the design if required.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: PRIVATE SECTOR COMMERCIAL POTENTIAL: A large commercial potential exists for highly integrated/synergistic structures in the aerospace, automobile, wireless and infrastructure industries.

DUAL-USE APPLICATIONS: The development of an improved antenna technology can be incorporated into the existing radio communication systems that will increase their operating performance and will reduce the overall operating and support costs.

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KEYWORDS: phase shifters, gain; phased-array antenna, wideband RF beamformer, switching networks, JTRS

N09-T036 TITLE: <u>Optimal Implementation of Complex Algorithms in Multi-Core Digital Signal Processors</u>

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: Handheld, Manpack, Small Form Fit (HMS), ACAT I, Joint Tactical Radio System

OBJECTIVE: Develop techniques and tools to optimally program a multi-core Digital Signal Processor with complex communications-related algorithms that must be shared among multiple processors. Source code may be VHDL (for FPGA devices), ANSI C, a common C++ variant, or a mixture of these. Optimization should focus on minimizing power consumption while meeting minimum performance requirements.

DESCRIPTION: Multi-core Digital Signal Processor (DSP) devices are being introduced by several firms; many of these devices contain over 100 processor cores. These multi-core devices can potentially reduce the chip count for programmable embedded applications, such as software-defined radios, and also improve capabilities and reduce power consumption and corresponding heat dissipation.

Although the device vendors provide development tools to enable programmers to port their code to these multi-core devices, the tools are not currently capable of optimizing the code – especially for processes that are shared among multiple cores. In addition, most optimization techniques focus on execution speed rather than the minimization of power consumption – which is often a more important parameter for many military and commercial applications that utilize battery power.

PHASE I: Select one or more multi-core DSP architectures (based upon available devices) and at least two complex algorithms to implement. (One algorithm should be based on C-code and the other should be a port of an algorithm native to an FPGA or other gate-based device.) Using analysis and/or Modeling and Simulation (M&S), develop and demonstrate an approach to optimizing the runtime execution of these algorithms (with minimal power consumption) across multiple processors within the device.

PHASE II: Develop a prototype tool for optimizing the development of code on a multi-core DSP device. Demonstrate the effectiveness of this tool on an actual multi-core DSP device using the algorithms of Phase I and at least two additional communications-oriented algorithms. Compare results to optimized implementations on conventional DSP and FPGA devices.

PHASE III: Complete the development of the optimization tool and refine to the degree necessary for commercialization. The product may be stand-alone or it may be integrated with a DSP vendor's software development tools.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: When optimized for minimum power consumption, multi-core DSPs have a wide range of applications in consumer electronics including Smartphones, commercial radio equipment, mobile video devices, and medical equipment. There are also many military applications including mobile or unattended surveillance devices; high-speed computer processing capability in the field, and the potential of greatly increasing the targeting capabilities of weapons.

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3. JTRS Open Information Repository (IR). Contains reference "waveform" source code and other documentation of interest for this project http://jtrs.calit2.net/index.php?option=com_content&task=view&id=26

KEYWORDS: multi-core; manycore; DSP; parallel; massively; JTRS

N09-T037 TITLE: Agnostic Wireless Communications Waveform Gateway

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Network Enterprise Domain (NED), ACAT I, Joint Tactical Radio System

OBJECTIVE: To develop a rule-based wireless communications waveform gateway that can translate between multiple independent wireless/radio waveforms.

DESCRIPTION: Communication waveforms are typically tailored for specific environments and missions. Bluetooth, for example, was designed for very short distance communication between inexpensive transceivers. WiMAX however, was designed to provide wireless broadband connectivity. Frequently there is an operational need to relay or transfer information from a user community on one waveform such as APCO-25 to another community on a waveform such as TETRA. Historically waveform gateways have been hardcoded pair-wise to translate a small subset of features from one waveform into another. The gateway then transmits the translated information in the new format upon the other waveform. A rule-based or other semantically-programmed gateway could interpret the waveform descriptions of multiple waveforms and automatically perform the translation.

PHASE I: Generate a system concept for semantically processing waveform descriptions in XML or similar open standard and configuring a gateway engine to perform automatic translation. Prototype higher risk system elements to demonstrate feasibility and effectiveness.

PHASE II: Develop the system elements necessary to implement the system concept generated in Phase I. Demonstrate the automatic translation of two different waveforms such as Tetra and APCO-25 or another relevant pair for emergency services or commercial use. Propose improvements to the technology based upon system performance measurements.

PHASE III: Produce and demonstrate an improved agnostic gateway suitable for Homeland Defense or military communications (JTRS).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial sector has competing waveforms that overlap in functionality and mission such as GSM, W-CDMA, etc. There are also complementary waveform groupings such as Bluetooth, GSM, etc, that can benefit from the availability of an automatic waveform translator. The Homeland Defense, emergency services, and the international market represents a large opportunity for automatic waveform translation.

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KEYWORDS: Defined Radio, JTRS, Waveform, Gateway, wireless, SDR