NAVY
SBIR FY05.1 PROPOSAL SUBMISSION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Deputy SBIR Program Manager is Mr. John Williams, (703) 696-0342. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **15 December 2004.** For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST).

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

PHASE I PROPOSAL SUBMISSION (NEW Phase I and Phase I Option Amounts for NAVAIR topics only!)

Read the DoD Program Solicitation at www.dodsbir.net/solicitation for detailed instructions on proposal format 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 Phase I option should 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 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 section 4.0 of the program solicitation. 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

For topics N05-036 thru N05-086 the base effort should not exceed $70,000 and 6 months with an option not exceeding $30,000 and 3 months. For topics N05-001 through N05-035 the base amount should not exceed $80,000 and 6 months with an option not exceeding $70,000 and 6 months. **PROPOSALS THAT HAVE A HIGHER DOLLAR AMOUNT THAN ALLOWED FOR THAT TOPIC WILL BE CONSIDERED NON-RESPONSIVE**.

All proposal submissions to the Navy SBIR 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 Submission website at http://www.dodsbir.net/submission. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457 (8AM to 5PM EST).

Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the **6:00 a.m. EST, 14 January 2005** deadline. A hardcopy will NOT be required. A signature by hand or electronically is not required at the time of submission.

Acceptable Formats for Online Submission: All technical proposal files will be converted to Portable Document Format (PDF) for evaluation purposes – do not lock/protect your pdf file. The Technical Proposal should include all graphics and attachments, but not include Cover Sheets. You are required to include your company name, proposal number and topic number as a page header in your technical proposal document. Cost sheets can be included in the technical proposal or submitted separately through the Cost Proposal form available through the Submission website. Technical Proposals should conform to the limitations on margins and number of pages specified in the DoD Program Solicitation. However, your on-line Cost Proposal form will only count as one page and your Cover Sheets will only count as two, no matter how they print out after being converted. Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on your file before you upload. If a virus is detected, the file will be deleted. To verify that your proposal has been received, click on the "Check Upload" icon to view your proposal. Typically, your proposal will be virus checked and converted within the hour. However, if your proposal does not appear after an hour, please contact the DoD Help Desk. It is recommended that you submit early, as computer traffic gets heavy nearer the solicitation closing and slows down the system.

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 FINAL REPORT

All Phase I award winners must electronically submit a Phase I summary report through the Navy SBIR website at the end of their Phase I contract. The Phase I Summary Report is a non-proprietary summary of Phase I results. It should not exceed 700 words and should include potential applications and benefits. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR website at: **http://www.onr.navy.mil/sbir**, click on "Submission", then click on "Submit a Phase I or II Summary Report".

ADDITIONAL NOTES

The Small Business Administration (SBA) has made a determination that will permit the Naval Academy, the Navy Post Graduate School and the other military academies to participate as subcontractors in the SBIR/STTR program, since they are institutions of higher learning.

The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR website 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 efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR Phase II it will not count against them. Phase III efforts should also be reported to the Navy SBIR program website noted above.

NAVY FAST TRACK DATES AND REQUIREMENTS

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

PHASE II PROPOSAL SUBMISSION (NEW Phase II and Phase II Option Amounts!)

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which achieved success in Phase I, as determined by the Navy Activity point of contact (POC) measuring the results achieved against the criteria contained in section 4.3, will be invited to submit a Phase II proposal by that Activity's proper point of contact, listed in Table 1. During or at the end of the Phase I effort awardees will be notified to participate for evaluation of their proposal for a Phase II award. Evaluation criteria for the invitation will be based on the success to which the company has accomplished for the particular topic as evaluated by the monitoring activity/command. If you have been invited to submit a Phase II proposal to the Navy, obtain a copy of the Phase II instructions from the Navy SBIR website or request the instructions from the Navy Activity POC listed in Table 1. The Navy will also offer a "Fast Track" into Phase II to those companies that successfully obtain third party cash partnership funds ("Fast Track" is described in Section 4.5 of the program solicitation). The Navy typically provides a cost plus fixed fee contract or an Other Transition Agreement (OTA) as a Phase II award. The type of award is at the discretion of the contracting officer.

Since the inflation rate over the past twelve years approximates 33%, at the discretion of the Navy Activity, the Navy has increased the amount of phase II funding offered up to $1 million. Specific guidelines on the new base and option amounts will be explained in your invitation letter from the requesting activity. Upon receiving an invitation, submission of a Phase II proposal should consist of three elements: 1) A base effort, which is the demonstration phase of the SBIR project; 2) A 2 to 5 page Transition/Marketing plan (formerly called a "commercialization plan") describing how, to whom and at what stage you will market and transition your technology to the government, government prime contractor, and/or private sector; and 3) At least one Phase II Option which would be a fully costed and well defined section describing a test and evaluation plan or further R&D. Phase II efforts are typically two (2) years and Phase II options are typically an additional six (6) months. **Each of the Navy Activities have different award amounts and schedules; you are required to visit the website cited in the invitation letter to get specific guidance for that Navy Activity before submitting your Phase II proposal**.

Phase II proposals together with the Phase II Option are limited to 40 pages (unless otherwise directed by the TPOC or contract officer). All Phase II proposals must have a complete electronic submission. Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** 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 website. Your proposal must be submitted via the submission site on or before the Navy Activity specified deadline.

All Phase II award winners must attend a one-day Transition Assistance Program (TAP) meeting typically held in the July to August time frame in the Washington D.C. area during the second year of the Phase II effort. If you receive a Phase II award, you will be contacted with more information regarding this program or you can visit http://www.dawnbreaker.com/navytap. It is recommended to budget at least one trip to Washington in your Phase II cost proposal.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary report through the Navy SBIR website at the end of their Phase II. The Phase II Summary Report is a non-proprietary summary of Phase II results. It should not exceed 700 words and should include potential applications and benefits. It should require minimal work from the contractor because most of this information is required in the final report.

Effective in Fiscal Year 2000, a Navy Activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

PHASE II ENHANCEMENT

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in additional SBIR funds for $1,000,000 match of acquisition program funding, can be provided as long as the Phase III is awarded and funded during the Phase II. If you have questions, please contact the Navy Activity POC.

PHASE III

Public Law 106-554 provided for protection of SBIR data rights under SBIR Phase III awards. A Phase III SBIR award is any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a

Phase II SBIR/STTR contract and awarded to the company which was awarded the Phase I/II SBIR. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description. The government's prime contractors and/or their subcontractors will follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect data rights of the SBIR company.

TABLE 1: NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT (POC) FOR TOPICS

Topic Numbers	Point of Contact	Activity	Email
N05-001 thru N05-035	Mrs. Carol Van Wyk	NAVAIR	carol.vanwyk@navy.mil
N05-036 thru N05-038	Mr. Nick Olah	NAVFAC	olahnj@nfesc.navy.mil
N05-039 thru N05-065	Ms. Janet Jaensch	NAVSEA	JaenschJL@navsea.navy.mil
N05-066 thru N05-070	Ms. Cathy Nodgaard	ONR	nodgaac@onr.navy.mil
N05-071 thru N05-073	Mr. Joseph Garcia	ONR2	GarciaJP@nswc.navy.mil
N05-074 thru N05-085	Ms. Linda Whittington	SPAWAR	linda.whittington@navy.mil
N05-086	Mr. Charles Marino	SSP	charles.marino@ssp.navy.mil

For general program and administrative questions, please contact the Program Managers above; do not contact them for technical questions. For technical questions, please contact the topic authors during the pre-solicitation period from 01 November 2004 through 14 December 2004. These topic authors are listed on the Navy website under "Solicitation" or the DoD website. Beginning 15 December, you must use the SITIS system listed in section 1.5c of the program solicitation to receive answers to technical questions.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria <u>must be met</u> or your proposal will be REJECTED.

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

____2. Your technical proposal has been uploaded and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 a.m. EST 14 January 2005.

____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. For topics N05-036 thru N05-086, the Phase I proposed cost for the base effort does not exceed $70,000 and 6 months and for the option $30,000 and 3 months. For NAVAIR topics N05-001 thru N05-035, the base effort does not exceed $80,000 and 6 months and the option does not exceed $70,000 and 6 months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

Navy 05.1 Topic Index

N05-050	Modeling to Support Damage Control Assessment and Decision-making in Shipboard Environments
N05-051	Integrated Shipboard and Shore-based Maintenance Management Decision Tool
N05-052	Prognostic Tool to Estimate Mission Readiness Based Upon System Health States
N05-053	Modeling the Impact of Technology Transition on Ship Operational Capabilities
N05-054	Automated, Wireless, Structural Damage Assessment and Health
N05-055	Automated Launch and Recovery of Small Unmanned Aerial Vehicles from Unmanned Surface Vehicles
N05-056	Advanced Variable Speed Drive
N05-057	Innovative Modeling and Gaming Approaches for Submarine Battle Space Components to Identify Cost-Effective Capabilities and Technologies.
N05-058	Robust, Reconfigurable, High Speed Fiber Optic Data Communication between Remote Sensors and Inboard processing Equipment
N05-059	High Fidelity Front End Simulation for Complex Physics-Based Processing Systems
N05-060	Multilevel Data Storage Technologies
N05-061	Next Generation Controlled Impulse Ejection System
N05-062	Multiplexed Optical Fiber Sensor Arrays for Submarine Atmosphere Analysis
N05-063	Acoustic Data Software “Intelligent Agent” Search Tool
N05-064	Human Interface Evaluation Methods for Submarine Combat Systems
N05-065	Submarine Non-Hull Penetrating (Wireless) Hydrophone
N05-066	Guaranteed Information Assurance in Netcentric-Compliant Information Systems
N05-067	Variable Buoyancy Device for Autonomous Underwater Vehicles
N05-068	Wet Film Thickness Sensor/Device for Navy Platforms
N05-069	Enhancing Tactical Decision-Making in Navy Seal Operations
N05-070	Synthesis of Alpha Aluminum Hydride an Advanced Propellant Ingredient
N05-071	Development of a miniature, hyperspectral imaging digital camera
N05-072	Portable Infrared Monitor for in-field identification of chemical unknowns
N05-073	Advanced RF Power Amplifier Techniques
N05-074	Advanced Wide Band RF Distribution System
N05-075	High Speed (15 kts) Long-Length Fiber Optic Deployment System
N05-076	Cost-Effective Mission Planning for Persistent Surveillance of the Littoral Physical Environment
N05-077	Station-Keeping Gateway Buoy ("Gatekeeper")
N05-078	Adaptive Anti-Jam Radio
N05-079	Adaptive Gridding in Complex Physical Environments to Reduce Uncertainty
N05-080	Autonomous Undersea Vehicle Mission Planner for Shallow Water and Very Shallow Water Environmental Data Collection
N05-081	High-Density Environmentally-Friendly DC Power Source
N05-082	Secure Legacy Application Integration with NCES (SLAIN)
N05-083	Cross-Domain Secure Database Access – EAL-6/PL-5
N05-084	Multi-Band Rotary Joint for Antenna Feeds/Waveguides
N05-085	Cross-Domain Document-Based Collaboration in a Multi-Level-Secure Environment
N05-086	Improved Vacuum Process for Advanced Inertial Sensors

Navy 05.1 Topic Descriptions

N05-001 TITLE: Alternative Area Source Materials for Infrared Decoy Countermeasure Applications

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop a method of producing alternative area source materials with tailorable infrared emissions for airborne expendable decoy countermeasure applications.

DESCRIPTION: The current generation of special material decoys relies on an area source comprised of pyrophoric metal foils that possess specific infrared signatures. These foils are produced by a sole manufacturer, using a patented, proprietary process. Alternative materials that match or exceed the performance characteristics of these materials are sought.

PHASE I: Identify approaches for material production and produce candidate materials for testing that will meet or exceed performance criteria relating to infrared output, burn duration, and spontaneous initiation at a desired point in time.

PHASE II: Tailor material performance for desired infrared signatures and burn durations. Evaluate repeatability and scalability of the production method.

PHASE III: Scale production methods to produce prototype units for field testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These materials could be used for the self-protection of commercial aircraft. Also, a competitive market exists for air-activated hand warmers and self-heating therapeutic heat wraps.

REFERENCES:
1. Baldi, A. L. “Activated Metal and Method of Preparing.” U.S. Patent 4,895,609, January 1990.

2. Wilharm, C. K. “Combustion Model for Pyrophoric Metal Foils.” Propellants, Explosives, Pyrotechnics, Vol. 28, No. 5. Weinheim, Germany: Wiley VCH, 2003.

3. Commerce Business Daily, "Subject 13—MJU-49/B Decoy Devices." Solicitation N00164-99-R-0123, July 13, 1999.

KEYWORDS: Infrared; Decoy; Countermeasures; Special Materials; Area Source; Emissions

N05-002 TITLE: Variable Neutral Density Filter

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop a cost-effective variable neutral density filter for use in a missile based active optical sensor.

DESCRIPTION: Active optical sensors have been used in missile systems for decades. The need exists for an improved method of light control for near range active optical sensors. One technique to provide this light control is with a stationary variable neutral density filter. This filter should be capable of providing a continually decreasing change in attenuation in one dimension. Although continually decreasing, this optical density (OD) versus position curve will not be linear. The lines of equal attenuation may need to be curved. Environmental parameters include storage and operation over a very wide temperature range (-54 to +71„a C for storage and -40 to +74„a C for operation), long storage times, and operation in a harsh vibration environment. This filter should be capable of providing a maximum attenuation of 6 OD. This filter also needs to change from the maximum attenuation to minimal attenuation (AR coated substrate) in a very short distance (approximately 0.15 inches).

PHASE I: Develop a conceptual design for a variable neutral density filter that meets the environmental and performance requirements for operation in a missile system. Develop a cost-effective approach for construction and testing of these filters.

PHASE II: Develop detailed designs for the Phase I filter and fabricate a limited number of filters suitable for environmental testing. Conduct testing of these filters under simulated environmental conditions.

PHASE III: Transition the filter into a Navy missile system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be used in rugged laser rangefinders, displays, and high speed printers.

REFERENCES:
1. Zhang, Z. M., Gentile, T. R., Migdall, A. L., and Datla, R. U. "Transmittance Measurements for Filters of Optical Density from One to Ten." Applied Optics, Vol. 36, 1997, pp. 8889-8895.

KEYWORDS: Nd filter, LADAR; Light Control; Sensitivity Time Control; Optical Density; Variable Attenuator

N05-003 TITLE: Shark Weak Electromagnetic (EM) Field Detection for Moving Objects

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop a covert/low-observable sensor system for detecting and classifying small, slow moving surface or subsurface bodies in coastal shallow water, bays, port areas, or waterways utilizing weak EM signals or field deviations.

DESCRIPTION: ASW and mine detection in littoral waters are at the forefront of operational maneuver planning and execution. This difficult environment imposes constraints on both acoustic and nonacoustic systems in the inventory or under development. The shark operates in this difficult environment with great success. The Department of Defense is pursuing innovative underwater detection technologies in the shark EM regime (< 100 Hz) that might be capable of supporting small underwater EM detection systems. Conceptually, such units are capable of deployment in military actions in littoral environments as a counter to the asymmetric threat posed by air independent propulsion submarines, which can project power ashore at high-value targets.

Development and integration of low-power, miniature electronics coupled with innovative sensor, transceiver, and battery technology in an A-size or smaller deployed package is sought. This sensor system will provide the short- or long-term ability to detect and monitor the threat’s ability to survey and maneuver in elevated security and/or contested environments. Having this capability may save lives by providing early warning, monitoring, and quick response thereby providing disruptive solutions to potentially dangerous situations in commercial, urban, or difficult acoustic environments.
Innovative solutions are sought that will provide the following capabilities:

- Detect, classify, and track EM signals or field deviations of small moving objects
- Operate in shallow coastal areas, reservoirs, and/or port areas (fresh, brackish, or salt water)
- Provide onboard signal/data processing with a land based display and replay subsystem
- Transmit/receive instruction and data (real-time) with low probability of intercept characteristics
- Deploy from air or shipboard A-size (4.75-inch-diameter by 36-inch-long) or smaller recoverable packaging
- Provide a sealed maintenance-free and environmentally friendly long-life battery that is rechargeable and high power

PHASE I: Identify operational requirements and features, advantages and disadvantages, and risks. Develop a conceptual system. Demonstrate the laboratory concept to verify subcomponents and design.

PHASE II: Develop two or three prototypes. One prototype should be developed within one year of the start of Phase II for concept experimentation. Incorporate the experimentation results into the final and other concept designs. Demonstrate the technology in a realistic tactical environment.

PHASE III: This system will have immediate use in surveillance and monitoring operations with Homeland Security, Global War on Terrorism, Joint Forces Operations, and future combat systems under development.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology may be used in commercial undersea surveys and explorations and water park monitoring systems.

REFERENCES:
1. Kalmijn, A.J. “Detection and Processing of Electromagnetic and Near-Field Acoustic Signals in Elasmobranch Fishes.” Philosophical Transactions of the Royal Society B Vol. 355, 2000, pp. 1135-1141.

2. Kalmijn, A.J. "The Electric Sense of Sharks and Rays." J. Exp. Biol. Vol. 55, 1971, pp. 371-388.

KEYWORDS: Remote Sensors; Micro Electro-Mechanical Systems; Digital Compass; Signal Processing; Rechargeable Battery; Materials

N05-004 TITLE: Wireless Airborne Data Recovery System

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop airworthy, lightweight, secure wireless technologies to transfer flight data to a ground station or a handheld system immediately after the flight terminates.

DESCRIPTION: Industrial wireless systems are rapidly becoming the preferred technology to satisfy fire, early warning signaling, and control function requirements for industrial and manufacturing facilities. The primary advantages afforded by radio frequency (RF) signaling are the drastic elimination of wire runs, underground conduits, and disruption of operations during installation. Additionally, wireless systems can be modified or expanded rapidly and cost effectively. The Navy is seeking to capitalize on emerging wireless technologies to reduce the cost associated with downloading airborne recorder flight data. The development of innovative airworthy aircraft equipment is sought that will permit the collection and transfer of data via a wireless method with minimal aircraft rewiring. The proposed solution should have minimum power requirements and be low in weight. Proposed technology will interface with the Airborne Data Recorder (ADR) via a standalone or embedded system in the aircraft. The data will be transferred to a ground station or a handheld system.

PHASE I: Indicate an understanding and knowledge of existing technologies in the area of aircraft wireless solutions and associated ground stations. Provide a conceptual design, which will produce an integrated solution based on the T-45C architect. The system concept and performance parameters are to be derived in Phase I.

PHASE II: Develop and demonstrate a prototype system that does not interfere with electronics and electrical aircraft systems. Demonstrate the necessary controller circuitry and software to download ADR data to a ground station and hand-held unit and demonstrate the functionality of the system.

PHASE III: Transition the wireless down load technology to the Fleet and produce capable system integration.

PRIVATE SECTOR COMMERICAL POTENTIAL: Commercial applications of this technology include recreational aircraft, commercial automobiles, and commercial aircraft.

REFERENCES:

1. Bensky, Alan. Range Estimation for Short-Range Event Transmission Systems. http:/rfdesign.com/ar/radio_range_estimation_shortrange/

2. Leeper, David G. Wireless Data Blaster. http://www.sciam.com/print_version.cfm?articleID=0002D51D-0A78-1CD4-B4A8809EC588EEDF

3. Torvmark, Karl H. Embedded System Programming. http://www.embedded.com/story/OEG20020926S0055

4. Wireless Data Standards and Technology Report. http://www.pswn.gov/admin/libarydocs12/WirelessDataStandards_SummaryReport3.pdf

5. Zimmerman, T. G. "Wireless Networked Digital Devices: A New Paradigm for Computing and Communication." http://www.research.ibm.com/journal/sj/384/zimmerman.html

KEYWORDS: ADR; Wireless; Radio Frequency; Digital; Transmission; Communication

N05-005 TITLE: Wing and Bomb Bay Launched (WBBL) Unmanned Air Vehicle (UAV)

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Develop a small UAV launched from a wing station or the bomb bay and controlled from P-3 aircraft in direct support of their mission.

DESCRIPTION: Due to the diverse missions and the limited quantity of P-3 aircraft, the most economical and expeditious way to enhance their operations and assure crew safety is to incorporate the use of small tactical UAVs. These UAVs are a cost-effective way to add to the unique mission capability associated with P-3 operations. If incorporated into each of these aircraft, a load-out of wing or bomb bay launched UAVs with interchangeable payloads, i.e., Infrared (IR), television, radio frequency (RF), HS, etc., tailored to the specific mission could be locally launched, controlled by the on-board sensor operators, and be utilized to assist the platform in carrying out its mission. It would not only enhance the sensor capability, but also in effect allow the aircraft to operate in several areas at the same time due to the UAVs ability to detect/confirm contact data and relay information to the airborne crew without forcing the aircraft to leave station. Additionally, the UAV would keep the crew out of harms way, as it would allow penetration and operation in areas that would be deemed hostile for manned operations.

The advantage of a universal WBBL UAV with the ability to have interchangeable payloads is that the bomb racks are standardized throughout the P-3 and other aircraft communities, propagating cost and time savings through consolidation of efforts, and reduction of redundant technology. These bomb racks include the BRU-12/A (P-3C Bomb Bay Stations), BRU-14/A (P-3C Bomb Bay Stations) and BRU-15/A Bomb Release Units (P-3C Wing Stations) with 14 inch or 30 inch (w/adapter assembly) suspension. In the end, each aircraft/community would be able to configure their aircraft based on mission requirements/needs.

While there are currently commercial off-the-shelf electro-optical (EO) equipment, cameras, receivers, and transmitters small enough to fit into the WBBL UAV application, there are no small tactical UAV vehicles designed to be launched from a wing or bomb bay and associated delivery systems currently in use. Based on current concept of operation studies, these vehicles would need to weigh less than 1000 pounds, be deployed at air speeds of 150 to 250 knots and altitudes of 5,000 to 30,000 feet, have an air speed less than 100 knots, have a flight duration more than 6 hours, and a range of greater than 150 nautical miles to meet current P-3 mission requirements. The propulsion can be accomplished by gliding, electric motors or heavy fuel engines. This capability is four to five years from introduction into operational scenarios.

PHASE I: Develop a design approach to meet the requirements for a wing and bomb bay launched UAV.

PHASE II: Develop and produce a UAV capable of launch from Navy P-3 aircraft utilizing the current bomb racks. Demonstrate capability for the aircraft to safely launch the vehicle, interact with it in tactically useful behaviors, and have plug and play payloads (EO/IR, RF, etc.)

PHASE III: Produce qualified UAV assets for use by the Navy maritime patrol aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be used by other government sectors for homeland defense purposes. Using search and rescue organizations would enable a wider area search than can be accomplished by current airborne assets as well as by commercial fishing fleets. In addition, they could potentially be utilized by fire fighting organizations to drop into large-scale fires to map the location of hot spots and the forward edge of the fire.

REFERENCES:

1. UAV Roadmap, April 2001, http://www.globalsecurity.org/intell/library/reports/2001/uavr0401.htm

2. BRU-12 Bomb Rack, http://www.fas.org/man/dod-101/sys/ac/equip/bru-12.htm

3. BRU-14/A weapons/stores rack, http://www.fas.org/man/dod-101/sys/ac/equip/bru-14.htm

4. BRU-15 Bomb Release Unit, http://www.fas.org/man/dod-101/sys/ac/equip/bru-15.htm

KEYWORDS: UAV; Maritime; Surveillance; P-3; Crew Safety; Intelligence, Surveillance, and Reconnaissance; Reconnaissance

N05-006 TITLE: <u>Radar Detection and Discrimination of Small Maritime Targets at High Altitude and Grazing Angle</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop a high-altitude, high-grazing-angle radar signal processing approach to detect and discriminate small maritime targets by exploiting the differences between small maritime targets and sea clutter.

DESCRIPTION: Maritime surface search radars have traditionally been operated at low altitudes when searching for small maritime targets such as periscopes and small boats. A major reason for this operational choice is that the mean radar sea clutter return drops significantly at low grazing angles (i.e., <10-15 degrees grazing), so target radar returns are readily masked by the large clutter signature. However, operation at high altitudes (10,000s of feet) will greatly extend the radar horizon, and, with effective signal processing techniques, will yield large search rates and hence enable persistent wide area surveillance. With current and future missions being developed for unmanned aerial vehicles, it is essential to their success to be able to execute intelligence, surveillance, and reconnaissance missions from higher altitudes and grazing angles than has been routinely done in the past. The feasibility of radar operation in this high altitude/grazing angle regime is dependent in part on the development of methods to discriminate between sea clutter and small targets of interest.

PHASE I: Define a candidate signal processing approach leveraging the statistical characteristics of sea clutter and hard body radar returns at high altitudes/grazing angles. Identify radar architectures necessary to support the signal processing approach. Identify how current and emerging radar systems might exploit these techniques with modest enhancements.

PHASE II: Design, build, and test a prototype radar processor that automatically detects and discriminates signatures associated with small maritime targets in near real time.

PHASE III: Design, build, and test a real-time radar processor that automatically detects and discriminates signatures associated with small maritime targets.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The signal processing approaches could be applied to a wide range of surveillance applications including large-area search and rescue operations, maritime counter-drug operations, and monitoring activities within the exclusive economic zone. The products of this small business innovative research would also be of significant importance to Homeland Security for coastal and harbor surveillance.

REFERENCES:
1. Ward, K.D., Baker, C.J., and Watts, S. "Maritime Surveillance Radar Part 1: Radar Scattering from the Ocean Surface." IEE Proc. F, Radar & Signal Processing, Vol. 137, 1990, pp. 51-62.

2. Gasparovic, R.F., and Jensen, J.R. "Sea Clutter Statistics and Detection Performance of High-Altitude Maritime Search Radars." SRO-04-01, JHU-APL, January 2004.

KEYWORDS: Radar Scattering; Radar Sea Clutter; Maritime Surveillance; Small Maritime Targets; Target Detection; Homeland Security

N05-007 TITLE: Nondestructive Inspection (NDI) of Small-Diameter Titanium Tubing

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: V-22

OBJECTIVE: Develop an NDI system capable of inspection of the interior wall of small-diameter titanium tubing for flaws 0.001 inch in depth and less.

DESCRIPTION: A nondestructive and rapid assessment technique is desired that will detect shallow cracks (less than 0.001 inch depth) and sharp trenches (approximately 0.0005 inch width and 0.001 inch deep) on the interior surface of small-diameter (typically ¼-inch outer-diameter) thin-wall (typically 0.0225-inch) titanium tubing. Inspection of tubing diameters up to 0.75-inch-diameter is also desired. The tubing is in both straight and bent shapes. It is inspected during production and installed on aircraft. Tubing lengths may be 10 feet and more. The development of portable inspection equipment of small size is therefore desirable. Higher inspection speed will translate to lower costs and increase the attractiveness of the technique.

PHASE I: Develop a conceptual design and construct a laboratory demonstration for proof of principal. It is desirable to detect micro cracks on the order of 0.001 inch and smaller in depth on the inside surface of the tube with lengths of several thousandths of an inch. Surface irregularities on the order of 0.0005 inch should be detected.

PHASE II: Construct and evaluate a prototype system. Use real tubing samples to refine testing parameters. Optimize system design for portability and small size for field inspections. Design and construct a field portable system.

PHASE III: Finalize the design and produce a system for transitioning to field use.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Most aircraft use small thin-wall hydraulic tubing for device actuation. High-speed portable inspection would prove very attractive for increased flight safety.

REFERENCES:
1. "Standard Practice for Ultrasound Examination of Metal Pipe and Tubing," ASTM E-213-04.

2. "Standard Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys," ASTM E-426-98, 2003.

KEYWORDS: Tubing; Hydraulic; NDI; NDE; Titanium; Inspection

N05-008 TITLE: Multiple Source Capable Miniature Directional Acoustic Receiver

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop innovative miniaturized sensors for use in helicopter, unmanned air vehicle (UAV), and multi-mission aircraft (MMA) multistatic antisubmarine warfare (ASW) systems.

DESCRIPTION: The use of an air deployed acoustic receiver is an accepted, effective enhancement for air ASW and is presently used for the extended echo ranging (EER) system and its variants. These systems have been based on airborne acoustic sources available or under development. However, recent studies have indicated that considerable performance gain can be achieved through the use of multistatic receivers used in conjunction with other high-power active source such as helicopter airborne low frequency sonar (ALFS), surface ship SQS-53C sonar, off-board multistatic ASW capability enhancement (MACE), and Distant Thunder. Additionally, the high effective target strength available from specular geometries suggests that highly multistatic sonar system deployments may overcome the harsh acoustic environments likely to be encountered with quiet diesel-electric threats to be prosecuted in littoral environments. In operation, a relatively dense field of acoustic receivers would be deployed encompassing the search area, and the source or sources available and appropriate to the mission would acoustically illuminate the area. Note that both coherent and impulsive sources could be used in the same mission. The numerous positions for receipt of echo energy would significantly improve multistatic operations, including specular opportunities. The small size and low cost of the miniaturized receivers enable cost-effective deployment from helicopters and P-3 aircraft. Potentially, UAVs could benefit in the future.

The U.S. Navy is looking for new and innovative directional miniature broadband acoustic sonobuoy receivers for use by all active multistatic programs. The present directional sensor SSQ-53 (DIFAR) uses ceramic vane technology to determine the direction of the incoming signal. These vanes are arranged in orthogonal pairs yielding a receive beam pattern of two orthogonal cosine functions. Direction of the incoming signal is determined by the ratio of the levels appearing on the two orthogonal beams that are then referenced to a magnetic compass reading. This technique gives acceptable performance for A-size sensors but when the sensor size is reduced (smaller than A-size diameter) the frequency response, acoustic sensitivity, dynamic range, self-noise level and beam pattern are degraded. The Navy desires to investigate alternate measurement technologies that will enable the achievement of the legacy DIFAR performance in smaller than A-size e.g. MJU-10 package.

PHASE I: Identify innovative solution(s) for the technology and establish feasibility through paper study analysis, component developmental testing, or computational computer modeling. Analyze the achievable frequency response, sensitivity, dynamic range, and self-noise tradeoffs associated with the new measurement technologies. Establish volume budget with tolerances for major components. Based on the study/analysis propose a preliminary design concept for packaging the sensor in the MJU-10 size store.

PHASE II: Develop and fabricate the prototype design concepts(s)proposed in Phase I. Verify that the acoustic performance goals for sensitivity, bandwidth, beam pattern, dynamic range and self-noise are met. Based on the initial test results propose design modification(s) to achieve or further improve the performance goals/requirements. The prototype should include the miniature directional sensor and any associated signal conditioning electronics. The electronics need not meet the miniature packaging requirements if miniaturization is too costly.

PHASE III: In conjunction with sonobuoy vendors, integrate the technologies into a logistically supportable miniature package that is compatible with air carriage and air drop for existing and future Navy launch platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The small size, low cost, and standardized form factor will enable use of these sensors for marine mammal surveys, commercial harbor defense, and potentially drug interdiction of high-speed drug smuggling vessels.

REFERENCES:
1. Program Executive Officer (PMA-299) Air ASW, Assault, and Special Missions Programs, “Technology Issues,” 5 February 2002.

2.N88 "Air ASW Vision Statement" at http://www.hq.navy.mil/airwarfare/Programs/N880E/Air%20ASW%20Vision%20Statement.htm

3. Mission Needs Statement for "Multi-Static Search System Compatible with Rotary Wing, UAV and other weight and volume Limited ASW Platforms," May 1999. (Available on SITIS)

4. Raytheon Company, Airborne Low Frequency Sonar (ALFS) AN/AQS-22 System Overview, http://www.raytechstaffing.com/products/alfs/.

5. AN/SSQ-53 Directional Frequency Analysis and Recording Sonobuoy, http://www.fas.org/man/dod-101/sys/ship/weaps/an-ssq-53.htm

KEYWORDS: Miniaturized; Sensors; Multistatic Antisubmarine Warfare (ASW); Chaff; Flare; Acoustics

N05-009 TITLE: Alternative Material for Beryllium Copper in Military Aerospace Applications

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and demonstrate an alternative material to copper-beryllium (CuBe) in military aerospace applications, specifically for CuBe bushings in high-load, stress, and wear environments.

DESCRIPTION: Beryllium compounds are widely used in military aerospace applications because of Be's ability to impart desirable properties to alloys even at quite low concentrations (less than 5 percent). These desirable properties include elevated melting point, resistance to oxidation, decrease in density-to-strength ratio, and increased modulus of elasticity. Typical applications include bearings, bushings, and electrical conductivity improvements. The Occupational Safety and Health Administration (OSHA) (regulatory requirement) and American Conference of Governmental Industrial Hygienists (ACGIH) (consensus guide) are calling for reductions in exposure levels for Be. There is continuing potential for Be dust emission to the environment and concurrent personnel exposure since the typical applications are in high-wear/high-vibration environments that produce dust. This dust exposure can occur when performing remove and replace operations or during aircraft compartment investigations. Alternative materials must meet the requirements of Society of Automotive Engineers (SAE) AMS 4534 (Cold Worked to 177Ksi Ftu for <2" rod) specification and be compatible with other aircraft system materials such as aluminum; titanium; and SAE AMS 3281 sealants, primers, and topcoats. The use of the alternative alloy should not interfere with the logistical and operational requirements of the manufacturer or potential Fleet level users.

PHASE I: Demonstrate the feasibility of the proposed alternative material to perform in high-strength high-load-capable low-wear bushings and bearings and to meet all requirements.

PHASE II: Develop and demonstrate prototype material(s) for conformance to SAE AMS 4534. The material should be capable of meeting the performance criteria of the stated specification and meet application requirements for the aircraft manufacturer and repair activities.

PHASE III: Transition to the Fleet. Ensure that any logistical constraints that may negatively affect program schedules have been resolved. Provide a drop-in replacement for CuBe.

PRIVATE SECTOR COMMERCIAL POTENTIAL: All current military aircraft (F-16, F/A-22, C-130, C-5, F-18, etc.) utilize CuBe alloys in many different applications. All of these aircraft platforms face the same concerns with respect to beryllium. In addition, commercial manufacturing or repair facilities could realize significant cost savings by utilizing less occupationally hazardous alloys.

REFERENCES:

1. SAE AMS 4533, Copper-Beryllium Alloys.

2. "OSHA Occupational Exposure to Beryllium, Request for Information." Federal Register Vol. 67, No. 228, 26 November 2002.

3. ACGIH, 2003 TLVs® and BEIs®, Threshold Limit Values for Chemical substances and Physical Agents and Biological Exposure Indices. Notice of Intended Changes.

KEYWORDS: Copper; Beryllium; Beryllium Dust; CuBe Bushings; Bearings; Alternative Materials

N05-010 TITLE: Efficient Low-Cost Interface Coatings for Three-Dimensional (3-D) Reinforced Ceramic Matrix Composites (CMCs)

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and demonstrate effective low-cost boron nitride (BN) interface coatings for 3-D reinforced CMC components.

DESCRIPTION: The JSF and other military platforms are targeting CMCs for exhaust and engine applications with an ultimate goal of weight reduction. However, concerns exist over acquisition cost, reliability, durability, and life expectancy. CMCs are typically fabricated with two-dimensional (2-D) woven CG Nicalon fabric reinforcement, which is coated with a BN interface coating. 2-D CMC components have been found to be life-limited in high thermal gradient environments due to inherently low matrix dominated interlaminar shear strengths. 3-D fiber architectures offer the promise for increased durability by enhancing the interlaminer and through-thickness mechanical properties; however, ineffective and inefficient processing issues need to be resolved.

The specification of 3-D composite architectures is problematic for the application of the interface coating using existing technology. Weaving 3-D preforms with coated fibers inevitably abrades the coating and renders it ineffective. A preferred approach is to coat the woven preform with a BN coating with controlled chemistry and controlled layer thickness. Current approaches for applying the interface coating are effective for 2-D fabric; however, they exhibit limitations when considered for 3-D architectures since the interface coating is prevented from permeating throughout the fiber preform. Efficient methods for ensuring that the interface coating is deposited uniformly on the fiber architecture throughout the 3-D preform is required. Requirements for the BN interface coating include low oxygen content and a minimum thickness around each filament. Stability of the BN interface coating is expected to have a major influence on the durability of ceramic composites, which will be affected by exposure to salt-water environments for Navy applications.

PHASE I: Develop efficient low-cost approaches for applying BN interface coatings on 3-D fiber architectures woven with CG Nicalon, using low-oxygen BN coatings. Demonstrate the feasibility of applying one such approach by uniformly coating different types of 3-D woven preforms, and by fabricating and testing coupon specimens.

PHASE II: Provide practical implementation of a production-scaleable process to implement the recommended interface coating approach developed under Phase I. Evaluate the processing approach through the fabrication and testing of a sufficient quantity of material property test coupons. Develop a 3-D reinforced design for a CMC propulsion component and fabricate the part using the recommended interface coating method.

PHASE III: Transition the interface coating process to the JSF and additional propulsion and high temperature applications such as hypersonic platforms and the J-UCAS.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advanced CMC propulsion components have the potential to transition to the commercial aircraft market for weight reduction and enhanced life expectancy. The resulting processing approaches can transition to the energy and chemical industries for such applications as hot gas filters, radiant burners, corrosive handling equipment, waste incinerators, and power turbines.

REFERENCES:

1. Staehler, James M., and Zawada, Larry P. “Performance of Four Ceramic Matrix Composite Divergent Flap Inserts Following Ground Testing on an F110 Turbofan Engine.” J. Am. Cer. Soc. Vol. 83, No. 7, 2000.

2. Lee, S. Steven, Zawada, Larry P., Staehler, James M., and Folsom, Craig A. “Mechanical Behavior and High-Temperature Performance of a Woven Nicalon/Si-N-C Ceramic Matrix Composite.” J. Am. Cer. Soc. Vol. 81, No. 7, 1998.

3. More, K. L., Tortorelli, P.F., Lin, H.T., Lara-Curzio, E., and Lowden, R.A. “Degradation Mechanism Interfaces in SiC/SiC Composites in Oxygen- and Water-Containing Environments.” High T Corrosion and Materials Chemistry, Vol. 98-9, Editors: Hou, P.Y., McNallen, M.J., and Oltra, R. The Electrochemical Society, Pennington, N.J., 1998, pp. 382-94.

KEYWORDS: Ceramic Matrix Composite; Three-Dimensional Reinforcement; Fiber Interface Coating; Propulsion Systems; Interlaminar; Boron Nitride

N05-011 TITLE: Damage Tracking for Helicopters

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop and fabricate a wireless sensor to measure strain in dynamic components for Navy/Marine helicopters. Investigate the use of energy harvesting techniques to power the wireless strain sensors to minimize the maintenance burden of battery power.

DESCRIPTION: The structural life design process for Navy/Marine helicopters is one in which the usage is based largely on predictions as to how severely the aircraft are expected to be flown. Strains imposed on dynamic components are obtained by flight-testing with a fully instrumented (strain gauges/load cells/accelerometers) aircraft. Having been designed and tested to this predicted usage when the aircraft enters service, it is presumed that they are operated exactly in this manner. However, prior studies have shown that actual usage is often far different from what was predicted. This places individual aircraft and components in the position of being used in situations that are more severe than those for which they were designed, posing a safety risk. Alternatively, they are used less severely or are discarded well prior to the end of their safe life expenditure. The ability to implement the required instrumentation on multiple aircraft with today’s technology is impractical due to reliability issues associated with slip rings, exposed wiring, and strain gages operating in the sand, rain and sea-salt naval environment.

Installing structural monitoring sensors on one or more of the current Navy/Marine helicopters and measuring the actual loads imposed on each part could provide the data on a flight-by-flight basis. This information would then be converted into an accrued damage calculation on an individual component basis. The actual component damage and replacement time can then be compared to the current component replacement history and a description of the cost savings would be generated.

Innovative hardware solutions are sought that measure strain on individual components and deliver the data using wireless technology. Emphasis should be placed on a wireless strain gauge/sensor, capable of being used in the dynamic naval helicopter environment. The sensor must survive the shock, vibration, and temperature environments of helicopter rotor systems. In addition, this technology should be powered at least partially using energy harvesting techniques such as converting rotor torques, vibrations, and/or temperatures into energy that can be used to power the wireless sensors.

PHASE I: Develop a conceptual design for a wireless strain measurement and energy harvesting system that meets the needs of the Navy. Perform a bench test using a simulated helicopter environment in order to demonstrate the potential for wireless transmittal of strain information using energy harvesting techniques to power the sensors.

PHASE II: Develop detailed designs for the Phase I sensor and fabricate a limited number of sensors suitable for proof of concept testing on a Navy/Marine helicopter. Demonstrate functionality and data collection ability in a flight test environment. Develop a prototype of the overall system that would allow data collection and work well with other Navy systems that perform life calculations and component management.

PHASE III: Transition the sensor to Fleet aircraft (H-60, H-53, H-1, etc.) and integrate it with existing Fleet maintenance practices.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system will directly transition to many existing commercial helicopters.

KEYWORDS: Structural Monitoring; Wireless Sensors; Energy Harvesting; Helicopter Dynamic Components; Strain, Battery Power

N05-012 TITLE: Generic Electronic Interface Module for High Temperature Actuators

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and demonstrate open systems solution to the general problem of interfacing electronic controls to actuators in extreme environments in air vehicles. Improved performance and reliability of actuators used in air vehicle and propulsion control systems exposed to extreme thermal environments, with reduced total ownership cost and open systems interface(s).

DESCRIPTION: Current air vehicle and propulsion system thermal environments limit the standardization of interfaces, and other benefits, provided by distributed electronics in actuators and other accessories. The thermal environment of propulsion systems and flight control actuators in projected super-cruise air vehicles will be more demanding. A generic electronic module able to operate reliably above 400 deg. F. (initial target) is required to achieve the objectives. The following core functionality set for such generic actuation electronics is desired:
• Multiplex two-way data communications (over power wires and/or shared data bus, wireless an option)
• Actuator position feedback
• Signal conditioning for common pressure and temperature sensors
• Speed/frequency detection/conditioning
• Non-volatile memory capacity to store calibration and usage data

NOTE: Maximum physical integration and minimum digital processor requirement desired.

PHASE I: Demonstrate feasibility, capability and costs for proposed options and technologies; recommend a design concept and preliminary design for demonstration.

PHASE II: Detail design and fabrication of a prototype of the recommended approach, followed by integration and bench test in a representative actuator and environment. Demonstrate on a propulsion system (or equivalent) rig test.

PHASE III: If successful, it is expected that this technology will initially progress to applications in weapon systems and air vehicles operating in sustained supersonic cruise. These applications may include both propulsion and flight control. Follow-on applications to propulsion systems for more conventional air vehicles are also likely.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This development is expected to provide benefits for commercial aerospace propulsion, enabling improved control modes at reduced cost and weight. The interface module is also expected to find applications to actuation in industrial processing and petroleum exploration where extreme environments for controls are a common challenge.

REFERENCES:
1. Lall, Pradeep, Pecht, Michael, and Hakim, Edward. Influence of Temperature on Microelectronics and System Reliability: A Physics of Failure Approach. New York, NY: CRC Press, 1997.

2. McCluskey, F. Patrick, Grzybowski, R., and Podlesak, T. High Temperature Electronics. New York, NY: CRC Press, 1997.

3. Course at CALCE, http://www.calce.umd.edu/general/education/high_temperature_electronics.htm

4. SiC Components for Aircraft, http://www.grc.nasa.gov/WWW/SiC/aircraftbenefit.html

5. Dmitriev, Vladimir, Chow, T. P.; DenBaars, Steven P.; Shur, Michael S.; Spencer, Michael G. High-Temperature Electronics in Europe.

6. Kirschman, Randall. High-Temperature Electronics. Wiley-IEEE Press, ISBN: 0-7803-3477-9, August 1998.

7. Goetz, Jay. Sensors That Can Take the Heat. Honeywell SSEC, June 2000.

8. http://www.cnrs.fr/cw/en/pres/compress/Diamond.htm

9. http://www.eng.auburn.edu/department/ee/ADC-FCT2001/ADCFCTabstract/162.htm

10. SBIR: High Temperature Gallium Nitride-Based Sensors and Electronics. http://sbir.gsfc.nasa.gov/SBIR/successes/ss/5-009text.html

11. Wick, David G. Realizing Distributed Engine Control Subsystems Through Application Of High Temperature Intelligent Engine Sensors And Control Electronics. Honeywell SSEC, 1999.

12. Bratland, Tamara, and Wan, Dr. Hong. Linear Position Sensing Using Magnetoresistive Sensors. Honeywell Solid State Electronics Center.

13. Avionics And Engine Control Application Examples High Temp Operation (225°C). Honeywell Solid State Electronics Center, October 1999.

KEYWORDS: Propulsion; Control; Actuation; Thermal; Supersonic; High Temperature

N05-013 TITLE: Multi-Level Secure High-Speed Fiber-Optic Data Bus

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop integrated system components that provide low-cost, lightweight, robust, maintainable, flexible, high-speed, high-bandwidth, multi-level secure interconnectivity of aircraft avionic systems; accommodate both deterministic/real-time and non-real-time legacy protocols and connectivity for data, streaming data, video, and imagery transfer; and provide growth potential for future avionic systems and protocols.

DESCRIPTION: Fiber-optic technology, including wave division multiplexing fiber optics, is growing in usage and becoming more prevalent in commercial aircraft and satellite systems with the number of potential commercial suppliers growing. For example, 10-gigabit fiber-optic Ethernet exists today in many systems, including aircraft avionic systems. Also systems such as Fiber Channel and Firewire exist today in aircraft systems. Unfortunately, these systems are not robust enough, do not readily accommodate deterministic real-time requirements such as 1553B and ARINC 429, and do not handle multiple levels of security. To meet these requirements, system architectures typically are a mixture of copper and fiber with redundancies for robustness or replication for different security levels/enclaves.

A single optical fiber running in a ring architecture throughout an aircraft platform holds the potential to meet all present and future bandwidth needs; meet different security level requirements; reduce redundancies; accommodate all necessary legacy and future protocol and timing requirements; be maintainable over the life of the host platform; and significantly reduce weight, power, cooling, electromagnetic interference/electromagnetic compatibility shielding and other limitations of existing solutions. It is expected that this effort would use existing technology and build the integration elements, e.g., protocol adapters, to develop a fiber-optic system backbone suitable for present and future aircraft systems with low-cost, open, commercially available technology.

PHASE I: Develop a backbone architecture design concept and demonstrate the feasibility of meeting the stated objective. Ensure system design meets all requirements and is certifiable and accreditable for multi-level secure operations and segregation of avionic and navigation signals from mission data. Ensure system design accommodates all information types and provides significant growth potential.

PHASE II: Develop and evaluate integrated laboratory and flight demonstration systems and reassesses cost, weight, risk, etc. technical findings. Reassess future commercial availability of needed system components and costs. Develop a roadmap for integration on existing and future aircraft systems.

PHASE III: Integrate as spirals into existing and future aircraft systems as a commercially available system and components.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The system components could be applied in any number of other military platforms, commercial aircraft, and commercial data management systems.

REFERENCES:

1. Bretthauera, J. W., Chalfantb, C. H., Orlandoc, F. J., Rezekd, E., and Sawyere, M. “Spaceborne Fiber Optic Data Bus (SFODB).” NASA Goddard Space Flight Center, Code 561; Greenbelt, Maryland

2. Hunter, D. K., and Lowe, E. D. "Wavelength Use in Optical WDM Bus Networks without Wavelength Conversion." Optical Networks and Their Applications, OSA TOPS, Vol. 20, pp. 168-175.

3. Desurvire, Emmanuel. “Erbium-Doped Fiber Amplifiers, Principles and Applications.” ISBN: 0471264342, June 2002.

4. “Waveguides Force Diode Laser into Single Mode.” Photonics Research, March 2004 Edition, IEEE Photonics Technology Letters, January 2004, pp. 12-14.

5. “Erbium-Doped Fiber Amplifier Displays Low Noise.” Photonics Research, October 2003 Edition, IEEE Photonics Technology Letters, August 2003, pp. 1055-1057.

KEYWORDS: Fiber Optics; Data Bus; Multi-Level Security; Protocols; Robust; Imagery

N05-014 TITLE: <u>New Weather Depiction Technology for Night Vision Goggle (NVG) Training</u>

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop innovative technology to depict various weather/atmospheric conditions to aircrew undergoing Night Imaging and Threat Evaluation (NITE) training in conjunction with the 10’ by 10’ static Night Vision Terrain Board (NVTB).

DESCRIPTION: The Navy is seeking new and innovative technologies that will provide accurate and reliable weather/atmospheric simulation as part of night vision device (NVD) training. The imaging provided by NVDs changes dramatically as atmospheric and lighting conditions change. Currently, all U.S. Navy, U.S. Marine Corps, and some U.S. Coast Guard and U.S. Air Force units responsible for initial NVD training are using the Night Imaging and Threat Evaluation Laboratory (NITE Lab) concept. The NITE Labs utilize a 10' by 10' static terrain model equipped with both natural and cultural lighting that are used to demonstrate various illumination conditions, and visual phenomena which might be experienced when utilizing night vision devices. Military aircrew use night vision devices in varying weather and atmospheric conditions. Current capability does not exist to provide realistic, dynamic high fidelity weather depiction modeling capabilities in conjunction with the NVTB. Previous attempts to provide this capability have been unsuccessful and do not accurately model (algorithms) the atmospheric effects for near-IR imaging. An innovative system is sought that will simulate or replicate the effect(s) of varying weather conditions (i.e., rain, fog, snow) /atmospheric effects (i.e., smoke obscuration) as viewed through the windscreen of the aircraft. The system should be able to integrate and accommodate the physio-optic characteristics of Night Vision Device stimulation with the unique lighting requirements of the night vision terrain board. This system is intended for use in NITE Lab classes with multiple students. The technology should be capable of training at least three students at one time with full weather simulation. It should also allow for mobile weather simulation and be able to take advantage of different angles and aspects of the NVTB to emphasize learning points while using NVDs.

PHASE I: Investigate the technical feasibility of technology to simulate weather effects/atmospheric effects of NVDs. Develop a conceptual design for an accurate and reliable simulator that can be easily incorporated into the current NITE Lab scenario and meets all of the technical challenges.

PHASE II: Develop a detailed design for the Phase I simulation and fabricate a prototype. Demonstrate and evaluate the prototype in a designated NITE Lab environment.

PHASE III: Enhance the prototype developed in Phase II and co-locate it with the designated NITE Lab. Transition the prototype system to a designated organization.

PRIVATE SECTOR COMMERCIAL POTENTIAL: NVD indoctrination training is performed by multi-Service and multi-national facilities utilizing the NVTBs. Weather/atmospheric simulation is needed at all locations using static terrain models to provide effective NVD training. Spinoff uses are envisioned for NVD training in the civilian sector (e.g., search and rescue, drug interdiction, border patrol).

REFERENCES:
1. Knowles, S.J. "Night Vision Goggles-Integration and Operation in Fast Jet Aircraft: An Airworthiness Perspective." Proc Instn Mech Engrs 212, 1998, pp. 319-324.

KEYWORDS: Night Vision Goggles (NVG); Night Vision Terrain Board (NVTB); NVG Indoctrination; Weather Depiction Window; Training

N05-015 TITLE: Aircraft High-Power Semiconductor Line Contactors

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Develop innovative flight worthy high power solid-state switch technology to replace electro-mechanical power line contactors and to improve transfer of electrical power to aircraft power buses. Performance improvements should include quick, high reliability, light weight, fault free smart switches that can detect power loss/transient faults and automate bus transfers within miliseconds.

DESCRIPTION: The E-2 and C-2 aircraft are equipped with two 400-hertz, three-phase, 115-volt ac generators operating at up to 90 KVA through two main buses. During any power source deactivation, the single remaining generator supplies power to all respective buses. Bus transfer of power is accomplished through several electro-mechanical main line contactors only capable of 250 amps per phase. Main line contactor reliability has proven to be unacceptable due to age and overloading of the contactors. Mechanical interfaces are prone to failure due to weak springs and contactor arc-over damage. Failure of the primary power source may degrade aircraft power performance due to slow or missing contactor transfers, resulting in loss of platform systems during critical flight regimes. Electro-mechanical designs also limit aircraft electrical power characteristics to older specification limits of MIL-STD-704A, requiring modern avionic systems to incorporate weight increased power hold circuits to maintain operation. New and innovative smart switching technology is sought to increase reliability and improve and automate transfer of electrical power to aircraft power buses and detect power loss/transient faults. New and innovative packaging of this technology is sought in capability of low voltage application of up to 260 amps.

PHASE I: Determine the feasibility of an aircraft high power distribution system design that will allow quick, reliable, lightweight semiconductor power line smart contactors capable of delivering three-phase 115-volt 260-amp electrical power with the ability to transfer power to the main buses within miliseconds while simultaneously detecting power source failure.

PHASE II: Develop and demonstrate a flight worthy high power prototype semiconductor main line contactor for aircraft electrical power distribution systems. Demonstrate its suitability to MIL-STD-704(AS) electrical power characteristics and MIL-E-81910 environmental test methods.

PHASE III: Qualify new high power smart switching technology to MIL-STD-704. Manufacture, package, and integrate new high power smart switching technology for use in E-2C aircraft power distribution systems. The unit(s) will be subjected to full laboratory and aircraft qualification testing and flight test profiles.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be applied to any aircraft, auto or industrial high power distribution systems using high current electro-mechanical switching devices.

REFERENCES:
1. MIL-STD-704 (AS). Department of Defense Interface Standard, Aircraft Electric Power Characteristics.

2. MIL-E-81910. Military Specification, Electrical Power Generating and Control Equipment, Aircraft, General Specification for.

KEYWORDS: Contactors; Electrical; Power; Electro-Mechanical; Semiconductor; Distribution; Aircraft

N05-016 TITLE: Radar Multiscan Processing Algorithm Improvement

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop new radar signal preprocessing, and clutter identification and rejection algorithms that increase the number of nonclutter measurements available for local active sensor tracking of maneuvering targets, while reducing the probability of false detections.

DESCRIPTION: Many time critical data processors use simple and computationally inexpensive, but highly suboptimal, prefilters to separate relevant from irrelevant data; for example, radar detection and tracking systems. Radars that operate in dense or high clutter environments must solve the problem of separating legitimate target reflections from background noise, which can be especially difficult when the target is maneuvering. A common technique for separating clutter from target reflections is to preprocess the radar data by finding sequences of returns across multiple scans or detection frames that appear to come from a moving, but non-accelerating, target. Radar measurements that pass these multiple scan tests are then passed to the main tracking algorithm; those that do not are identified as clutter. This creates a conundrum: a non-maneuvering tracker filters measurements that are then provided as input to a maneuvering tracker. The unfortunate consequence is that the most important detections, those made while the target is maneuvering, frequently fail to meet the prefilter's criteria and make no contribution to the track picture. Recent advances in computing and data processing, such as multiple hypothesis and multiple frame correlators, have made sophisticated filters practical for real time systems. In the radar-tracking problem these advanced technologies have typically been applied to the maneuver-tracking phase, after the data have been prefiltered, and exploit only the kinematic or position information contained in the return. The purpose of this small business innovative research is to extend these technologies to the earlier, more data-dense part of the radar processing chain. The research should propose not only improved run time performance, but also and more importantly extension of these techniques to the non-kinematic information contained in the data. For example, the research should consider Doppler effects, signal to noise ratios, and scintillation characteristics, and other attributes that can discriminate between target reflections and clutter.

PHASE I: Develop a conceptual multiple scan radar prefilter, and demonstrate its effectiveness at separating maneuvering target reflections from background clutter through analysis or simulation.

PHASE II: Fully develop the methodology and software for the alternative filter. Demonstrate the algorithm's performance using recorded data or data from a validated, high fidelity simulation of an E-2C APS-145 radar.

PHASE III: Integrate the new algorithm into the E-2C radar data processor and demonstrate its capabilities in laboratory and flight tests.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercially available surveillance radars for law enforcement and air/sea traffic control require similar signal processing capabilities to reduce clutter. An advanced multiscan processing algorithm improves tracking capabilities and thus enhances the operator target awareness and traffic management capacity.

REFERENCES:

1. Bar-Shalom, Y., Li, X., and Kirubarajan, T., Estimation with Applications to Tracking and Navigation, John Wiley and Sons, New York, 2001

2. Bernstein, R. "An Analysis of Angular Accuracy in Search Radar." IRE National Convention Record, Vol. 3, No. 5, 1955, pp. 61-78.

3. Blair, W.D., and Bar-Shalom, Y. Multitarget-Multisensor Tracking: Applications and Advances. Vol. III. Boston, MA: Artech House, 2000.

4. Cantrell, B.H., and Trunk, G.V. "Angular Accuracy of a Scanning Radar Employing a Two-Pole Filter." IEEE Transactions on Aerospace and Electronic Systems, Vol. 9, No. 5, September 1973, pp. 649-655

5. Chen, H., Pattipati, K., Kirubarajan, T., and Bar-Shalom, Y., General Data Association with Possibly Unresolved Measurements Using Linear Programming, 2003 Workshop on Multi-Object Tracking, Madison WI.

6. Dunham, D. and Hutchins, R., Tracking Multiple Targets in Cluttered Environments with a Probabilistic Multi-Hypothesis Tracker, Proceedings from the 1997 SPIE Conference on Acquisition, Tracking, and Pointing XI, Orlando, FL, April 1997

7. Galati, G., and Struder, F.A. "Angular Accuracy of the Binary Moving Window Radar Detector." IEEE Transactions on Aerospace and Electronic Systems, Vol. 18, No. 4, July-982, pp. 416-422.

8. Mori, S., Barker, W., Chong, C., and Chang, K., Track association and track fusion with nondeterministic target dynamics, IEEE Transactions on Aerospace and Electronic Systems, April 2002

KEYWORDS: Surveillance Radar; Range-Bearing Estimation; Centroid Processing; Target Tracking; MSP; Clutter Reduction

N05-017 TITLE: Automatic Three-Dimensional (3-D) Target Template Generation

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop an innovative technique that automatically generates 3-D target templates that provide high-resolution digital elevation models (DEMs), differentiate between natural terrain and man-made objects, and provide enhancement capabilities such as infrared characteristics or corner point 3-D location extraction.

DESCRIPTION: Currently, several commercial off-the-shelf software tools are used to generate part of the 3-D target templates, which requires considerable human intervention. A major part of manual intervention is to assure the DEMs are based on actual ground versus man-made objects, i.e., buildings, which are false elevation points. Automation of this process alone could benefit several other highly manually intensive projects.

Automation of 3-D target template generation requires the ability to reliably extract edges from stereo electro-optical (EO) imagery to define man-made objects and to connect these edges with the actual ground DEM. A primary goal is to create a template with minimal false points such that little or no manual editing will be required. Once the template is defined and tied to ground control points, a 3-D point can be extracted for any point within the template. For this effort, assume digital point positioning data base (DPPDB) images are being used directly or stereo EO imagery is controlled to DPPDB for orientation. For infrared (IR) seeker applications, the ability to infer building material of these edge-extracted objects is required to understand the expected emissivity signature with the weapon IR sensors. In addition, each 3-D target template requires a reliable estimate of its quality for specific applications. Such performance predictions may well vary by sensor orientation to the target and by environmental conditions.

PHASE I: Demonstrate an overall understanding of 3-D target-template generation complexity. Demonstrate the feasibility of an overall algorithmic approach to generate 3-D target templates that includes the three main parts of the templates: feature extraction, minimization or elimination of false DEM elevation points, and attributes (inferred building materials). Finally, develop an approach to reliably estimate the quality of each 3-D target template.

PHASE II: Develop a prototype that demonstrates the ability to automatically generate 3-D target templates and estimate their quality. Optimize performance and tune algorithms based on demonstration results.

PHASE III: Integrate the 3-D target templates into operational systems such as the Tomahawk Command and Control Systems (TC2S) and Distributed Common Ground Station-Navy (DCGS-N).

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability can be applied to the commercial market sector in a wide range of applications that uses 3-D scene perspective, e.g., remote sensing, mapping, and medical imaging.

KEYWORDS: Sensor Data Exploitation; 3-D; Image Processing; Edge Extraction; Feature Extraction; DEM

N05-018 TITLE: Visualization Techniques for Multi- and Hyperspectral Imagery Exploitation

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Aid the imagery analyst in the screening and exploitation of sensor data, focusing on the data intensive multi-and hyperspectral imagery, by using graphic user interfaces (GUIs) and novel visualization techniques that cue the analyst to specific wavelength bands.

DESCRIPTION: Various programs address autonomous extraction of targets from different sensors. However, there is minimal progress being made towards techniques that focus on supporting/aiding the imagery analyst in semi-automatic extraction of targets. In particular, multi- and hyperspectral data exploitation require a high level of proficiency to determine which band or bands correlate with particular targets, features, and other important geographic characteristics.

Research is needed as to how and what type of GUI and other visualization techniques should be developed to aid the analyst in extraction and identification of regions of interests. Regions/objects of interest, target detection and classifications (and probability of each potential classification), and geographic characteristics, i.e., beach areas, land covers, vegetation, etc., are all associated with imagery screening and exploitation tasks. The research should be extended to encompass the automatic extraction of the unique attributes within an image once a GUI is activated. In terms of visualization, it is important to identify what and how much of the resulting image to present to the imagery analyst after GUI activation to speed the decision process.

GUI and visualization techniques are critical elements in defining what type of data the analyst needs based on tasking to exploit an image that allows automatic highlighting of regions of interest. Each of the GUIs should represent a specific characteristic within an image. Another goal is to define the GUI and visualization based on the analyst profile (needs or tasking) and/or type mission and/or type of sensor.

PHASE I: Demonstrate the feasibility of the proposed solution to meet the stated objective.

PHASE II: Develop a prototype of the visualization techniques, demonstrate functionality, optimize performance, and tune algorithms based on user demonstration results.

PHASE III: Integrate sensor-specific GUIs and visualization techniques into a workstation in full operational condition.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability can be applied to the commercial market sector in a wide range of applications that uses image analysts, e.g., remote sensing, industrial machine vision, and medical imaging.

KEYWORDS: Sensor Data Exploitation; Imagery Analyst; Imagery Screening; Imagery Exploitation; Sensor Characteristics; GUIs

N05-019 TITLE: Physical Phenomenon Visualization in F-35 Maintainer Training

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and test physical phenomenon visualization software for interactive courseware (ICW).

DESCRIPTION: The development of software that will identify methods for depicting effects of physical forces (i.e., torque) or phenomenon (i.e., fluid dynamics) in the most effective manner is an area of interest to both commercial and military training. The availability of software tools with embedded instructional guidance for courseware developers is critical to the capability of the developer to design ICW that incorporates these objects. Maintenance related physical phenomena should be mapped to instructional methods using known empirical or theoretical data. A number of presentation methods can be used to accomplish instruction goals. These include simulation, a VRML virtual environment, two-dimensional and three-dimensional graphics, photographs, or video. Empirical and theoretical guidance should be used to develop supporting guidance within a software tool for instructional designers and developers.

PHASE I: Determine the feasibility of and develop a design concept for interactive courseware that provides supporting guidelines for instructional designers on the theoretical use of physical phenomenon visualization software.

PHASE II: Build and test a prototype based upon the concept prepared in Phase I including the prototyping of software development tools needed. Produce a concept demonstration ICW to further assess the effectiveness of the derived techniques compared to methods currently employed in ICW.

PHASE III: Develop a software package of the tools for deployment in a military facility and commercial training program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This research has application in the educational and commercial arenas. The study could draw from and add to visualization in physics studies in education and research. Applications of lessons learned could also be derived in commercial training as well as in any application that employs visualization of physical phenomenon in educational institutions, research facilities, manufacturing and engineering professions.

REFERENCES:
1. Mayer, R. E. "Multimedia Learning. Are we Asking the Right Questions?" Educational Psychologist, Chapter 32, 1997, pp. 1-19.

2. Mayer, R. E., and Moreno, R. "Animation as an Aid to Multimedia Learning." Educational Psychology Review, Chapter 14, 2002, pp. 87-99.

3. Monro, A. "Authoring Interactive Graphical Models." The Use of Computer Models for Explication, Analysis, and Experiential Learning, 1994.

4. Towne, D. M. "Automated Knowledge Acquisition for Intelligent Support of Diagnostic Reasoning." Authoring Tools for Advanced Technology Learning Environments: Toward Cost-Effective, Adaptive, Interactive, and Intelligent Education Software, 2002.

KEYWORDS: Interactive Courseware; Simulation; Information Visualization; Modeling; Information Display; Performance Enhancement

N05-020 TITLE: Advanced Helmet Display Electronics

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop improved performance light modulation and drive electronics for displaying imagery for helmet mounted displays (HMD).

DESCRIPTION: The electronic component that modulates light based on the video signal is the key component in determining the performance of displays. The electronics that drive this component also play a key role in performance, functionality, and cost. The kind of advances that will improve HMDs for use in aircraft as well as real-time simulation training include such parameters as contrast, gamma, size of drive electronics, efficiency, accurate synchronization with minimal time delay, black level, uniformity, cost, etc. The technology will be incorporated into a display for use in real-time training simulation.

PHASE I: Develop a preliminary design approach beneficial to real-time simulation training that addresses issues of production cost, risk, weight, performance, and ease of incorporation. Evaluate performance benefits, technical risk, and productization risk.

PHASE II: Develop the technical solution as a prototype. Demonstrate it in a display appropriate for real-time training simulation.

PHASE III: Integrate the solution into training simulator programs. Productize the proposed solution.

PRIVATE-SECTOR COMMERCIAL POTENTIAL: Advances in HMD electronics will very likely translate to advances in other head mounted displays due to highly shared technology. HMD is widely used in commercial industries from movie making to medical. Advances in HMD electronics will help maintain a viable/competitive product line for this U.S. manufacturing industry.

REFERENCES:
1. Head Mounted Displays: Designing for the User. New York: McGraw Hill, 1997.

KEYWORDS: Simulation; Training; HMD; Light Modulation; Virtual Reality; Display

N05-021 TITLE: Field Portable, Low Cost, Fiber-Optic Reflectometer

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop a fiber-optic field-portable hand-held instrument capable of finding the location of fiber breaks, point discontinuities, or other locations of signal loss within a couple of centimeters over 100 meters or less of cable. The intent is to utilize state-of-the-art opto-electronic integrated circuit technology to develop the low-cost fiber-optic equivalent of an omni present electrical multimeter.

DESCRIPTION: In order for optical fibers to be effectively used for communications in aerospace applications, it is necessary to trouble shoot fiber breaks and bend losses. The current state-of-the-art for commercial applications typically utilizes optical time-domain reflectometry (OTDR) to identify break locations. Besides finding a break, OTDRs can also determine the magnitude of the loss over a link and determine the size of reflections (as well as a number of other characteristics well beyond the minimum maintenance needs). If provided with the right software, an OTDR can provide a highly intelligent, user friendly, front end that simplifies the interpretation of the test data and minimizes the training required by the user.

Current state-of-the-art OTDRs designed for telecommunications applications have achieved the desired cost target, have the ruggedness required to survive in the field, and are provided with an intuitive user interface to simplify their use. Unfortunately, they have resolutions and/or dead zones on the order of tens of meters, which can be the total link length for aerospace applications. A resolution on the order a few centimeters is required to be effective for use on aircraft. Reflectometers available for aerospace applications have achieved the required resolution. However, they utilize technology that is very expensive; typically lacks a user interface, which would make them easy to use; and appear to be modified laboratory units, which fail to meet the weight, ruggedness, or power requirement necessary to make them portable.

The hand-held instrument must be lightweight (10 pounds) and approximately the size of a standard electrical multimeter. To achieve the size, weight, reliability/ruggedness, portability, etc. objectives, application of state-of-the-art opto-electronic integrated circuit technology is anticipated. The opto-electronic development should enable extension to transceiver built-in-test (BIT) and/or link health monitoring, as well as the capability to test future wavelength division multiplexing (WDM) and/or radio frequency photonic networks. Other methodologies besides the industry standard, full-featured OTDR should be considered.

PHASE I: Evaluate the feasibility of the proposed technology to achieve the resolution and dynamic range requirements. Develop a recommended design concept and determine its ability to meet the requirements. Evaluate its applicability to WDM networks, and the potential future extension of the technology to handle transceiver BIT and link health monitoring.

PHASE II: Perform a final evaluation of the recommended technology and demonstrate the solution in a hand-held, integrated package with a working user interface. Include both the fabrication of the opto-electronic hardware necessary to achieve the measurement equipment as well as integration of the opto-electronics into a suitable portable package (showing size and weight reduction).

PHASE III: Complete the user interface.

PRIVATE SECTOR COMMERCIAL POTENTIAL: While the long-distance commercial market appears to have addressed its needs, the short-distance computer room of the not too distant future will likely use WDM networks extensively used. Current test equipment is ill suited to support this. Initiatives have begun looking at various standards organizations for the right end-user group to begin discussions of networking architectures for computer room WDM networks. The technology resulting from this small business innovative research (SBIR) will address their testing needs.

REFERENCES:
1. Derickson, D. Fiber Optic Test and Measurement. Prentice-Hall, 1998.

KEYWORDS: Fiber Optics; Optical Time Domain Reflectometry (OTDR); Optical Frequency Domain Reflectometry (OFDR); Wavelength Division Multiplexing (WDM); Testing; Built-in Test (BIT)

N05-022 TITLE: Advanced Techniques for Electrical Wire Fault

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop electrical wire diagnostic and prognostic technology that can detect electrical opens and shorts as well as latent faults such as damaged/degraded insulation, conductors, shields, and corroded connectors.

DESCRIPTION: Current generation technology is making advances in the diagnosis/prognosis of aircraft wiring but has started to exhaust the capabilities of time domain reflectometery, frequency domain reflectometery, and standing wave ratio technologies. These technologies have demonstrated the ability to detect opens and shorts, and their abilities to locate these faults are improving. Unfortunately, they have not been able to successfully demonstrate the ability to reliably detect latent faults, detect faults in branched circuits, and locate these faults on active circuits. In addition, they require access to both ends of the wiring system. Current generation technology, although a significant improvement over the multimeter used by the Fleet today, will still require the maintainer to remove aircraft panels, break connections at both ends of the wire, and disturb existing wire in the process of troubleshooting the wire. Innovative solutions are sought in one or more of the following areas:

• Fault Locating on Electrical Wire Networks/Branch Circuits. Current technology does not support location of any type of fault using a single-ended testing of a wire network/branched circuit. With aircraft having many branched circuits, it is important to be able to locate electrical wire faults on any of those branches.

• Latent Fault Locating. Since latent faults, such as chafing and other small anomalies of the electrical insulation on the wire, account for 37 percent of the short circuit and arcing of electrical wiring on naval aircraft, new techniques are needed for easily locating these latent faults at all maintenance levels (organizational, intermediate, and depot). This may include advancement of reflectometery technology, the advancement of algorithms for interpreting the reflectometery signatures, and the advancement of user-friendly interfaces.

• Fault Locating on Active Circuits. Many latent faults are not detectable during troubleshooting because the circuit is not live and the symptoms of the latent fault are only detectable in the presence of power or signal transmission.

PHASE I: Develop and demonstrate innovative techniques for electrical wire diagnostic and prognostic approaches, and develop an implementation plan. Validate the approach analytically or provide test data or bench top hardware that would validate the approach.

PHASE II: Design, develop, and demonstrate the technology that can reliably diagnose electrical wire faults addressing one, some, or all of the subtopics above.

PHASE III: Package and integrate electrical wire diagnostic and prognostic technology for use at Navy maintenance organizations.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The issue of aging wiring and the diagnosis and troubleshooting of wiring faults is common to commercial and military aviation. In addition, any densely wired system such as ships, submarines, subways, nuclear power plants, etc., all have the issue of aging wiring and troubleshooting wiring faults.

REFERENCES:
1. Furse, C., Chung, Y.C., Dangol, R., Nielson, M., Mabey, G., and Woodward, R. “Frequency-Domain Reflectometery for On-Board Testing of Aging Aircraft Wiring.” IEEE Transactions on Electromagnetic Compatibility, Vol. 45, No. 2, May 2003.

2. Furse, C., and Haupt, R. "Down to the Wire: The Hidden Hazard of Aging Aircraft Wiring." IEEE Spectrum, February 2001.

KEYWORDS: Wiring; Reflectometery; Latent Faults; Diagnostics/Prognostics; Branch Circuits; Active Circuits

N05-023 TITLE: Lightweight Ballistic Armor for Military Aircraft

TECHNOLOGY AREAS: Air Platform, Materials/Processes

OBJECTIVE: Develop, fabricate, and test ballistic armor that is innovative, lightweight, and cost effective, and can be installed in aircraft structures.

DESCRIPTION: Many aircraft platforms would be able to supplement crew protection schemes if a lightweight and cost effective armor were made available for military use. Currently, aircrews are only partially protected at best during conflicts. The weight penalty suffered by the installation of current protection systems is prohibitive, and would require the significant loss of payload or range, which often is not negotiable. Significant weight reduction could allow more aircraft platforms to incorporate more armor protection. The proposed armor technology must be able to stop projectiles at the following protection levels and weight goals. Installation weight is not included in the following weights but the capability to install the armor with a low associated installation weight is critical for transition to a Navy platform:

- Protection Level 1: 7.62 x 39 mm ball round; velocities up to 2,500 ft/sec; 0 degree obliquity angle; goal of <3.5 lb/sq ft
- Protection Level 2: 7.62 x 51 mm (NATO) armor piercing (AP); velocities up to 2500 ft/sec; 0 degree obliquity angle; goal of <4.5 lb/sq ft
- Protection Level 3: 12.7 x 99 mm M2 AP; velocities up to 2000 ft/sec; 0degree obliquity angle; goal of <9 lb/sq ft

While there is not a specified manufacturing cost goal for each protection level, cost reductions greatly improve the likelihood of system implementation. Low cost could also open the armor technology to use in land warfare systems such as body armor or high mobility multipurpose-wheeled vehicles (HMMWV). Thinness of the armor is desirable. High deflection of the armor can lead to blunt trauma on passengers, causing incapacitation or death. Therefore, static and dynamic defection of the armor (upon impact) should be low and will be determined and evaluated during test.

The armor materials must be compatible with a shipboard aircraft environment (e.g., acceleration, temperature, vibration, fluid compatibility, humidity and salt fog constraints) as detailed in MIL-STD 810. Reparability and maintainability are also critical factors.

PHASE I: Develop a conceptual design for the material and manufacture testable coupons of the material. Perform limited ballistic tests on the material at one or more of the protection levels in order to validate the material's potential. Weight and performance results are critical.

PHASE II: Develop detailed designs and manufacturing techniques for the armor. Construct and place the fabricated samples on an aircraft "mockup" for in-depth testing for each of the three protection levels described above, and at a range of velocities. Determine the velocity at which 50 percent of the shots penetrate the armor (referred to as V50). The V50 goals are those listed in the protection levels. Provide sufficient data to thoroughly characterize the ballistics of the armor. The testing should consist of no less than 50 shots per protection level, including a range of velocities and impact angles. Weight, performance, cost to manufacture, and ease of aircraft integration are critical evaluation factors. Multi-hit capability of the armor, as well as minimum spacing of those multiple rounds stopped by the armor must be determined and will be evaluated, but there are no specific goals for this. The contractor may have limited access to the government range facilities as necessary at no cost to the Phase II contract.

PHASE III: Test the armor (ballistic, integration, airworthiness, etc.) on an in-service aircraft in need of lightweight ballistic protection.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Lightweight armor could be transitioned into law enforcement vests used to protect personnel. Likewise, a transition to wheeled vehicles would provide better performance and a reduction in the costs of armoring law enforcement vehicles.

REFERENCES:
1. MIL-STD-662F, V50 Ballistic Test for Armor.

2. MIL-STD-367A, Armor Test Data Reporting.

3. MIL-STD-810F, Environmental Engineering Considerations And Laboratory Tests.

KEYWORDS: Armor; Ballistic Protection; Aircraft Armor; Lightweight Armor; Structure; Material

N05-024 TITLE: Development of an Accelerometer-Based Shaft Coupling Prognostic Indicator

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop advanced vibration analysis technology that can accurately identify the features that provide a prognostic health indication for highly loaded mechanical transmission couplings.

DESCRIPTION: Highly loaded mechanical transmission couplings are utilized to compensate for alignment tolerances over relatively long transmission paths. These couplings are typically safety critical components in aviation, land, and sea-based power systems. As such, frequent inspection and monitoring regimens are put in place to ensure that failures do not occur. These inspections are costly and time consuming. The development of a real-time vibration analysis technology to provide an accurate prognostic health indication can reduce or eliminate the existing inspection regimen.

PHASE I: Define the prognostic accuracy required to eliminate today's inspection regimens. Identify and evaluate candidate vibration processing algorithms for their effectiveness in meeting these previously defined requirements. Select the top two algorithms based on their prognostic accuracy and their computational burden.

PHASE II: Develop and demonstrate a system prototype with the selected algorithms in a real time environment with representative processing hardware during seeded fault rig testing of a selected mechanical power transmission coupling.

PHASE III: Finalize the design and integrate it into a comprehensive asset readiness management system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The development of this capability can eliminate costly routinely schedule maintenance actions for aviation, land, and sea-based mechanical power transmissions where couplings are required.

REFERENCES:
1. Henley, S., Currer, R., Sheuren, B., Hess, A., and Goodman, G.. "Autonomic Logistics—The Support Concept for the 21st Century." IEEE Proceedings, Track 11, Paper zf11_0701.

2. Byer, B., Hess, A., and Fila, L. "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics." Aerospace Conference 2001, IEEE Proceedings, Vol. 6, pp. 3095-3103.

3. SAE E-32 Committee Documents. http://forums.sae.org/access/dispatch.cgi/TEAE32_pf/showFolder/100001/def/def/3f4f

4. IEEE Aerospace Conference Proceedings for 2001 and 2002, Track 11, PHM.
KEYWORDS: Vibration Analysis; Shaft Coupling; Prognostics; Diagnostics; Prognostic Health Maintenance (PHM); Transmission

N05-025 TITLE: Efficient Low-Cost Ceramic Grade Nicalon Textile Sizing for High-Temperature Polymer Matrix Composites

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and demonstrate effective low-cost textile sizing for ceramic fiber reinforcements used in polymer matrix composite (PMC) components.

DESCRIPTION: The JSF and other military platforms are targeting high-temperature PMCs for turbine engine fan and exhaust applications with an ultimate goal of weight reduction. However, concerns exist over their acquisition cost, reliability, durability, and life. Some PMCs are fabricated with two-dimensional (2D) woven ceramic grade (CG) Nicalon fabric reinforcement, which requires coating of the textile fiber with a compatible sizing to avoid yarn packaging and weaving damage. The laminated PMC components have also been found to be structurally limited in their intended thermal environments due to inherently low translation of the fiber/matrix properties and poor thermo-oxidative stability of the current state-of-the-art silicone based DCC-2 sizing. Textile sizing that provides improved properties for these laminated fabric composites offers the potential for increased performance and durability by enhancing the mechanical properties; however, their intrinsic processing issues will need to be resolved.

The specification of a textile sizing for ceramic fiber is required for both weaving of the fabric and fabrication of high-temperature structural composite applications using the existing sizing technology. Without a protective textile sizing, the weaving process damages ceramic yarns due to abrasion, reducing both quality and the structural efficiency in the resulting composite. Efficient materials and methods for ensuring that the sizing is deposited uniformly on the ceramic yarn are required. Requirements for the sizing also include efficient translation of the fiber properties to the matrix that will benefit the overall composite behavior. Shelf life of the sizing prior to composite fabrication is important and the thermal stability of the sizing in the final cured composite is expected to have a major influence on the translation of properties and the durability of polymer composites. Severe thermal cycling and exposure to salt-water environments experienced by Navy applications can affect these properties.

PHASE I: Demonstrate proof-of-concept for structurally efficient low-cost textile sizing and suitable approaches for applying it uniformly to CG Nicalon. Demonstrate the approach by uniformly sizing CG Nicalon yarn, weaving a representative sample, and fabricating and testing composite coupon specimens from it.

PHASE II: Provide a practical implementation approach for a production-scaleable process to implement the recommended textile sizing approach. Define the required test plan for the qualification of the Phase I processing approach for the manufacture of PMC propulsion components. Using a subset of the test plan, evaluate the processing approach through the fabrication and testing of a sufficient quantity of test specimens. Demonstrate a PMC propulsion component by fabricating the part using the recommended textile sizing method.

PHASE III: Transition the CG Nicalon textile sizing material and process to additional propulsion applications such as hypersonic platforms and the Joint Unmanned Combat Air Systems (J-UCAS).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advanced PMC propulsion components have the potential to transition to the commercial aircraft market for weight reduction and enhanced life expectancy.

REFERENCES:

1. "High Temperature Organic Matrix Composite (HTOMC) Technology Transition," WL-TR-97-4023. GE Aircraft Engines Company, Sponsored by Materials Directorate, Air Force Research Laboratory, 1997.

2. Broutman, L. J., and Agarwal, B. D. " A Theoretical Study of the Effect of an Interfacial Layer on the Properties of Composites." Polymer Engineering Scientific, Vol. 14, 1974, p 581.

3. Petrisko, R. A. "NICALON SiC Fiber in Plastic Matrix Composites." Proceedings of High Temple Workshop VI, Cocoa Beach, Florida, 1986.

KEYWORDS: Polymer Matrix Composite; Organic Matrix Composite; Fiber Sizing; Ceramic Fiber; Propulsion Systems; Textile Sizing

N05-026 TITLE: Design Tools for Fatigue Life Prediction in Surface Treated Aerospace Components

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop a validated design tool to predict fatigue behavior in components subjected to residual compression inducing surface treatments.

DESCRIPTION: No comprehensive set of design tools exists to predict fatigue behavior of metallic systems in the presence of deep compressive residual stresses induced by surface treatments such as laser shock processing and low plasticity burnishing. A validated design tool would be extremely useful since it would reduce the costly experimental iteration currently required to field each new application. Further, it would allow for optimized designs rather than those that simply meet the requirement.

A successful design system will allow for the prediction of fatigue behavior in components containing both applied stresses and residual stresses induced by processes including, but not limited to, laser shock processing (LSP), low plasticity burnishing (LPB), and conventional shot peening. A successful design system will also be capable of accounting for elastic stress concentrations. An incorporated methodology for predicting lower bound fatigue behavior due to the material damage and residual stress states surrounding foreign object damage (FOD) would also be desirable.

PHASE I: Demonstrate the feasibility of the proposed model to predict fatigue behavior in a relevant alloy in simple configurations that can be tested using conventional methods. Conduct critical experiments to ensure that model inputs not available in literature are available. Demonstrate the model's ability to predict residual stresses.

PHASE II: Develop and demonstrate a prototype model. Demonstrate that the model can reasonably predict fatigue performance of relevant geometries including stress concentration and surface treatment induced compressive residual stresses. Deliver the model in the form of a user friendly, executable code or as a package that can be used with commonly available finite element modeling software.

PHASE III: Integrate model into design systems at client original equipment manufacturers (OEMs).

PRIVATE SECTOR COMMERCIAL POTENTIAL: The impact of surface treatment induced residual stresses has been limited to certain high value added applications where costly empirical optimization could be accommodated. Robust design tools such as those proposed in this document will facilitate better life predictions on existing components and more efficient new designs through the incorporation of residual stresses. Such a capability would be readily adopted by aerospace OEM's in order to increase or maintain competitive advantage.

REFERENCES:
Residual Stresses in Life Prediction:
1. Beghini, M., Bertini, L. (1990). "Fatigue Crack Propagation Through Residual Stress Fields with Closure Phenomena." Engineering Fracture Mechanics 36(3): 379-387.

2. Beghini, M., Bertini, L., Vitale, E. (1994). "Fatigue Crack Growth in Residual Stress Fields: Experimental Results and Modelling." Fatigue Fract. Engng Mater. Struct. 17(12): 1433-1444.

3. Boyd, K. L., S. Krishnan, et al. (1997). Development of Structural Integrity Analysis Technologies for Aging Aircraft Structures: Bonded Composite Patch Repair and Weight Function Methods. WPAFB, OH, Flight Dynamics Directorate, Wright Laboratory, AFMC: 133.

4. Glinka, G. (1979). Effect of Residual Stresses on Fatigue Crack Growth in Steel Weldments Under Constant and Variable Amplitude Loads. Fracture Mechanics, ASTM STP 677. C. W. Smith, American Society for Testing and Materials: 198-214.

5. Glinka, G. and G. Shen (1991). "Universal Features of Weight Functions for Cracks in Mode I." Engineering Fracture Mechanics 40(6): 1135-1146.

6. Kang, H. J., Song, J. H., Earmme, Y. Y. (1989). "Fatigue Crack Growth and Closure Through A Tensile Residual Stress Field Under Compressive Applied Loading." Fatigue Fract. Engng Mater. Struct. 12(5): 363-376.

7. Mutoh, Y., Fair, G. H., Noble, B., and Waterhouse, R. B. (1987). "The Effect of Residual Stresses Induced by Shot-Peening on Fatigue Crack Propagation in Two High Strength Aluminum Alloys." Fatigue Fract. Engng Mater. Struct. 10(4): 261-272.

8. Shen, G. and G. Glinka (1991). "Determination of weight functions from reference stress intensity factors." Theoretical and Applied Fracture Mechanics 15(1991): 237-245.

9. Shen, G. and G. Glinka (1991). "Weight functions for a surface semi-elliptical crack in a finite thickness plate." Theoretical and Applied Fracture Mechanics 15: 247-255.

10. Shen, G., A. Plumtree, et al. (1991). "Weight Function for the Surface Point of Semi-Elliptical Surface Crack in a Finite Thickness Plate." Engineering Fracture Mechanics 40(1): 167-176.

Surface Treatment Methods:

1. Peyre, P. and R. Fabbro (1995). "Laser shock processing: a review of the physics and applications." Optical and Quantum Electronics(27): 1213-1229.

2. Clauer, A. H. and D. Lahrman, F. (2001). Laser Shock Processing as a Surface Enhancement Process. International Mechanical Engineering Congress & Exposition, Orlando, FL, Trans-Tech Publications, Switzerland.

3. Montross, C. S., Tao Wei, Lin Ye, Graham Clark, and Yiu-Wing Mai (2002). "Laser Shock Processing and its Effects on Microstructure and Properties of Metal Alloys: a Review." International Journal of Fatigue 24(10): 1021-1036.

4. Prevey, P., Gabb, T., Ravindranath, R., Shepard, M. (2003). Case Studies of Fatigue Life Improvement Using Low Plasticity Burnishing in Gas Turbine Engine Applications. ASME Turbo Expo, Atlanta, Georgia, ASME.

KEYWORDS: LSP; LPB; Life Prediction; Residual Stress; Multi-Axial Fatigue; Component Surface Treatments

N05-027 TITLE: Integrated Combined Sensor System for Situation Awareness and Aircraft Self-Protection

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop an advanced all weather, all aspect, multi spectral threat warning system by fusing two-color infrared (IR) and radio frequency (RF) leading edge technologies. The proposed system would solve two survivability requirements: all aspect warning and enhanced situational awareness. While a new system is envisioned, the proposed avionics must use imbedded radar warning receiver processing equipment and cabling as well as current cockpit indicators using host system conventions to reduce costs.

DESCRIPTION: Currently, fixed- and rotary-wing tactical aircraft have significant threat problems from both RF and IR guided surface-to-air missiles. Countermeasure systems to defeat these types of threats are limited. The APR-39 and ALR-67 are RF warning sensors. The AAR-47 is an ultraviolet (UV) IR warning system. All of these systems can be found in Jane's. Both types of sensors consume space, weight, and operating and support costs. Leading edge technology is just now working on uncooled IR focal plane arrays that go beyond the limitations of the current UV sensors.

In this research project, the Navy is seeking innovative, leading edge technology to investigate a concept that would permit fusing, in one package, uncooled IR technology behind an RF antenna in one sensor/aperture, producing one composite missile warning alarm and location. The new multi band missile warning sensor would contain both the IR and RF sensing function and transmit high-speed data as well as power requirements down an existing coaxial RF line and a high speed data line. Both IR and RF sensor functions would be packaged so that a new radar warning receiver (RWR) antenna would have the proper gain and be transmissive to infrared energy for the two color receiver. The IR data would be digitized at the sensor and be multiplexed over a variety of data transmission lines. The new system would utilize extended frequency advanced dual-pole antenna with digital signal processing.

PHASE I: Develop a design concept for the all aspect, multi sensor system that satisfies all of the requirements for next generation IR and RF warning systems. Demonstrate proof of concept for miniaturizing the multi-band sensors as an integrated unit. Evaluate data flow using existing RF lines, Fibre Channel, Firewire, and Hotlink.

PHASE II: Develop and demonstrate a brassboard integrated multi-band sensor in a laboratory environment. Demonstrate the functionality on a full-scale mockup.

PHASE III: Build prototypes to conduct adequate flight-testing. Testing will evaluate the system capability against IR missiles, gunfire, rocket propelled grenades (RPGs), and RF guided missiles. Transition technology to tactical aircraft, rotary wing aircraft, and large aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Potential areas of interest include the electronics industry and commercial aircraft Counter Manpads Program (DHS and commercial airline companies) as well as any areas where data flow across voltage lines, as in high-speed modems using power lines.

REFERENCES:
1. Northrop Grumman Defensive Systems Division Site Map. http://www.dsd.es.northropgrumman.com/sitemap/

2. Jane's Information Group. http://www.janes.com
KEYWORDS: Integrated Sensor System; Situation Awareness; Countermeasures; Focal Plane Arrays; Infrared; Ultraviolet

N05-028 TITLE: Development of False Alarm Mitigation Techniques

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop technologies, methodologies, and model-based approaches to greatly reduce and mitigate false alarms within the prognostic and health management (PHM) system.

DESCRIPTION: PHM is a JSF system function that provides comprehensive assessment and reporting of system health, and detection of performance degradation for safety critical and/or maintenance significant functions. The PHM system is specified to meet a low false alarm rate. This requirement will be met through the development and implementation of advanced methodologies and cross-correlation techniques to improve fault accuracy.

PHASE I: Identify and evaluate techniques to provide false alarm mitigation strategies within a PHM system. Provide a model of the recommended software and algorithms and demonstrate the model's ability to reduce false alarms. Recommend the technique or techniques which show the most promise for follow on development and demonstration.

PHASE II: Develop and demonstrate a protype using the selected techniques in a real time environment with representative processing hardware. Demonstrate the ability of the false alarm mitigation and resolution techniques to perform within a PHM system.

PHASE III: Work with a propulsion or power prime contractor to finalize the design and integrate it into a comprehensive asset readiness management system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The application of hybrid bearings invalidates traditional bearing condition monitoring techniques. For these bearings to become operationally feasible, a condition monitoring capability needs to be developed and deployed.

REFERENCES:
1. Henley, S., Currer, R., Sheuren, B., Hess, A., and Goodman, G.. “Autonomic Logistics-The Support Concept for the 21st Century.” IEEE Proceedings, Track 11, Paper zf11_0701.

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

3. SAE E-32 Committee Documents. http://forums.sae.org/access/dispatch.cgi/TEAE32_pf/showFolder/100001/def/def/3f4f

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

KEYWORDS: False Alarms; Condition Monitoring; Prognostics; Diagnostics; PHM

N05-029 TITLE: Low-Probability-of-Intercept/Low-Probability-of-Detection (LPI/LPD) Data Link

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop a small, powerful, secure LPI/LPD data link for tactical and below unmanned aerial vehicles (UAVs).

DESCRIPTION: There is a need for a robust lightweight, LPI/LPD, secure data link to support tactical and below UAVs. The data link must be capable of receiving and transmitting voice, data, and video over a bandwidth that is hard to detect and exploit. The data link must provide uninterrupted connectivity to at least 30 KMs.

PHASE I: Define an innovative solution that includes performance parameters and design optimization. Define plans, schedule, and cost to develop a prototype. Provide a functioning breadboard for risk reduction and Phase II definition.

PHASE II: Develop and test a prototype design. The prototype must be airworthy.

PHASE III: Produce a fieldable unit that can be integrated into UAVs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This will provide an alternative to high-use frequencies and potentially free up bandwidth that the Federal Communications Commission can allocate to the cell phone industry.

REFERENCES:
1. Win, M. Z., and Scholtz, R. A. "Ultra-Wide Bandwidth Time Hopping Spread-Spectrum Impulse Radio for Wireless Multiple-Access
Communications." IEEE Trans. Commun., Vol. 48, April 2000, pp. 679-689.

2. Foerster, J. R. "The Performance of a Direct Sequence Spread Ultra Wideband System in the Presence of Multipath, Narrowband Interference and Multiuser Interference." Proc. 2002 UWBST, 2002, pp. 87-92.

3. Choi, J. D., and Stark, W. E. "Performance Analysis of Ultra-Wideband Spread-Spectrum Communications in Narrowband Interference." Proc. 2002 MILCOM, 2002.

4. Ramirez-Mireles, F., Win, M. Z., and Scholtz, R. A. "Performance of Ultra-Wideband Time Shift-Modulated Signals in the Indoor Wireless Impulse Radio Channel." Proc. 1998 Asilomar Conf., 1998, pp. 192-196.

5. Welborn, M. L. "System Considerations for Ultra-Wideband Wireless Networks." Proc. 2001 RAWCON, 2001, pp. 5-8.

KEYWORDS: UAVs; LPI/LPD; Secure Data Link; Covert Signal; Ultra-Wideband Communications; Wireless Communication

N05-030 TITLE: All-Weather Feature-Based Combat Identification

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18E/F

OBJECTIVE: Develop air-to-ground combat target identification feature-based algorithm tools to enhance existing template-based tools.

DESCRIPTION: Current image-based identification techniques are a blend of pixel-based pattern matching using images taken from different view angles and empirically based matching (i.e., template-based) with prior images collected with the same or similar sensors. Current feature-based tools are restricted to electro-optic (EO) sensors, which limit their use to clear weather/short range conditions. Shadows and available lighting conditions can also complicate EO interpretation. In addition, these tools are restricted to predetermined view angles, which in turn constrain Blue sensor platform flight paths that can be exploited by Red forces. In addition to attriting Blue sensor platforms, this increased vulnerability hinders the timely collection of Blue sensor data, slowing the Blue Observe, Orient, Decide, Act loop.

Technologies are sought to enhance template-based tools with feature-based tools that use points and lines extracted from the image objects of interest. Solutions should extend combat identification (CID) of objects in images from radio frequency (RF) sensors such as synthetic aperture radar (SAR) and inverse SAR (ISAR), which can be used in all-weather/standoff conditions. The most promising feature-based all-weather approach should be identified with performance estimates. Because of the continuing investment in improving airborne sensors, the focus should be on tools that can upgrade enhancements to deployed platform sensors as well as new sensors that are scheduled for introduction into Fleet airborne platforms.

In light of the recent heightened interest in force protection from “friendly fire” incidents, methods that identify Blue platforms using the same feature-based all-weather tools should be considered. In this way, it may be possible to get additional protection for Blue ground or maritime platforms that can be confused with nearby Red platforms.

PHASE I: Extend existing algorithms and/or formulate new ones. Develop proof-of-concept implementation and/or develop and demonstrate a deterministic (rather than a heuristic) real-time processing capability to accomplish all-weather feature-based CID. Demonstrate basic algorithm capability to identify objects/targets using RF sensors.

PHASE II: Demonstrate that the algorithm and developmental system can perform all-weather feature-based CID on potential targets utilizing minimal sensor data. Develop and demonstrate that this approach is not restricted to limited angles of approach to the objects/targets. Demonstrate the computational requirements of algorithm and developmental system and reduction in the required bandwidth for the object/target transmissions. Demonstrate that the algorithm and prototype system enable automated onboard surveillance, reconnaissance, and identification data processing. Demonstrate the algorithm and prototype system in an operationally representative environment.

PHASE III: Transition to all intelligence, surveillance, reconnaissance, and strike platforms. The transitions can be either a complete CID software system or a set of CID software modules for incorporation into legacy systems and platforms. Incorporate this enhanced capability in the baselines of legacy, developing, and deployed airborne platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Improved fidelity at reasonable computational cost will allow hosting on low-cost platforms, a significant advantage for widespread acceptance and use in the commercial sector. The facility protection capability could be beneficial to the commercial security sector. The facilities protection and identification capabilities could be beneficial to Homeland Security as well as force protection in hostile areas and the identification capabilities could be beneficial to rescue services.

REFERENCES:

1. Gleeson, R., Grosshans, F., Hirsch, M., and Williams, R.M. "Algorithms for the Recognition of 2D Images of M Points and N Lines in 3D." Journal of Image and Vision Computing, Vol. 21, Issue 6, June 2003, pp. 497-504.

KEYWORDS: CID; RF; SAR; ISAR; Target Recognition; Sensors

N05-031 TITLE: Application Specific Integrated Circuit (ASIC) Redesign Approach

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18E/F

OBJECTIVE: Develop a die cell configuration, macro-cell library, and design software logic (DSL) for ASICs that match the parametric characteristics of the original sub-cell and macro-cell.

DESCRIPTION: Modern day foundries use 0.2-um to 0.5-um technology to replace the 0.85-um to 2.0-um technology that was used in the original designs of ASICs. Currently, ASIC redesign or emulation processes attempt to match the performance characteristics at the macro-cell level. New approaches using 0.2-um to 0.5-um technology are sought to develop die at the sub-cell and cell levels to ensure that the overall performance of redesigned ASICs will match the originally designed parameters. The macro-cells will be used in the emulation of 43 obsolete ASICs in the F-18 APG 73 radar. Use of these new emulation techniques should reduce redesign costs and allow the emulations to be performed in less time.

Developing a die with sub-cell parametric characteristics that match the original design while still allowing modern foundries to utilize 0.2-um to 0.5-um technology will further reduce the wafer fabrication costs. Developing the DSL that allows for the proper lay out of metalization, layer definition, and other design guidelines will allow continued long-term support without future risk. The capability to generate the parametric test parameters and screening evaluation is also desired in order to establish a full comprehensive set of parametric performance requirements.

PHASE I: Determine the feasibility of performing parametric matching at the cell and sub-cell levels for ASICs.

PHASE II: Develop initial die cell configurations and common package configurations, create the DSLs for the emitter coupled logic (ECL) and complementary metal oxide semiconductor (CMOS) ASICs, and create the macro-cell library to emulate the first 43 ASICs utilized on the APG-73 radar. Complete certification of the developed ASICs to the component level.

PHASE III: Complete the certification process of the ASICs and transition the technology to production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A lower cost faster response capability to ASIC obsolescence and the avoidance of production line impact due to loss of product support will have commercial applications.

KEYWORDS: ASIC; ECL; CMOS; Design Software Logic; Macro Cell; Radar

N05-032 TITLE: 1024 x 1024 Snapshot Two-Color Infrared Focal Plane Array (FPA) for Air-to-Ground Applications

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18E/F

OBJECTIVE: Improve Navy tactical aircraft infrared (IR) targeting system capability through incorporation of state-of-the-art FPA application, either dual band IR mid-wave (MW) (3-5 um) and long-wave (LW) (8-12um) array or single band large array size formats. Develop snapshot readout capable of forming images simultaneously, as opposed to interlacing or progressive scan.

DESCRIPTION: Dual-band IR FPAs could provide improved mission flexibility for Navy tactical aviation IR sensors by allowing optimization of the image by wavelength under conditions that would be stressing in one band or the other such as humidity, aerosols, haze smoke, and obscurants. The availability of both MW and LW lengths would provide the best that the IR spectrum could deliver for this problem in day/night and in marginal and good atmospheric conditions. The MW band is subject to solar glints and ocean glitter. The LW band is essentially immune to this problem. This could be an advantage when trying to image maritime targets “embedded” in the ocean glitter pattern. Reference 1 describes the impact of dual wavelength approach to imaging as follows: “Two-band IR detection is an important technique for determining the temperatures of objects in a scene and discriminating targets from decoys and background clutter.” Here the simultaneous use of both bands can be used to advantage by exploiting spectral signatures of targets versus decoys or clutter.

The current state of the art for IR focal plane arrays varies greatly by material type and wavelength. In general, arrays of 1024x1024 are becoming more common mostly as a result of the Multifunction Infrared Distributed Aperture System development. Dual waveband (MW/LW) FPAs are now available at 640x480 pre-production array size driven by missile warning and missile defense applications. Furthermore, the use of snapshot readouts is becoming more common as a means to reduce image artifacts. Any of these improvements could in and of themselves provide increased capability to currently fielded IR targeting systems. Current state of the art dual-band arrays have detector sizes on the order of 25 - 30 micrometers. Single band arrays have detector sizes that range from 18 x 18 micrometers to 25 x 25 micrometers. At this dimension a large scale 1024 x 1024 array would be 2 to 2.25 times the size of the current 640 x 480 FPAs and would therefore be incompatible with the legacy system optics. Some legacy infrared systems also use optics that are incompatible with dual-band MW/LW operation. These would require a major optics redesign. Other systems use reflective optics, which could with minor modification be used for dual-band MW/LW operation assuming that the total array size did not exceed the size of the current FPA. Applying these technologies individually or in combinations requires a thorough understanding of legacy system constraints including detector sizes, installation size and power constraints, optical unit cell/pixel size, packaging, i.e., SADA II, and current optics spectral transmission.

For most applications, the optimal improvement would provide both larger scale format and dual-band operation but as an alternative the investigation should look at potential for improvements in system performance through application of either larger scale or dual band (MW/LW). A potential third improvement area is the use of snapshot readout. The investigation should look at the constraints of the legacy system design and determine where the FPA enhancements might be incorporated that would provide additional capability without requirement for legacy system optics redesign.

PHASE I: Investigate trades that could be reasonably accommodated by the legacy systems such as benefits of either larger format array, or selectable/combined dual band (MW/LW) capability along with the feasibility of incorporating multiple improvements including snapshot or progressive scan readouts or some other improved readout capability. Thoroughly examine legacy constraints (i.e., SADA II Dewar) of two candidate systems: the Advanced Targeting Forward Looking Infrared for F/A-18 and Lightning Pod for AV-8 Harrier.

PHASE II: Optimize the most promising alternative that could provide improved Navy targeting pod performance for further refinement and development. Design, manufacture, and demonstrate the prototype focal plane array advancement.

PHASE III: Incorporate the new focal plane array into a prototype dewar for a specific targeting pod. The selected pod will be modified with the improved FPA and modified optics and electronics as required. Conduct preliminary evaluation on performance of specific areas selected for enhancement in laboratory, rooftop, and flight conditions.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial sector for infrared imaging has been directly dependent on the technologies for thermal imaging developed by the Department of Defense. The evolution toward large-scale high-definition television (HDTV) quality thermal imaging for military systems will migrate to the commercial thermal imaging sector, as have the earlier generations of military thermal imaging technologies. Indeed, as HDTV becomes the commercial standard for broadcast video there will be increasing pressure to provide similar quality imaging for commercial thermal imaging systems. The commercial thermal imaging sector has not generally used multi-spectral thermal imaging except in special spectral-radiometric systems. However, the benefits of a dual-band MW/LW thermal imager will find benefits in the commercial sector for reasons similar, though, different from military applications. The MW band will provide higher resolution for a given aperture while the LW could provide better imaging through haze and smoke conditions.

REFERENCES:
1. McDaniel, R., Scribner, D., Krebs, W., Warren, P., Ockman, N., and Mcarley, J. "Image Fusion for Tactical Applications." Proceedings of the SPIE-Infrared Technology and Applications XXIV, Vol 3436, 1998, pp. 685-.

KEYWORDS: Dual Band Focal Plane Array; Target Detection and Recognition; Large Format Focal; Tactical Targeting Pod; Infrared Imaging; Thermal Imaging

N05-033 TITLE: Extended Data Rate MIL-STD-1553 Databus

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18E/F

OBJECTIVE: Utilize communications compression techniques on an ASIC based circuit design to provide enhanced network connectivity by the coexistence of legacy 1Mbps MIL-STD-1553 digital traffic with superimposed high-speed commercial based digital signals such as FibreChannel and/or Ethernet.

DESCRIPTION: Many Naval aircraft and avionics systems developed since the mid-1970s have utilized the MIL-STD-1553 databus as the primary communications path between on-board avionics and sensors. These existing 1553 databuses support a 1 Mbps data rate and operate over 75 ohm shielded twisted pair cable. While sufficient for legacy command/response functions, this data rate is insufficient to meet the higher data rate demands of future Network Centric Operations. In particular, increased data throughput is required to meet the increasing demands for new capabilities involving video, map displays, mission planning, weapons management, reconnaissance, and maintenance loading of larger Operational Flight Programs (OFPs). In order to meet these new data demands, several alternatives exist. Newer technologies and architectures such as Ethernet, Firewire and Fibre Channel are available and are being implemented on later generation aircraft systems using fiber optics and other enhanced copper medium, but the retrofit of these architectures into legacy aircraft already wired for 1553 is expensive and time consuming. Additional 1553 databuses could be added, but this also requires similar cost and aircraft downtime. Finally, data throughput rates could be increased on existing 1553 cable plants by applying modern information technologies. By adapting legacy interfaces in certain critical subsystems to recognize either "standard" or "high speed" data transfers, legacy networks can be augmented to provide the high data rate demands between these subsystems while leaving the remainder of the legacy network intact. These increased bandwidth 1553 networks could also be linked (through network bridges) to newer high-speed networks such as Ethernet or Fibre Channel on later generation aircraft to allow reuse of these enhanced avionics subsystems on multiple aircraft platforms. This approach enables incremental system growth on both legacy and newer aircraft platforms without the need for wholesale architecture redesign and aircraft modifications. Real time principles must be integrated into the technology and demonstrated to meet the environment that includes EMC/EMI and multi-drop applications at greater than 200 Mbps over 100 meters of 1553 cable @10^{-12} bit error ratio (BER). These principles are described as follows:

1. System level stability under variable network load conditions

a. Predictable, no catastrophic critical application failures under changing loads
b. Predictable, rapid recovery for non-critical application failures under changing loads
2. High Utilization
a. Capability for predictable over subscription of bus utilization while maintaining critical functionality and applications
3. Predictable, accurate, and high resolution temporal operation

The innovative research is the enhanced functionality in a single chip design capable to being inserted into existing MIL-STD-1553 PMC design and newly emerging miniature smart weapons.

PHASE I: Leveraging an existing dual mode MIL-STD-1553 technology, develop a proof of concept PC-based 1553 interface capable of functioning as both a "standard" 1Mbps Bus Controller/Remote Terminal as well as a "high speed (greater than 200 Mbps)" multi-drop network interface operating concurrently and non-intrusively over standard 75 ohm, direct and transformer coupled 1553 cable plants. The proof of concept design proposed should address the real time principles presented in the description as well as the capability of handling real time determinism features such as fast response (microseconds) to external interrupts, priority scheduling…etc. Demonstrate both multi-drop (up to 31 terminals) and the ability to simultaneous transmit and receive both 1553 data packets and high speed (200 Mbps) imagery (static and/or video) across standard 1553, 75 ohm cable over 100 meters @10^{-12} bit error ratio (BER).

In conjunction with this interface, develop a proof of concept bridge module capable of transferring data between standard 1553 data packets, new high-speed data packets and Fibre Channel data packets. Provide the design modeling and simulation analysis and circuitry to transfer data to/from the extended 1553 interfaces through the Fibre Channel bridge at both the 1 Mbps and 200 Mbps rates. Demonstrate the ability to intermix "standard" data transfers, "high speed" data transfers and Fibre Channel data transfers utilizing all MIL-STD-1553B protocol options on the low speed side of the bridge and basic Class 3 Fibre Channel protocol on the Fibre Channel side of the bridge.

PHASE II: Using the functionality from Phase I, shrink the design to fits onto an ASIC based PMC form factor design. The design should be capable of withstanding the harsh Naval aviation environment. Additionally, using the interfaces developed in Phase I, develop a Memory Loader/Verifier simulator (MLVS) (PC-Based) capable of emulating the functions of the Navy's existing MLVS while operating both as a "standard" speed loader for legacy equipment and "high speed" loader for modified equipment. Integrate the Fibre Channel to 1553 bridge developed in Phase 1 with the F/A-18E/F Advanced Mission Computer (AMC) via the Fibre Channel Network Switch (FCNS). Develop a Fibre Channel based application for the AMC capable of performing the Operational Flight Program (OFP) load function for the AMC. Demonstrate load time improvements by first loading an OFP benchmark using the legacy 1553 method and then performing the same load via the "high speed" protocol through the FC/1553 bridge. Also demonstrate the capability to transfer imagery or video across the bridge to the F/A-18F large area display.

PHASE III: Shrink the Phase II design to a safety of flight mature article based on a single PCM ASIC based design and provide needed support tools to conduct final test and verification activities.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Increased data rates on legacy 1553 networks may provide significant improvements for commercial aviation in much the same way it can provide enhancements for Naval aviation. Commercial navigation aids are demanding increased data and imagery throughput requirements, and as with Naval aircraft, rewiring aircraft is expensive and time consuming. Likewise, the use of a bridging capability could enable modified avionics to provide enhanced capability to both new and older aircraft systems.

KEYWORDS: Affordable Data Rate Expansion; High-Speed Data Bus; MIL-STD-1553 Data Bus; Fibre Channel Bridge; Network Centric Operations; Imagery

N05-034 TITLE: Conformal X-Band Satellite Communications Antenna Array for Military Tactical Aircraft

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18E/F

OBJECTIVE: Develop a conformal X-Band satellite communications (SATCOM) antenna system for military tactical aircrafts to enable over-the-horizon high-speed communications.

DESCRIPTION: Current Navy tactical aircraft such as the F/A-18 do not have over-the-horizon communications capabilities. The military is relying on SATCOM for this capability. SATCOM capabilities currently span from the ultra-high frequency to the Ka frequency band and are made up of military and commercial systems. The higher frequency band systems provide higher data rates. A new X-Band system, XTAR, is being considered by the Defense Department for their use. This system has many advantages for the military. The technology challenge will to be able to develop a small conformal antenna system for the tactical aircraft, such as the F/A-18. This antenna system not only has to be small and conformal but will need to have a low radar cross section. Other requirements for the antenna system are the need to support both right and left circular polarization, the ability to transmit and receive, and a gain of 25 dBic. The antenna system should provide coverage for the upper hemisphere, which requires a steerable beam since the gain requirement will produce a directive pattern.

PHASE I: Develop and demonstrate antenna design using either computer modeling and/or a fabrication of a lab model antenna system with limited measure data.

PHASE II: Develop, fabricate and demonstrate prototype antenna system. If a laboratory model was developed during phase I further maturity of design is expected to be demonstrated.

PHASE III: Transition this antenna technology for airborne integration, operation evaluation, and production, provided sponsorship is secured from F-18, Joint Strike Fighter, EA-6, P-3, V-22 or other aircraft programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This antenna system would be useful for the commercial aviation community also for use with X-Band SATCOM.

REFERENCES:
1. XTAR, LLC, Arlington, VA, "XTAR Services", PowerPoint Presentation, March 15, 2004, 39 pages.

KEYWORDS: Airborne; Over-the-Horizon Communications; Antenna; SATCOM; X-Band; Antenna

N05-035 TITLE: Innovative Methodology for Composite Structural Durability Analysis

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a methodology for the durability and fatigue analysis of composite structures. Demonstrate how this methodology can be used to analyze the mechanical behavior of airframe structural systems.

DESCRIPTION: A general failure theory for the fatigue of composites does not exist. Engineers rely on building block test programs to develop the components of composite airframes. This expensive process results in “point designs” that are not amenable to change. Thus, each weapon system development program must start from scratch. The need exists to develop a method to optimize composite designs prior to component level durability testing. This method should also generate data that is readily useable by subsequent development efforts. Recent advances in the static strength failure analysis of composites (see reference) may serve as a basis for developing a theory for composite durability and fatigue strength.

PHASE I: Devise a methodology for predicting the durability and fatigue behavior of composite materials. Demonstrate the process of test and analysis on basic coupon or beam specimens. Develop and propose a validation program to be executed in Phase II. Complete the Phase I feasibility study with a plan to commercialize the methods and tools that will be produced in Phase II.

PHASE II: Apply the composite durability analysis to coupons, elements and sub-components. Demonstrate the validity of the method through subcomponent tests. Develop a computer software package that incorporates the calculations required to reduce and store basic laboratory data, to analyze composite designs and to predict durability and fatigue strength. Develop instructions delineating the test procedures and develop user's manuals for the computer code. Provide copies of the instructions, manuals, and code to the Navy for further test and validation.

PHASE III: Upon meeting the Navy's validation requirements, the durability methods will be incorporated into the airframe development process. The computer code supporting the methodology will be available as a commercial product. The methodology and software will be transitioned to airframe companies.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A successful composite durability analysis would find utility throughout the advanced composite materials industry including aerospace, automotive, marine, and power industry applications.

REFERENCES:
1. Gosse, J. H. "An Overview of the Strain Invariant Failure Theory." Proceedings of the Tenth U.S.-Japan Conference on Composite Materials, September 2002, pp. 989-997.

KEYWORDS: Composite Structures; Fatigue; Durability; Airframes; Structural Failures; Building Block

N05-036 TITLE: Low VOC, Isocyanate Free Topcoat for Corrosion Control

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a spray applied, fast-cure, reduced cost, high build, less than 100 g/l Volatile Organic Compounds (VOC), isocyanate free, semi-flexible, UV resistant, acrylic modified polysiloxane topcoat that exceeds the performance requirements of MIL-PRF-85285D and MIL-PRF-81352B for use in Unified Facilities Guide Specification (UFGS)-09971.

DESCRIPTION: To protect against corrosion, all exterior engineered steel structures including Aboveground Storage Tanks (AST) initially receive a three-coat coating system consisting of epoxy primer (MIL-DTL-24441, Formula 159, Type III), epoxy intermediate (MIL-DTL-24441, Formula 152, Type IV), and polyurethane topcoat (MIL-PRF-85285D, Type II) formulated with 304 g/l (2.5 lbs/gal), 340 g/l (2.8 lbs/gal) and 340 g/l (2.8 lbs/gal) of Volatile Organic Compounds (VOCs), respectively, as specified in Unified Facilities Guide Specification (UFGS) -09971 "Exterior Coating of Steel Structures1,2." In effect since August 2002, California's South Coast Air Quality Management District (SCAQMD) Rule 1113 "Architectural Coatings" required all Industrial Maintenance Coatings (IMC) to contain no more than 250 g/l of VOC and, effective August 2006, no more than 100 g/l of VOC. In addition, MIL-PRF-85285D contains isocyanates identified as Hazardous Air Pollutant (HAP) with a Time Weighted Average (TWA) of 0.005 ppm and a Permissible Exposure Limit (PEL) of 0.020 ppm. As such, the development of a spray applied, fast-cure, reduced cost, high build, very low VOC (less than 100 g/l), isocyanate free, semi-flexible, UV resistant, acrylic modified polysiloxane topcoat that exceeds the performance requirements of MIL-PRF-85285D and MIL-PRF-81352B for use in UFGS-09971 is required for current and future environmental compliance. Interested proposers should have previously demonstrated their capability for commercialization and production either by in-house or joint venture partnering. Interested proposers should have the corporate (in-house or joint venture) capability of commercial marketing and production.

PHASE I: Develop a spray applied, fast-cure, reduced cost, high build, very low VOC (less than 100 g/l), isocyanate free, semi-flexible, UV resistant innovative topcoat.

PHASE II: Refine, test and field demonstrate the innovative topcoat developed under the Phase I effort. Demonstrate by standard Industry practice that the topcoat exceeds acceptable performance criteria as detailed in MIL-PRF-85285D and MIL-PRF-81352B, including testing and/or documentation of: VOC, Total Solids (wt), Total Solids (volume), Percent Pigment, Stormer Viscosity, Brookfield Viscosity, Pot Life, Sag Resistance, Theoretical Coverage, Drying Times, Mixing Ratio, Shelf Life, Infrared Analysis, Heavy Metals, Dry Film Leachable Metals, 4,000 hrs Salt Fog Resistance, 336 hrs Cyclic Weathering, Abrasion Resistance, Adhesion Testing, 30 Day Freeze Thaw Stability, and Small Scale Field Application to 200 SF of primed steel. For the topcoat draft a new Product Data Sheet (PDS) detailing material properties and application procedures.

PHASE III: Produce and market the innovative topcoat demonstrated in the Phase II effort. Topcoat manufacturer will include this product and an improved PDS in their current list and/or catalogue of commercial products and further commercialize the topcoat by advertising in a reputable paints and coatings trade journal. The topcoat will be procured by Naval activities through amendments to UFGS-09971. Intended users are Navy, Army, Air Force, Marines, Bureau of Reclamation, and the private sector.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The innovative topcoat could be employed on all Aboveground Storage Tank (AST) exterior surfaces.

REFERENCES NOTES:

1. Available at http://assist2.daps.dla.mil/quicksearch/

2. Available at http://www.ccb.org/ufgs/ufgs.htm

KEYWORDS: Paint; paints; coating; coatings; topcoat; corrosion control

N05-037 TITLE: Low VOC, Zinc Rich Epoxy Primer for Corrosion Control

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a spray applied, fast-cure, reduced cost, greater than 80 % metallic zinc content in dry film, less than 100 g/l Volatile Organic Compounds (VOC), epoxy primer to replace MIL-DTL-24441/19B Formula 159, Type III for use in Unified Facilities Guide Specification (UFGS)-09971.

DESCRIPTION: To protect against corrosion, all exterior engineered steel structures including Aboveground Storage Tanks (AST) initially receive a three-coat coating system consisting of epoxy primer (MIL-DTL-24441, Formula 159, Type III), epoxy intermediate (MIL-DTL-24441, Formula 152, Type IV), and polyurethane topcoat (MIL-PRF-85285D, Type II) formulated with 304 g/l (2.5 lbs/gal), 340 g/l (2.8 lbs/gal) and 340 g/l (2.8 lbs/gal) of Volatile Organic Compounds (VOCs), respectively, as specified in Unified Facilities Guide Specification (UFGS) -09971 “Exterior Coating of Steel Structures1,2.” In effect since August 2002, California’s South Coast Air Quality Management District (SCAQMD) Rule 1113 “Architectural Coatings” required all Industrial Maintenance Coatings (IMC) to contain no more than 250 g/l of VOC and, effective August 2006, no more than 100 g/l of VOC. As such, the development of a spray applied, fast-cure, reduced cost, greater than 80 % metallic zinc content in dry film, less than 100 g/l Volatile Organic Compounds (VOC), epoxy primer that exceeds the performance acceptance requirements of the American Association of State Highway & Transportation Official’s (AASHTO) Standard Practice for Evaluation of Coating Systems with Zinc-Rich Primers (AASHTO Designation: R 31-04)3 for use in UFGS-09971 is required for current and future environmental compliance. Interested proposers should have previously demonstrated their capability for commercialization and production either by in-house or joint venture partnering. Interested proposers should have the corporate (in-house or joint venture) capability of commercial marketing and production.

PHASE I: Develop a spray applied, fast-cure, reduced cost, greater than 80% zinc content in dry film, less than 100 g/l Volatile Organic Compounds (VOC), innovative organic resin primer.

PHASE II: Refine, test and field demonstrate the innovative primer developed under the Phase I effort. Demonstrate by standard industry practice that the primer exceeds acceptable performance criteria as detailed in American Association of State Highway & Transportation Official’s (AASHTO) Standard Practice for Evaluation of Coating Systems with Zinc-Rich Primers (AASHTO Designation: R 31-04)3, including testing and/or documentation of: VOC, Total Solids (wt), Total Solids (volume), Percent Pigment, Stormer Viscosity, Brookfield Viscosity, Pot Life, Sag Resistance, Theoretical Coverage, Drying Times, Mixing Ratio, Shelf Life, Infrared Analysis, Heavy Metals, Dry Film Leachable Metals, Epoxide Value, Amine Value, 4,000 hrs Salt Fog Resistance, 336 hrs Cyclic Weathering, Abrasion Resistance, Adhesion Testing, 30 Day Freeze Thaw Stability, and Small Scale Field Application to 200 SF of grit blasted steel. For the primer draft a new Product Data Sheet (PDS) detailing material properties and application procedures.

PHASE III: Produce and market the innovative primer demonstrated in the Phase II effort. Primer manufacturer will include this product and an improved PDS in their current list and/or catalogue of commercial products and further commercialize the primer by advertising in a reputable paints and coatings trade journal. The topcoat will be procured by Naval activities through amendments to UFGS-09971. Intended users are Navy, Army, Air Force, Marines, Bureau of Reclamation, and the private sector.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The innovative primer could be employed on all Aboveground Storage Tank (AST) exterior surfaces.

REFERENCES NOTES:
1. Available at http://assist2.daps.dla.mil/quicksearch/

2. Available at http://www.ccb.org/ufgs/ufgs.htm

3. Available at http://www.ntpep.org

KEYWORDS: Paint; Paints; Coating; Coatings; Primer; Corrosion Control

N05-038 TITLE: New Ferrocene Based Anticorrosion Formula for Concrete Steel Rebars

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a reduced cost, high performing, water based ferrocene or similar metallocene chemical formulation, with low toxicity, that can be applied to carbon steel rebars at an oceanfront site, to provide 30 to 50 year protection from marine corrosion in steel reinforced concrete.

DESCRIPTION: The corrosion problems of the Navy's waterfront infrastructure are that ordinary carbon steel rebars have the requisite properties of strength, stiffness and low cost (about $0.30/lb) for reinforcing Portland cement concrete (PCC) but carbon steel rebars corrode extensively, even deeply within PCC, when used in a marine environment. PCC used in naval construction has a water cement ration (W/C) of about 0.50, which is porous enough to allow transport of sulfate (SO4) and chloride (Cl) anions. Steel (alloy of iron, Fe) is rapidly converted to ferrous ions at the surface (Fe+2), which then react with oxygen and water to form ferrous hydroxide [Fe(OH)2] Previous chemical formulations for protecting steel rebars have included phosphoric acid. Phosphoric acid coats the steel and forms a thin film of ferric phosphate that passivates the surface of the steel. However, phosphatizing methods are of limited value in protecting steel from seawater based harsh marine exposure. It is anticipated that a more chemically resistant coating or surface treatment can be developed from a metallocene formula.

PHASE I: Determine most effective ferrocene derivatives or comparable compounds, and compare with the corrosion rates of uncoated steel, galvanized steel and epoxy coated steel (FBE). Identify field handling and field application procedures.

PHASE II: Validate the feasibility of the anti-corrosion formulae in an accelerated corrosion apparatus that simulates the harsh corrosive marine and nearshore environment. Determine the long term performance of the selected formulae and establish its toxicology and environmental impact.

PHASE III: Produce and market the new metallocene anticorrosion product and include this product and an improved PDS in their current list and/or catalogue of commercial products and further commercialize the formulae by advertising in a reputable trade journal. The new anticorrosion formula will be procured by Naval activities through amendments to existing products. Intended users are Navy, Army, Air Force, Marines, Bureau of Reclamation, and other federal customers.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The general use of this anticorrosion formula will be to treat all exposed steel alloys.

REFERENCES:
1. Federal Highway Administration Internet site for epoxy coated rebars is at "http://www.tfhrc.gov/pubrds/novdec99/rebars.htm"

KEYWORDS: Anticorrosion formula; steel rebar; concrete reinforcement

N05-039 TITLE: <u>Technology for Shipbuilding Affordability</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: The objective of the project is to develop and implement innovative technologies that will reduce the cost and cycle time to construct, modernize and repair Navy ships.

DESCRIPTION: The Navy's Program Executive Office for Ships is leveraging the National Shipbuilding Research Program (NSRP) to effect change across the non-nuclear surface shipbuilding, modernization and repair enterprise by coordinating with U.S. shipbuilders to adapt and implement "World Class" commercial best practices in the areas of "Environmental Protection" and "Systems Support Technology Capabilities." Proposals should indicate which of these two research areas is being addressed. Of particular interest are initiatives with a clear business case. Proposals should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the estimated benefits will be and how it might be transitioned into the shipbuilding industry.

As background information, US shipyards along with suppliers, owners, operators, and government personnel have developed the NSRP Advanced Shipbuilding Enterprise (ASE) Strategic Investment Plan (SIP). This plan contains an industry led strategy to reduce the cost of Navy ships and implement best commercial practices. It identifies Major R&D Initiatives and Sub-Initiatives to improve the competitiveness of the domestic shipbuilding and repair industrial base. The SIP is available for review on the World Wide Web at http://www.nsrp.org/..

While NSRP members are available to provide technical guidance and assistance in the preparation of proposals and in the execution of efforts awarded from this solicitation, teaming or consulting with the shipbuilding and repair industry (both public and private yards) is not required and will not be a factor in proposal selection.

More than one proposal may be submitted, but each must address only one of the following two research areas related to the SIP. Proposals will be evaluated and rated separately for each research area. Efforts cited within each research area are illustrative only and proposals dealing with other efforts within each research area are also solicited:

1. Environmental Protection. Develop, pilot, and provide environmental protection programs or technologies that address and/or employ standardized environmental procedures and processes, accident prevention techniques, and integrated environmental performance measurements into ship design, shipbuilding, ship modernization, repair or disposal. These efforts may include a focus on:

- Facility pre-existing condition remediation
- Reducing the impact of new or proposed regulations
- Facility Wetlands issues
- Tributyltin Antifouling Coatings
- Shipyard National Emission Standards for Hazardous Air Pollutants (NESHAP)
- Storm Water Discharges
- Barge Cleaning/Residual Waste

• Ship Ballast Water Discharge/Invasive Species

2. Systems Support Technology Capabilities. Functionally based systems technology capabilities are required to support U.S. shipbuilding and repair operations. The NSRP Integrated Shipbuilding Environment (ISE) Project is developing and deploying an industry-wide architecture for computer interoperability and a variety of tools that implement this architecture. Develop, pilot, and provide to industry systems technologies that address and/or employ ISO product model standards and the NSRP ISE into ship design, shipbuilding, ship modernization or repair. These efforts may include a focus on:

• Wireless applications
• STEP numerical control for pipe bending, cutting and marking. New models need to contain the geometry, tooling and operation information necessary to fully describe and check a an operation.
• Open source tools specifically designed to complement the current ISE tool set.

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

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

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

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology developed under this topic shall be directly applicable to current military and commercial shipbuilding repair operations and practices. The products developed should also find wide use in most heavy industrial plant facilities such as in the power industry and chemical refining industry.

REFERENCES:
1. NSRP ASE Strategic Investment Plan, available on line at http://www.nsrp.org/
2. US Naval Shipyard information is available at http://www.shipyards.navy.mil/
3. Shipbuilding and repair industry contacts are available at http://www.usashipbuilding.com and http://www.nsrp.org/. SBIR points of contact are listed under "R&D programs".

KEYWORDS: shipbuilding; affordability; production; manufacturing; processes; maintainability

N05-040 TITLE: <u>Hydrogen Separation from a Logistic-Fuel Reformate Stream</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop a sulfur tolerant hydrogen separation method/membrane, scalable to high kW levels, for recovering concentrated hydrogen from a logistic fuel reformate stream.

DESCRIPTION: Fuel cells operating on naval logistic diesel fuel (NATO F-76) offer a viable means to provide distributed ship service power, and electrical power for unmanned air and undersea vehicles. However, fuel processors are still much too complex for the compact, lightweight systems needed in military applications. The system complexity is necessary to eliminate potential contamination of the fuel cell from generated poisons, such as hydrogen sulfide, in the reformate stream. By specification, NATO F76 fuel can contain as much as 10,000 ppm sulfur.

In order to achieve the desired logistic fuel reformers for military applications innovative hydrogen separation methods or membranes are sought which can operate without the use of prior desulphurization components, produce high purity hydrogen (99.99%) for fuel cell operation, and is scalable for shipboard use (up to 500kWe). This effort will produce clean hydrogen fuel at a continuous rate, with high efficiency, and in a manner that is compatible with current PEM or SOFC fuel cell technologies.

PHASE I: Identify a hydrogen separation method/membrane that produces a clean hydrogen fuel stream from a logistic fuel reformate stream. Perform scaled evaluation to demonstrate technical feasibility

PHASE II: Develop a prototype 50kWe scale hydrogen separation method/membrane with potential to scale up to 500 kWe levels. Perform laboratory tests to validate and demonstrate the systems ability. Based upon the prototype, develop a conceptual design (including cost estimates) of a separation method integrated with a fuel reforming system that is compatible with current fuel cell technologies at the 500 kWe power level.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL: The system will be applied to a variety of commercial fuel cell technologies, currently being applied to civilian applications and being evaluated for marine application. This technology also has potential to be utilized by the Rail and Truck industries as well as many portable standby emergency power modules.

KEYWORDS: Naval logistic fuel; reforming; hydrogen; fuel cells; enrichment

N05-041 TITLE: Passive Thermal Management for a Fuel Cell Reforming Process

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop a system, scalable to high kW levels, to passively control fluid stream temperatures in a logistic-fuel reforming process under various operating conditions and reuse the thermal energy to improve overall efficiency.

DESCRIPTION: Fuel cells operating on naval logistic diesel fuel (NATO F-76) offer a viable means to provide distributed ship service power, and electrical power for unmanned air and undersea vehicles. However, fuel processors are still much too complex to provide compact lightweight marinized systems needed in military applications. A large contributor to the overall complexity in existing fuel processor designs is the thermal management hardware i.e. heat exchangers and associated control regulation valves, required to actively control process temperatures.

In order to achieve the desired logistic fuel reformers for military applications, innovative thermal control processes utilizing passive technology, such as heat pipes, are sought to control fuel reformate stream temperatures. The design and operating requirements for the desired thermal management component is defined in reference 1. The system needs to be scaleable up to a 500 kWe (electric power output from a fuel cell) size for distributed ship service power.

PHASE I: Conduct a feasibility assessment of the proposed solution to passively control process temperatures in reformate streams during operation (including startup and shutdown); to recover and reuse waste heat available in the fuel reforming process; and to provide adequate response to flow transients. Reference 1 provides operating requirements for typical heat exchangers in a fuel reforming process.

PHASE II: Develop a prototype a 50 kWe (electric power output from a fuel cell) scale passive control heat recovery and reuse system. Perform laboratory tests to validate and demonstrate the systems ability. Develop a conceptual design, including cost estimates, of a thermal management method to demonstrate scalability to higher power levels (up to 500kWe), integrated with a fuel reforming system that is compatible with current fuel cell technologies.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL: The system will be applied to a variety of commercial fuel cell technologies, currently being applied to civilian applications and being evaluated for marine application.

REFERENCES:

1. “Performance requirements for passively-controlled heat exchangers in a logistic-fuel reforming application”, May 2004

2. Donald Hoffmann, “U.S. Navy Shipboard Fuel Cell Program” www.nsrp.org/st2003/presentations/hoffman.pdf, January 2003,

3. Idaho National Engineering and Environmental Laboratory, “Reforming Diesel Fuel to Hydrogen”, March 2004, www.inel.gov/ env-techengineering/diesel_reformer_fs.rev3.3-22-04.pdf

KEYWORDS: Waste Heat Flux; Heat Pipe; Energy Conversion; Fuel Cell; Heat Recovery; Reforming

N05-042 TITLE: Shipboard V-Band Wireless Network

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Development and demonstration of a shipboard, V-Band, Wireless Network capable of high bandwidth, low-signal propagation communications.

DESCRIPTION: Current Navy wireless communications systems require high bandwidth while minimizing signal propagation beyond the ship. The V-Band (60GHz) is currently unlicensed and is available world-wide. Due to the high atmospheric attenuation of signals in this frequency band, the radiated signal is greatly extinguished over a relatively short range. For this reason, this topic seeks innovative concepts to demonstrate a 60 GHz V-Band wireless network for internal and topside shipboard applications.

The proposed V-Band wireless network concept should be capable of being implemented in both a client/server, as well as an ad-hoc network configuration. Design considerations must include signal characteristics and effects in a variety of environments including: multipath effects due to operating in metal enclosures (inside metal ships); performance in smoky and charged particle environments (must penetrate smoke / charged particles to be used during damage control operations); performance in inclement weather (rain, snow, fog, salt fog, etc.) and the impact on personnel and explosive materials. Product ruggedization must be considered for operations around water, chemicals, salt fog, humidity, etc., and military shock and vibration requirements. Size and power requirements must be considered as shipboard personnel could be required to carry / wear this equipment. Maximal use of open standards and open architecture principles is desired.

PHASE I: Demonstrate the feasibility of a V-band wireless network concept for internal and topside shipboard applications. Conduct limited testing of the concept to support feasibility demonstration and recommendations for Phase II effort. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the system and component design, as appropriate, and demonstrate a working prototype of the system. Perform laboratory and shipboard tests to validate the performance goals established in Phase I.

PHASE III: The small business shall work with the Navy and Industry in the implementation of the developed system onboard Naval platforms. Prepare an updated system design based on these test results applicable to Navy ships.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Because of the low signal propagation inherent in such a proposed system, the V-band is ideally suited for a secure, short-range, wireless network for use in banks, financial institutions, homeland security, law enforcement, government agencies, and all who desire that their wireless network be secure.

REFERENCES:
1. Information on industry WLAN standards: http://grouper.ieee.org/groups/802/11/

2. Information on DoD wireless requirements: DoD Directive 8100.2: Use of Commercial Wireless Devices, Services and Technologies in the DoD Global Information Grid

3. MIL-STD-464, Electromagnetic Environmental Effects Requirements for Systems

KEYWORDS: V-Band; signal propagation; signal attenuation; wireless network; ad-hoc, client, server, communications

N05-043 TITLE: Automated Multi-Static Processing Of Off-Board Sensors

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop and demonstrate concepts for automated multi-static processing of off-board sensors that provide improved ASW capability for surface combatants.

DESCRIPTION: Use of off-board ASW sensor assets in multi-static operation can provide beneficial complementary coverage to on-board organic sensors for surface combatants. Possible off-board assets include consort platforms, helicopter dipping sonar, active and passive sonobuoys, as well as, conventional and explosive off-board sources. In some environments, cooperative multi-static operation is required to successfully complete the ASW mission. However, reduced manning for ASW remains a priority for surface combatants. Therefore, in order to realize the full potential of multi-static operation, Detection, Classification, and Localization (DCL) processing and Data Fusion of multi-static data received from both on-board and off-board sensors must be highly automated to enable reduced manning.

A number of key issues must be addressed in order to make automated multi-static processing feasible. One issue is automated management of the communication links that are necessary to coordinate and schedule transmissions from both on-board and off-board sources. Another issue is the strategy for frequency-bandwidth-time allocation of transmissions to minimize effects of mutual interference and to maximize sonar coverage for a given sensor field configuration. The automated processing proposed must include tracking of off-board sensor positions to localize contacts and to enable Data Fusion. This topic seeks to develop techniques that address one or more of these issues and provide algorithmic solutions for automated DCL and Date Fusion processing to support multi-static operation.

PHASE I: Document and demonstrate the feasibility of the proposed concept(s) that will enable multi-static processing of off-board sensors. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Develop a prototype based on the design concept(s) proposed in Phase I. In a laboratory environment, demonstrate the viability of automated multi-static processing involving off-board sensors and sources. Develop automated, multi-static, algorithmic procedures using a modular software philosophy and incorporate associated software into a suitable open architecture system.

PHASE III: Utilizing the concept developed during Phase I and II, Work with the Navy and Industry to adapt the automated multi-static processing to current surface combatants and to the future ship combat system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Techniques developed under this topical area are expected to support automation of monitoring systems that use remote acoustic sensors to measure undersea environmental parameters for meteorological or navigational applications.

REFERENCES:

1. “Shallow Water Acoustics” B. G. Kaetisnelson

2. “Multi-Feature Fusion using Neural Networks for Underwater Acoustic Signal Processing. Signals, Systems and Computers, 1991 Conference Record of the 25th Asilomar Conference. Krieger, A. Brotherton, T, Mears, E.

3. “Location Ambiguity in a Multistatic Sonar System with Range only Information” Journal of the Acoustical Society of America v71, n1, Jan, 1982 pg 218 – 220

4. “Deployable Multistatic Active Sonar: The cycle of system design, tests, and data analysis” Oceans Conference Record (IEEE) v3, 1998, pg 1547-1552, Mozzone, Lorenzo

KEYWORDS: ASW; Multi-Static; Sonar; Off-board Sensors; IPS; Automated

N05-044 TITLE: Environmental Adaptation for Off-Board Sensors

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop a toolset that will enable the optimum placement and processing of multi-static off-board sensors.

DESCRIPTION: The performance provided by on-board organic sensors is not adequate to address all littoral USW environments; such as own-ship hull, towed array sensors and off-board sensors. Active and passive off-board sensors, operating in concert with on-board sensors, have the potential to provide outstanding USW coverage. Off-board sources and sensors such as sonobuoys, helicopter deployed dipping sensors, and deployed surveillance array sensors can be used to fill-in coverage gaps and otherwise support mission requirements. Multi-static performance is sensitive to the environment, source/sensor placement, own ship/target tactics and the target aspects generated. (Whereas a submarine can keep his bow or stern pointing at a mono-static source, it cannot simultaneously present a minimum aspect to the multiple sensors).

The complexity of bi-static geometry can make it difficult for an operator to discriminate between environmental paths from target paths without the aid of an environmental model. This topic seeks an innovative toolset that will enable the optimum placement and processing of multi-static off-board sensors. Specifically, there are needs for real-time (minutes not hours) tools for:

- Planning source/sensor placement
- Selection of best operating modes and processing for own ship and off-board sources and systems
- Optimization of towed array depth and beam patterns
- Determination of the composite active/passive multi-static performance
- Environmentally adaptive Detection, Classification and Localization (DCL) aids
- Mission effectiveness assessment

PHASE I: Document and demonstrate the feasibility of the proposed concept(s) through laboratory analysis using available model(s), as appropriate. Define a proposed concept and provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Based upon the Phase I results, fabricate and demonstrate a prototype toolset. Integrate the techniques and prototypes into a DCL processing suite and demonstrate viability through laboratory testing. Develop a Phase III test plan to validate the toolset’s capabilities. Testing may consist of laboratory testing, at-sea testing and/or analysis of previously collected data.

PHASE III: Working with the Navy and Industry, the small business will adapt the Environmental Adaptation techniques and algorithms for future ship combat systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology has direct application to numerous commercial sonar systems. This technology can be used to set up in-harbor, object avoidance sonar systems or underwater survey sonar systems to ensure the best possible performance for a given environment.

REFERENCES:
1. “Ocean Variability and Acoustic Propagation: Proceedings of the Workshop held in LaSpezia Italy June 4-8 1990” John F. Potter Editor

2. “Fundamentals of Acoustical Oceanography” Herman Medwin

3. “Characterization of Coastal Environments for Acoustic Models”, Oceans 2000 MTS/IEEE Conference, NUWC, Newport Rhode Island

4. “Remote Sensing of Ocean Sound Speed Profiles by a Perception Neural Network” IEEE Journal of Ocean Engineering, v21, n2, April 1996, pg 216-224. Joseph C. Park

KEYWORDS: ASW; active; passive; multi-static; environmental adaptation; classification

N05-045 TITLE: Automated Techniques to Reduce Operator Workload at the Passive ASW and Human-System Interface

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop and demonstrate improved techniques for reducing operator work load at the Human-System Interface (HSI) of passive ASW systems

DESCRIPTION: In order to reduce manning associated with passive ASW operation, a high level of Detection, Classification, and Localization (DCL) processing must be automated. Automated, passive ASW operation provides both true and false alerts to the operator for validation. The operator must validate true alerts and dismiss false alerts in a timely and accurate manner. Fast validation time contributes to an earlier ASW reaction, allowing for successful engagement action and effective self-defense. Accurate operator validation reduces the probability of false reactions and the unnecessary expenditure of ASW resources. The HSI associated with current Passive ASW HSI uses controls, displays, and audio alerts that require a high level of operator workload.

Improved HSI techniques and the effective use of displays and audio are critical to reducing workload. Techniques and technologies are desired for:

- Intelligent decision aids that reduce operator delays and complex interactions with the system while maintaining and improving the quality of operator decisions.
- Improvements in display technology to better communications knowledge and focus the operator on the most critical decision elements.

Candidate techniques might include those that provide for the effective assembling and presentation of target clues for faster operator validation and template match confidence. Techniques to reduce involvement by the operator in searching through Passive Broadband (PBB) and Passive Narrowband (PNB) waterfall displays would also be desirable.

PHASE I: Demonstrate the feasibility of HSI techniques for reduced operator workload. Define a proposed concept and address the development of prototypes for HSI controls, displays, and audio capability as part of the Phase II development approach. Provide a schedule that contains discrete milestones for system development and implementation.

PHASE II: : Finalize the techniques and develop a set of prototypes. Integrate the techniques and prototypes, as applicable, into a workstation environment compatible with typical multi-display workstations (Three display heads per workstation should be considered). Conduct limited laboratory testing as a means of demonstrating the viability of the prototypes capabilities. Provide a detailed test plan and test report with test analysis of potential operational HSI system benefits.

PHASE III: Working with the Navy and Industry, the small business will adapt the HSI techniques and prototypes for future ship combat systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The HSI techniques are applicable to commercial applications such as air and maritime traffic control where rapid and accurate response on the part of flight and ship navigation controllers is critical.

REFERENCES:
1. "Proceedings of the 1998 IEEE International Conference on Robotics and Automation" v 4, 1998 p 2771-3744

2. "ARACHYDE:A sensor-to-situation assessment software architecture for passive acoustic signal understanding" IEEE Conference on Neural Networks for Ocean Engineering, 1991, p 255-262

3. "Mapping experience to human computer interaction: Taking sonar into the 21st Century" IEE Conference Publication, n 481, 2001, p 92-97 ISSN: 0537-9989 CODEN: IECPB4 Hill, K.J. et al

4. "Toward Automatic Undersea Search Using Pattern Recognition Techniques" Proceedings – International Conference on Pattern Recognition, 1982, p 941-943 CODEN: PICREG, Huang, T.S. et al

KEYWORDS: ASW; Passive; human-system interface; controls; displays; workstation

N05-046 TITLE: Automated Passive Target Signature Fusion

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop and demonstrate improved techniques and processing algorithms for automated passive target signature fusion for the Passive ASW and Torpedo Defense (TD) mission areas.

DESCRIPTION: The Navy desires to fuse data from a variety of sensors in order to improve passive ASW and TD capability. Data fusion can substantially increase operator workload as the operator attempts to correlate features that contribute to validating true alerts and identifying false alerts. The Navy is seeking data fusion techniques and associated decision support aids that utilize multi-sensor information to improve passive ASW and TD capability without significantly increasing operator workload.

Techniques that fuse both narrowband and broadband spectral features, energy vs. time temporal features, and bearing and range rate spatial features are needed without increasing the work load of the operator. These techniques should combine signature features obtained using multi-sensors such as own-ship hull and towed array sensors and off-board sensors such as sonobuoys, helicopter deployed dipping sensors, and deployed surveillance array sensors. Varied processing techniques should be utilized such as Passive Narrowband (PNB), Passive Broadband (PBB), and DEMON for signature feature extraction. Multi-sensor ranging and Target Motion Analysis (TMA) should be applied for spatial feature extraction.

Automated techniques and processing algorithms for passive target signature fusion should be adapted to run in real-time. Real-time is defined as the ability of the techniques and algorithms to provide a fused result within a 1-second time interval after initial classification by individual own-ship acoustic sensors.

PHASE I: Demonstrate the feasibility of passive target signature fusion techniques in providing fast and accurate automated target alerts. Define a proposed concept and provide a preliminary set of prototype algorithms. Provide a Phase II development approach and schedule that contains discrete milestones for algorithm development and implementation.

PHASE II: Finalize the techniques and develop a set of prototypes. Provide a detailed test plan, and conduct limited laboratory testing as a means of demonstrating the viability of the prototype's capabilities. Provide test report and test analysis, as applicable.

PHASE III: Working with the Navy and Industry, integrate the techniques and prototypes into ASW processing suite in the DD(X) prototype laboratory. Details of the architecture of this facility will be provided by the DD(X) Design Team. The small business will adapt the passive target signature fusion techniques and algorithms for DD(X) combat systems use as installed in future ship construction.

PRIVATE SECTOR COMMERCIAL POTENTIAL: General data fusion techniques developed as a result of this technology could form the basis of any search or decision mechanism which has correlated data from independent sources. One such example would be financial databases. Another would be improvements to civil aviation monitoring systems to identify and isolate suspicious air-tracks in support of Homeland Security and collision avoidance objectives.

REFERENCES:
1. "Passive Sonar Fusion for Submarine C2 Systems" IEEE Aerospace and Electronic Systems Magazine, v15, n3, 2000, p29-34

2. "Real-Time data fusion processing of inter-netted acoustic sensors for tactical applications" IEEE International Conference on Multisensor Fusion and Integration for Intelligent Systems 1994, p 443-446. Swanson, David C. University of Pennsylvania

3. "Sensor fusion and classification of acoustic signals using Bayesain networks" Larkin, Michael J. NUWC, Conference Record of the Asilomar Conference on Signals, Systems and Computers, v2, 1998 p 1339-1362

4. "Spectral feature-aided multi-target multi-sensor passive sonar tracking" IEEE Oceans Conference Record v4,2003, p 2120-2126, Pace, Donald, W.

KEYWORDS: ASW; passive; torpedo defense; data fusion, classification; multi-sensors

N05-047 TITLE: Methods to Assess Technology Insertion Impact and Optimized Manning

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop and demonstrate a synthetic environment that will allow the user the capability to both estimate the relationship between a technology and shipboard manning as well as to compare the manning requirements associated with sets of competing technologies.

DESCRIPTION: The impacts of new technology insertion upon the crew's workload and manning capabilities cannot be fully realized until after the technology has been installed on-board ship. Logistics, maintenance, business processes, training, and manning levels are all affected with each technology insertion. While a new system may function properly in a lab, interaction with other systems or the crew can provide results that cannot be anticipated. Modeling the relationships between systems and people and using intelligent agents to simulate the behavioral rules affecting them makes it is possible to address the "What if . . .?" questions before they turn into "What happened?". Modeling the fundamental characteristics of the shipboard systems including physical and functional parameters, the ship's crew characteristics, and the relationships between them enables understanding of how a technology insertion affects not only a given desired capability, but also the impact to the ship as a whole.

This topic seeks the development of a synthetic simulation environment that will enable the ability to assess the impacts of technology insertion and drive optimal manning solutions onboard ships. The simulation environment must allow for the variability that can occur in a Navy vessel by allowing the user to inject different scenarios that incorporate aspects of human intervention and operational actions. It must also have the ability to assimilate the results of different planned responses by the various elements and predict the optimum solution.

PHASE I: Demonstrate the feasibility of a single synthetic environment that utilizes intelligent agents to simulate humans and systems onboard Navy ships to address the impact of technology insertion and to drive optimal manning. Develop validation criteria and approach, as well as milestones, for Phase II.

PHASE II: Develop a prototype synthetic environment as identified in Phase I. Through laboratory characterization experiments, demonstrate the utility of this system and compare the results of using / not using the synthetic environment. Address the applicable performance, human factors analysis, dependability, and cost measurements of the technology. Demonstrate how various scenarios can be analyzed quickly and that various technology trade-offs can be performed. Demonstrate how the system can be used to drive optimal manning.

PHASE III: Working with the Navy, implement on a ship design program. Perform total system demonstration and validation exercise.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The models developed for the Department of Navy are equally applicable for use by the Coast Guard, Cruise lines and other commercial maritime vessels. In a broader context there is application to technology impact on human performance regardless of operating environment.

REFERENCES:
1. Law, A. M. and D. Kelton (2000). Simulation Modeling and Analysis, McGraw-Hill.

2. Wetteland, C. R., J. L. Miller, et al. (2000). The Human Simulation: Resolving Manning Issues Onboard DD21. Winter Simulation Conference.

3. N.R. Jennings, T.J. Norman, P. Faratin, et al. “Autonomous agents for business process management”. Applied Artificial Intelligence, 14(2): 145-189, 2000.

KEYWORDS: Intelligent agents; model; simulation; technology insertion; manning

N05-048 TITLE: Approach to Joining Multiple Displacement Hulls Together To Increase Speed

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Development of innovative approaches for joining multiple transport craft together to form "In-line” powered trains.

DESCRIPTION: At-sea surface transport of equipment, material and personnel will continue to be required in future operational concepts including those supporting seabasing. This topic seeks to develop the key enabling capability required to connect multiple transport craft (such as powered barges or craft similar to LCU 1600 Class vessels) one behind the other in "In-Line" trains which should increase transport craft speed on the order of 30% or more. Since hydrodynamic drag becomes less and less for each successive vessel connected in the train, it is envisioned that the speed of the train will be greater than could be achieved by each vessel acting independently. The key enabling capability sought is the connecting device between vessels. The joining methods proposed must be able to transmit both tensile and compressive forces and must also minimize the transmission of pitch, yaw, and roll moments between vessels. The connector must also be designed so that all the thrusts produced by each individually powered ship can be combined together. The concept will also address a means of automated docking between the crafts to allow a rapid link-up as well as a rapid disconnect while in motion. The method of disconnect should allow the vessels to continue independently and seamlessly with their individual mission(s). Other factors to be considered are the integrity of the data transmission through the connecting device that will be required to control and operate multiple craft in the "In-Line" train concept. This may also include information on the local mechanical and geometric status of each connector.

PHASE I: Demonstrate the feasibility of the proposed approaches. Perform modeling and simulation as needed as a means of demonstrating feasibility. Provide a preliminary concept design and validation plan.

PHASE II: Design ,develop, and fabricate a prototype linkage using the approach proposed in Phase I. In a laboratory environment, demonstrate the capabilities of the proposed concept as means of validation.

PHASE III: Working with the Navy, prepare a boat alteration and develop and install on two or more transport craft. At this time, LCU 1600 class vessels are available and may be appropriate for the test craft. Conduct at-sea testing as required.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The coupling technology would be applicable to articulated tug/barge concepts and linked tugs and powered barges to permit operation at greater speeds and/or with reduced power and manning on rivers and inter-coastal waterways.

REFERENCES:
1. "Experiments and Predictions of the Resistance Characteristics of a Wave Cancellation Multihull Ship Concept" by Wilson, Hsu, and Jenkins, 1993
2. Janes Fighting Ships
3. LCU 1600 Class Vessel Drawings Available Upon Request
4. http://www.fas.org/man/dod-101/sys/ship/lcu.htm

KEYWORDS: Articulated Connectors, Automated Docking Systems, Manual Docking Systems, and Shock Absorption Systems

N05-049 TITLE: <u>In-Situ and Temporary Augmentation of Ship Hull Forms to Improve Top Speed</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Development of innovative approaches to provide in-situ hull form augmentations to the existing ships and craft to allow for increased speed without a significant reduction in payload capacity.

DESCRIPTION: This topic seeks innovative approaches to modify transport craft hull forms in-situ in order to reduce hull hydrodynamic drag and consequently increase significantly increase top speed (on the order of 30% or more). Proposed concepts can be either organically employed from the vessel and/or require ship/pier-side assistance for implementation or removal and should not, when implemented, interfere with the movement of the vessels to or from the beach. The craft must be able to be returned back to their original un-deployed state for the purposes of stowage. Proposed concepts should address the ability to augment the hull form while in-situ. Emphasis in award will be on concepts that do not require a lot of manpower or time to implement. For proposal purposes, craft similar in size and configuration to the Navy's LCU 1600 Class should be considered.

PHASE I: Demonstrate the feasibility of the proposed approaches. Perform modeling and simulation to demonstrate feasibility of the augmentation to achieve speed enhancement. Provide a preliminary deployment design and validation plan.

PHASE II: Design, develop, and fabricate a prototype hull augmentation for the approach proposed in Phase I. In a laboratory environment, demonstrate and validate the deployment and removal approach. As required, perform additional modeling and simulation to validate speed enhancement potential of the augmentation.

PHASE III: Working with the Navy, prepare a boat alteration and develop and install on a transport craft. At this time, LCU 1600 class vessels are available and may be appropriate for the test craft. Conduct at-sea testing as required to validate deployment, removal, and speed enhancement performance.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology being developed under this topic for reducing hydrodynamic drag will allow heavy lift displacement hulls to achieve higher speeds. Examples of commercial displacement hulls include: (1) bulk cargo carriers, (2) containerized cargo carriers, and (3) ferries for transporting rolling stock.

REFERENCES:

1. Jane's Fighting Ships.
2. LCU 1600 Class Vessel Drawings Available Upon Request
3. Boat Alteration record ESWBS 114 Kort Nozzle Protection
4. http://www.fas.org/man/dod-101/sys/ship/lcu.htm

KEYWORDS: Hydrodynamics, hull forms, mechanical fastners, pneumatics

N05-050 TITLE: Modeling to Support Damage Control Assessment and Decision-making in Shipboard Environments

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: To reduce the amount of time required to process damage control information and estimate casualty spread in order to support automated damage control systems.

DESCRIPTION: In order to support advanced, automated DC planning and operations for low manning ship concepts, prognostic modeling of the spread of fire, smoke, radioactive, chemical and biological agents is needed. Existing models do not address propagation in confined spaces such as onboard ship. Furthermore, current models require unacceptable processing time (days vs. minutes). For existing models, processing time is controlled by physics based models which are mathematically complex and require precise code instantiation. Automation of DC systems, through the use of advanced decision making tools, is viable but only if sensors data can be collected and processed in a real-time fashion in order to support prediction of casualty spread. Consequently, processing and estimation times must be significantly reduced.

Proposals are sought which address one of the following research areas:

- Fire Spread Modeling
- Smoke Spread Modeling
- Radioactive (RADFO) Modeling
- Chemical and Biological Cloud Modeling

A proposal must address no more than one research area. More than one proposal may be submitted. Proposals will be evaluated and rated separately for each research area.

Teaming with the shipbuilding industry to form integrated project execution and implementation teams will improve transition potential and is strongly encouraged.

PHASE I: Demonstrate the feasibility of the proposed approach and define the systems architecture that will be used to support future decision making tools. Establish performance goals and metrics to determine the feasibility of the proposed solution and provide a plan for key component technological milestones for further project development.

PHASE II: Produce a prototype software product based on Phase I efforts. Demonstrate that the prototype product meets the performance goals established during Phase I. Provide a detailed plan for software certification, validation, and method of implementation into a damage control decision making tool.

PHASE III: Working with Navy and Industry personnel, certify and validate the model developed during Phase II and implement into a future ship environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology would have universal applications on oil tankers, cruise liners, and in industrial manufacturing plants where fire propagation modeling could assist in preventing loss of life and/or facilities.

REFERENCES:
1. Modeling of Shipboard Smoke Propagation with a Forced Counter-Flow Air Supply; Farman, Garrett J.; NAVAL POSTGRADUATE SCHOOL MONTEREY CA

2. Propagation of Fire Generated Smoke in Shipboard Spaces with Geometric Interferences; Abaya, Amado F., Jr; NAVAL POSTGRADUATE SCHOOL MONTEREY CA

KEYWORDS: damage control; propagation; modeling; physics-based; decision-making

N05-051 TITLE: Integrated Shipboard and Shore-based Maintenance Management Decision Tool

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Demonstrate and develop an approach that will optimize maintenance resources, both personnel and financial, and assess the optimum point in time to conduct shipboard and shore-based maintenance activities taking into consideration ship mission profiles and readiness requirements.

DESCRIPTION: Existing and future Navy ships will utilize sensors and other automated technologies to monitor equipment health and availability. As the Navy reduces ships complement, much of the maintenance and repair work of a deployed ship will need to be performed by shore-based activities. The integration and optimization of ship board maintenance activities with shore-based Full Service Operations (FSO) is of critical importance to ensuring mission readiness on a reduced manning ship and the achievement of reduced Operation & Support (O&S) costs. Shore-based FSOs routinely perform maintenance, repair, and the installation of new systems.

The central goal of this topic is to develop the ability to quickly and efficiently determine, prioritize, and optimize maintenance efforts. For illustration, the following types of functionality to support shipboard and shore-side maintenance planning are germane to achieving the system performance desired:

- Ability to interface with equipment health management software modules to gather data
- Embrace of CBM approaches including the identification of components requiring maintenance and the cause of their systems degradation
- Consideration of the level of functionality for degraded systems in order to determine whether maintenance is required or whether there are maintenance alternatives such as system reconfiguration
- Update of status as maintenance is executed
- Provide a range of textual responses and/or recommendations to the user e.g. run-to-fail, secure, conduct repairs/maintenance, and reconfiguration options
- Consider long term mission profile/readiness over some predefined period
- Ability of the shore-based facilities to evaluate alternative scheduling scenarios
- Incorporation of maintenance prioritization, resource application, and backlog management in order to find the most effective plan for optimize the expenditure of resources (financial, personnel and time)
- Consideration to work process modeling and ergonomic issues such as space conflict (e.g. having too many bodies in one area) or work conflict (e.g. power chipping bilges while having a gas turbine disassembled for repair).

PHASE I: Define and determine the feasibility of a management approach which analyzes the alternatives and determines the optimal point in time at which to conduct shipboard or shore-side maintenance. Establish performance goals and metrics to analyze the feasibility of the proposed solution. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Produce a prototype software product based on Phase I efforts. Demonstrate that the prototype product meets the performance goals established during Phase I. Provide a detailed plan for software certification, validation, and method of implementation into a future ship support environment.

PHASE III: Utilizing the concept developed during Phase I and II, work with Navy and industry to certify and implement this technology to existing and future surface combatant systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology would have application with Commercial Marine Fleet owners and in commercial ship yards where both construction and maintenance activities must be planned.

REFERENCES:
1. 2004 IEEE Aerospace Conference Proceedings. Track 11: Diagnostics, Prognostics, and Health Management. Big Sky, MT, March 2004.

2. Nickerson, G.W. and B.L. Thomason. “Hierarchical Open Architecture Approach to Shipboard Condition-Based Maintenance.” Proceedings of ASNE Condition-Based Maintenance Symposium, Arlington, VA, 1998.

KEYWORDS: maintenance; planning; shore-based; shipboard; modernization; repair

N05-052 TITLE: Prognostic Tool to Estimate Mission Readiness Based Upon System Health States

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Demonstrate and develop decision-support tools that will estimate ship's mission and system readiness based upon estimates of system and component health states.

DESCRIPTION: Current surface ship equipment health and information management systems are focused on fault detection and problem isolation at the equipment component level of an individual ship system. The evaluation of such information is often complicated by complex, interconnected subsystems and components in which degradation levels in one may compound the health in another. Information and decision support technology is needed that seamlessly interoperates with repair and maintenance decision support systems to quickly and cost effectively estimate levels of mission readiness.

The Navy is interested in approaches that would integrate with component diagnostic and prognostic modules to collate the component and systems data collected and characterize the overall component or system health status in term of mission readiness. The approach proposed should address the following functionalities:

- Enable a detailed analysis in order to fuse individual component estimations and predictions and correctly assess the higher indentured systems’ impact on mission readiness
- Enable the impact of health status and forecasted changes on multiple critical factors to be dynamically and autonomously re-assessed for specific ship missions
- Explore the use of implicit and explicit reasoning technologies based upon current artificial intelligence methods, information fusion techniques, model-based representations, and adaptive learning systems to enable more effective mission impact assessment and decision support for future combatants.

The implementation of this approach will improve the accuracy and cost effectiveness of maintenance planning and assessing operational capability.

PHASE I: Demonstrate the feasibility of an approach that determines the mission readiness of a ship system based upon an analysis of multiple sub-system equipment health state conditions, assessments and performance predictions. Establish performance goals and metrics to analyze the feasibility of the proposed solution. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Develop a prototype software product based on Phase I efforts. Demonstrate that the prototype product meets the performance goals established during Phase I. Provide a detailed plan for software certification, validation, and method of implementation into a future ship support environment.

PHASE III: Using the lessons learned and metrics analysis from Phase II, refine and harden the toolset in conjunction with Navy and Industry in support of a future ship integrated support software suite. Develop a commercial-grade software package to integrate the software and support products on future ships. Evaluate technology insertion in legacy systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology developed under this topic can be used in the tracking of health changes in military and civilian mobility equipment and industrial monitoring systems. Commercial applications for the hierarchical reasoning architecture can be realized in many health monitoring system applications in the electrical generation industries, chemical processing industries, commercial aviation as well as gas transmission and oil industries.

REFERENCES:

1. 2004 IEEE Aerospace Conference Proceedings. Track 11: Diagnostics, Prognostics, and Health Management. Big Sky, MT, March 2004.

2. Roemer, M. J., "A Fuzzy-Neuro Scheme for Integrated Diagnosis and Life Consumption of Rotordynamic Systems," 50th MFPT Conference on Integrated Monitoring, Diagnostics, and Failure Prevention, Mobile, AL, April 1996.

3. Nickerson, G.W. and B.L. Thomason. “Hierarchical Open Architecture Approach to Shipboard Condition-Based Maintenance.” Proceedings of ASNE Condition-Based Maintenance Symposium, Arlington, VA, 1998.

4. Barnett, J. A., “Computational Methods for Mathematical Theory of Evidence”, Seventh International Joint Conference on Artificial Intelligence, Vol. 2, pp. 868-875, 1981.

5. Garga, A.K. “A Hybrid Implicit/Explicit Automated Reasoning Approach for Condition-Based Maintenance.” Proceedings of the ASME Intelligent Ships Symposium II, Philadelphia, PA, 25-26 November 1996.

6. Leferve, E., and Colot, O., “A classification method based on the Dempster-Shafer’s theory and information criteria” Proceeding of the 2nd International Conference on Information Fusion, July 6-8, 1999.

7. Byington, Watson, et al., “Integrating Prognostic Modules into Existing Naval CBM Systems,56th Meeting of the Society for MFPT”, Virginia Beach, VA, April 15-18, 2002.

KEYWORDS: Maintenance, Mission Planning, Automated Reasoning, Knowledge Fusion, Self-Learning Networks, Genetic Algorithms, Feature Extraction, Fuzzy Logic

N05-053 TITLE: Modeling the Impact of Technology Transition on Ship Operational Capabilities

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: To develop a technology insertion planning tool that relates ship, system, and technology capabilities to prognostic design variables such as cost, schedule, and life-cycle factors.

DESCRIPTION: Concepts such as Total Ship Design and Spiral Technology Insertion and Development involve large numbers of technology trade decisions within a complex and constrained programmatic design environment (cost, schedule, performance). Decisions involve estimates of technology maturity; impact on component, system, or ship performance, development and implementation costs and schedules; and life-cycle factors such as reliability, maintainability, and sustainability.

The Navy desires a decision-support capability that can:
• Identify sets of technologies that should logically be inserted into a ship design at about the same time
• Optimize technology insertion planning as a function of cost, schedule, and performance, and
• Relate ship or systems capabilities as a function of technology insertion

The envisioned toolset of decision-support aides would be used by Navy and prime contractors to support spiral technology insertion and development planning for new ship designs and existing ship modernizations.

PHASE I: Define and determine the feasibility of the innovative approach proposed for a technology insertion planning tool. Establish validation goals and metrics to analyze the feasibility of the proposed solution. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Develop a prototype software product based on the results in Phase 1. Utilizing representative inputs/data, demonstrate the viability of the prototype product to perform as projected. Develop testing procedures to measure the effectiveness of the tool and develop a plan for a ship-wide validation exercise. Provide a detailed plan for software certification and validation.

PHASE III: Utilizing the concept developed during Phase I and II, work with Navy and industry to conduct validation testing using real data for a sample system (ship). Use the results of this testing to tailor the decision-support capability to the needs and input capabilities of the DD(X) Program Office in concert with the DD(X) National Design Team.

PRIVATE SECTOR COMMERCIAL POTENTIAL: In a challenging competitive environment, there is a large market for decision-support capabilities that help to streamline operations, save costs, and reduce program risk. Organizations with high Plant and Equipment expenses will need tools that show tradeoffs in purchasing decisions and help to plan future technology purchases.

REFERENCES:
1. Interoperable Technologies, Specifications and Guidelines from the World Wide Web Consortium
2. ONR Affordability Measurement and Prediction Testbed and Study. John Hopkins University, Applied Research Lab. 2000
3. Parametric Operating and Support Cost Estimating Relationships for Shipboard Electronics. Naval Center for Cost Analysis and Tecolote Research, Inc. 1999
4. How to Achieve Assured Operation With Complex Systems". Warrington, L & Jones, J.A., University of Warwick
5. RAMS.org
6. Keeney, R.L. "Value-Focused Thinking: A Path to Creative Decision-Making" Harvard University Press, Cambridge, MA 1992
7. Military Modeling for Decision Making, 3rd Edition; Hughes, Wayne P.
8. “Applications of Discrete Event Simulation Modeling to Military Problems". Hill, R., McIntyre, G. & Miller, J.O., Winter Simulation Conference, 2001

KEYWORDS: financial impact; RAMS; modernization; decision-making; readiness; technology insertion

N05-054 TITLE: Automated, Wireless, Structural Damage Assessment and Health

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop and demonstrate an approach for automated data acquisition and data analysis of advanced materials structures in a shipboard environment in order to monitor their structural integrity.

DESCRIPTION: Current technologies require the erection of scaffolding (interior and exterior) to perform point measurement, non-destructive, structural assessments. Assessments of multi-material systems pose an additional challenge for all currently used non-destructive evaluation methods. The development of an innovative method to assess the structural integrity of advanced materials is essential to the implementation of these new advanced material concepts in ship manufacturing and the acceptance and utilization of new, multifunctional materials in the fleet.

The Navy seeks an innovate approach to provide reliable, quantitative structural health data (e.g. damage state, damage locations, etc.) to aid integrated maintenance management planning functions as well as damage control decision making tools. The structural health data desired should include, but is not limited to: crack growth/jump in metals; fiber breaks/kinks/delaminations in fiber composites; chemical changes e.g. corrosion. Concepts proposed should address sensor types, methods of embedding or surface mounting wireless sensors in/on advanced materials structures, automatically gathering reliable and quantitative data, and methods for performing an analysis to assess the health of the structural system. Automated structural health monitoring via sensing networks and wireless data acquisition are essential to realizing integrated ship maintenance, improved decision tools and reduced shipboard manning.

It is envisioned that once developed, this technology will provide an enhanced capability for automated structural damage assessment/control for surface ship structures by providing structural health information to support Condition Based Maintenance (CBM) and mission readiness reporting.

PHASE I: Demonstrate the feasibility of an approach for automated data acquisition and data analysis of advanced materials structures. Establish Phase II performance goals and provide a plan for key component technological milestones.

PHASE II: Finalize the Phase I design and develop a prototype product based on the Phase I efforts. In a laboratory environment, demonstrate the viability of the prototype and that the performance goals established during Phase I have been met. Prepare guidelines for integration into equipment health management and integrated maintenance management systems.

PHASE III: Working with the Navy and shipbuilders, implement and evaluate onboard DD(X) and other future ship systems. Implementation of the technology into other applications, such as civil aviation and automobiles will be pursued with Industry.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Equipment health and integrated maintenance management technologies have direct applicability to commercial civil and mechanical fields particularly in for the use with large structures and composite pressure vessels.

REFERENCES:
1. Acoustic Emission Testing, Vol.5, Nondestructive Testing Handbook, R.K. Miller and P.K. McIntire, Ed., American Society of Nondestructive Testing, 1987.

2. Glaser, S.D., Weiss, G., and Johnson, L.R., “Body Waves Recorded inside an Elastic Half Space by an Embedded Sensor” J. Acoustic Soc. Of America, 1998, Vol. 104, No.3, p.1404.

3. Yoyama, S., Imanaka, T. , and Ohtsu, M., “Quantitative Evaluation of Microfracture due to Debonding by Waveform Analysis of Acoustic Emission”, J. Acoustic Society of America, 1988, Vol.83, No.3, p.976.

KEYWORDS: equipment health management; integrated maintenance; acoustic emission; composite materials; large area inspection

N05-055 TITLE: Automated Launch and Recovery of Small Unmanned Aerial Vehicles from Unmanned Surface Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: LCS

OBJECTIVE: Develop a system for automated launch, recovery and recharging/refueling of small Unmanned Aerial Vehicles (UAVs) from Unmanned Surface Vehicles (USVs).

DESCRIPTION: Unmanned Surface Vehicles of length 30-40' are being considered by the US Navy for various missions. The ability of a USV to carry one or more small UAVs into an operational area would be of great value as this would result in a longer time on station for the UAV.

This topic seeks to develop innovative approaches to autonomously launching and recovering small UAVs from a USV. Concepts should address the capability to charge the batteries or refuel the UAV, start the UAV's engine, download sensor data from the UAV to the USV and upload new mission parameters from the USV to the UAV. This concept requires the development of a common UAV launch and recovery (L&R) system on-board the USV. The common UAV L&R system should be capable of reconfiguration to accommodate a variety of UAVS. The small UAVs will weigh a maximum of 25 lbs, be no longer than 6 feet and have a wingspan no greater than 6 feet, and will have either electric or JP-5 propulsion. The Navy's SWARM and SWIFTFOX UAVs are examples of such UAVs. The L&R system proposed should be capable of handling up to 4 UAVs from a USV. A critical aspect of the system will be its autonomous operation. The Unmanned Sea Surface Vehicle (USSV), being developed by ONR, and the SPARTAN, being developed by Naval Undersea Warfare Center, Newport, RI, are examples of USVs. The USV's payload bay is approximately 10 feet long, 9 feet wide and 6 feet high and can accommodate a weight of 3000 lbs, although smaller and lighter common UAV L&R systems are very advantageous. Particular attention should be paid to the challenges of the marine environment and to operation of the L&R system in sea states.

PHASE I: Develop a design concept for an automated launch and recovery system for UAVs from a USV. Establish performance goals and metrics to analyze the feasibility of the proposed solution. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Fabricate a prototype system designed in Phase I. Through testing at an airfield, validate the performance of the system as defined in Phase I.

PHASE III: Install and demonstrate prototype system fabricated in Phase II on a USV. Provide at-sea demonstration of ability of prototype system to launch, recover, recharge/refuel and provide data interface to a small UAV from a USV. Provide detailed drawings and specifications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Small boat-builders and machinery automation industries will benefit from this topic. Commercial applications include use on oceanographic survey vessels, off-shore oil exploration and salvage ships.

REFERENCES:
1. "SPARTAN Unmanned Surface Vehicle Extends the USW Battlespace-SPARTAN Concept", Naval Forces, Special Issue 2001, p. 18.

2. "Mini-Plane with High IQ", Popular Science, August 2002, pages 62-66.

KEYWORDS: USV; UAV; Launch; Recovery; Minehunting; Automation

N05-056 TITLE: Advanced Variable Speed Drive

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: LPD 17

OBJECTIVE: Develop an Advanced Variable Speed Drive (AVSD) for potential fleet-wide implementation as an intelligent controller for variable load systems.

DESCRIPTION: Conventional technology available to control variable load systems uses system elements with unacceptable ship impacts. These include large heavy transformers or large capacitive filters. An AVSD is desired, likely based upon solid-state power electronics, which can handle a variety of variable loads at medium voltages (nominally 450 VAC) up to 300 Hp. The system must be capable of taking sensor data from the load system as feedback and adjusting the load input power to accommodate variable load conditions. The AVSD must also be capable of communicating with existing Navy equipment monitoring software (ICAS). The Phase III AVSD system must also meet MIL-STD-1399 (Electrical Power System Interface Standards), MIL-STD-461 (EMI Standards) and MIL-STD-901D (Shock Standards).

PHASE I: Demonstrate the feasibility of the AVSD approach proposed. Develop communication interface requirements to make the AVSD compatible with existing Navy equipment monitoring software (ICAS) and other automation control technologies. Establish performance goals and metrics to analyze the feasibility of the proposed solution.

PHASE II: Design, fabricate, and demonstrate a prototype AVSD. Develop AVSD-based sensing capabilities to enable remote motor performance monitoring for trending and predictive maintenance purposes. Develop testing procedures to measure the effectiveness of the device and estimate the number of VSD installations required to enable parallel operations between three ship service diesel generators (SSDG) for the LPD-17 class.

PHASE III: Working with the Navy, develop standardized AVSD installation requirements to address application to other platforms. Upon successful demonstration in Phase II, the technology would be implemented by the LPD-17 program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Development of an AVSD would open new markets within the electrical commercial sector by demonstrating the capability to resolve commercial problems associated with supply-side harmonics, causing motor overheating, EMI suppression, winding insulation damage associated with heat dissipation, and electrical bus overload during motor start-up.

REFERENCES:
1. ICAS information available upon request.

KEYWORDS: variable speed drive; advanced motor drives; ICAS; motor controllers; AVSD

N05-057 TITLE: Innovative Modeling and Gaming Approaches for Submarine Battle Space Components to Identify Cost-Effective Capabilities and Technologies.

TECHNOLOGY AREAS: Information Systems, Battlespace

ACQUISITION PROGRAM: SSN 774

OBJECTIVE: Provide the Submarine Force and Acquisition Authorities with an innovative tool set of advanced models that will allow evaluation of the capabilities and performance of submarines in selected Joint and Navy theater scenarios. This enables development of investment strategies for future capabilities and technologies to achieve new efficiencies and savings while meeting force-level goals.

DESCRIPTION: The composition of the Submarine force is changing through the introduction of the VA class submarine and the Trident to SSGN conversions along with continued modernization of in service submarines –SSN 688 and Seawolf classes. Overall, the population of the submarine fleet, while stable, has been slowly decreasing when compared with the past. At the same time, mission assignments are increasing and becoming more complex. Effective and efficient planning for new capabilities could be optimized if one could identify critical variables and tailor technology investment to satisfy these requirements. Simply put, will a particular capability or technology provide the most efficient and effective performance improvement over current capabilities in selected scenarios when compared with other investment options?

This topic seeks, through the use of current state-of-the-art modeling techniques and innovations, the development of this tool set. The model will provide a total submarine force performance analysis.

PHASE I: Requirements definition of the model, development of model components and demonstration of innovative and key concepts. Definition of data requirements to support the exercising of these critical model components employed in the model. Develop validation criteria and demonstrate the use of the model components in conjunction with agreed upon criteria. Develop a Work Plan and Milestones for a Phase II effort.

PHASE II: Complete component development work and exercise these components to validate the model through an end-to-end scenario encompassing technical, threat and costs-benefit analysis. Show how the model will produce useful results leading to recommendations for investment strategies of technologies and capabilities for submarines. The results must be compiled, organized, and conveyed in a manner that creates a readily accessible database for future modeling efforts and Phase III follow-on efforts.

PHASE III: Application of the validated model, test data and gaming to advanced decision making for submarine acquisition decision makers. It is envisioned this tool set would be key to the Submarine Technology (SUBTECH) Process. However, once validated, it could be applied to other technology investment planning processes within Navy and DoD.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The model data applications and decision-making processes can be applied in the commercial industrial sector for major program development and investment.

REFERENCES:
1. O'Rourke, Ronald (2004). Navy Attack Submarine Force-Level Goal and Procurement Rate: Background and Issues for Congress. Congressional Research Service, The Library of Congress.
http://www.fas.org/man/crs/RL32418.pdf

2. The National Defense Authorization Act for Fiscal Year 2001, Report of the House Committee on National Security, Section 131, Virginia Class Submarine Annual Report on Operational Status, Technology Insertion. http://www.fas.org/man/congress/2000/hr616.htm

KEYWORDS: models; gaming; analysis; threat; applications; submarines

N05-058 TITLE: <u>Robust, Reconfigurable, High Speed Fiber Optic Data Communication between Remote Sensors and Inboard processing Equipment</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

OBJECTIVE: To design, build, and demonstrate an improved fiber optic data communication system through rotating mating surfaces (usually handled by slip rings and rotary joints) within between electronic imaging and electronic warfare sensors and inboard processing equipment.

DESCRIPTION: Submarine outboard sensors such as periscope mounted imaging cameras (bandwidth requirement ~10's Gbps), electronic warfare antennas (~100's Gbps), and communication antennas (~100's Mbps) require high speed conduits to distribute signal/data to various inboard processing systems. Current copper based rotary joints used in the submarine force are becoming unreliable due to age in addition to not being able to support the data communication bandwidth required by new sensors. A different approach, rather than overhauling these aging rotary joints, is necessary to enable the employment of better sensors (which always require more data communication bandwidth). As a point of reference, a single mode fiber can carry about 2.5x104 times more data than a typical coaxial cable. The larger bandwidth, low signal loss of fiber optic cable make it a good candidate to replace copper based conduit. A multi-channel optical rotary joint would support the signal and data transport requirements for all imaging, electronic warfare, communications, and navigation sensors for the foreseeable future. Advanced data communication technologies to be considered should include but not limited to electrical and/or optical conduits, multi-channel fiber optic rotary joint, and free space optical communication. The system should be designed such that redundancy may be achieved in a self reconfigurable manner should part of the data conduit bundle is damaged. Commonality of the data communication system design, using open architecture and industry standards, will enable continuous upgrades to handle the ever increasing data transmission bandwidth required by high resolution systems.

PHASE I: The contractor shall develop innovative concepts and designs using modeling and simulation as well as rapid prototyping. The signal path for submarine outboard sensors that meets all system constraints including physical interfaces due to mast and antenna arrangements, cable run, and electrical hull fitting configurations shall be developed. Phase I effort shall be documented in a technical report.

PHASE II: The contractor is expected to build and test a working prototype meeting all signal and physical requirements of the candidate outboard sensor systems.

PHASE III: The contractor is to develop a full-scale prototype for a particular sensor system to be tested at land based test facility that meets major physical, electrical, and signal requirements for eventual testing on a submarine..

PRIVATE SECTOR COMMERCIAL POTENTIAL: Improvements in data transmission between sensors and processors can be used in robotics, semiconductor processing equipment, motion simulators, surveillance equipment, packaging machines, remotely operated vehicles, the geophysical exploration industry, and military applications.

REFERENCES:

1. NAVSEA DRAWING 071044 rev. C: Rotary Joint, Coaxial, 12 Channel

2. Kollmorgen Corporation Report ER 353.3

3. WWW.kvh.com; 40 Gb/sec Photonic fiber modulator

4. WWW.miteq.com; 11 GHz High speed modulator

KEYWORDS: Sensor array; submarine; signal path; high data rate; reliability; underwater; acoustic; imaging and electronic warfare sensors; antennas; optical rotary joint.

N05-059 TITLE: <u>High Fidelity Front End Simulation for Complex Physics-Based Processing Systems</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

OBJECTIVE: To evaluate the effectiveness of high-fidelity stimulation in the testing and production cycle for tactical physics-based sensor systems.

DESCRIPTION: Develop a high fidelity front end simulation system to stimulate complex physics-based sensor systems as a supplement to real-world data collections and field tests. This simulation system should provide unlimited flexibility in processing parameters while generating high resolution data at a fidelity capable of serving as a substitute to collected data sets. The proposed simulation system shall provide physics-based sensor and algorithm designers with an alternative source of data for conducting performance testing and analysis in the laboratory. The stimulation should extend well beyond current technology to provide the correct physics that would be encountered in shallow water environments. The stimulation should exercise all system interfaces and generate data at the lowest possible level to accommodate the widest range of sensors. The stimulation system should provide data in near real-time and support the exact replication of test cases as required to verify changes in sensor design and algorithm enhancement. Additionally, the stimulation shall support the transmission of low bandwidth simulated data over a remote interface to test processing system components not located in the same geographic location. The use of a fully controllable simulated environment should be used to construct quantitative measures of effectiveness regarding the performance of the simulation relative to real-world collected data.

PHASE I: Develop and document an initial design that demonstrates an understanding of all aspects of the problem and a competency in the development of a stimulation system that can be implemented with a current generation tactical system.

PHASE II: Based on the initial design, document and develop a prototype system to integrate the stimulation system with a single physics-based sensor. This initial sensor should be selected to best demonstrate the benefits of providing high fidelity, real-time stimulation as an alternative to pre-recorded real-world data sets. The stimulation should be generic enough to provide infinite flexibility in processing parameters while providing element level data at a high enough resolution to serve as a substitute for real-world collected data. Also required in Phase II will be the design and initiation of the security measures to connect the stimulation to processing components located in different geographic locations via a Classified remote interface.

PHASE III: Based on performance and lessons learned in Phase II, expand the system to stimulate other sensors in real-time. Fully implement the process and security measures for stimulating these additional sensors via a Classified remote interface as initiated in Phase II. Phase III shall also demonstrate the use and effectiveness of the stimulation system by providing baseline quantitative performance analyses of the benefits of stimulation over real-world data collections and tests.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The development of high fidelity simulations as a front end stimulator to conceptual sensors has application beyond tactical systems. Similar modeling techniques can be applied to other physics-based problems like fluid dynamics and airborne particle dispersion. Modeling and stimulation in both these areas has implications for industry and in homeland security.

KEYWORDS: acoustics, electromagnetics, electro-optics, sensor, radar, stimulation, submarine, tactical, validation

N05-060 TITLE: Multilevel Data Storage Technologies

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop an approach that provides for the secure storage of multiple classifications of classified data.

DESCRIPTION: Current approaches to data storage requirements for multiple classifications of data involve the physical swapping of storage media (e.g., hard drives). Such an approach is both time-consuming and costly. It also requires that significant space be allocated to store media when not in use. The removal and replacement of storage media from its original installed configuration also creates reliability as well as security risks that could be mitigated by a multilevel approach to data storage.

PHASE I: Assess and document requirements for multilevel disk storage and research current approaches (e.g., encryption) to satisfying applicable Information Assurance (IA) requirements. Develop and document a system design capable of satisfying IA requirements while allowing the storage media to remain in its installed configuration. Possible solutions can include but are not limited to solid state storage devices, modified hard drives, and centralized network storage. Interfaces to this device should use existing computer system interfaces such as SCSI, Fibre Channel Standard (FCS), or Gigabit Ethernet. This approach should allow for a seamless transition between multiple classification levels, to include SECRET, TOP SECRET, and TS/SCI data. This approach should also address how applicable security requirements will be satisfied and provide a plan for obtaining formal IA Certification & Accreditation (C&A) for use aboard a Navy submarine. If possible design should support record data rates in excess of 200 MB/s with a storage capacity of greater than 40 TB. The unit must meet or be smaller than the space requirements allocated to exist AN/UNQ-9 Tactical Data Recorders (TDR) or the Acoustic Media Center (AMC) associated with the Digital Data Collection System.

PHASE II: Design and test a prototype of the solution proposed in Phase I on a simulated shipboard network (e.g., in a Navy lab environment). Initiate and document the process of obtaining formal IA C&A for the prototype. Demonstrate the proposed technology, manufacturability, and reliability of the Phase I design.

PHASE III: Install and test the Government approved system on board one or more designated Navy submarines.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This effort is directly applicable to any commercial environment with a requirement to protect stored data.

REFERENCES:

1. Department of Defense Instruction 8500.2, "Information Assurance (IA) Implementation," 6 February 2003.

2. Director of Central Intelligence Directive 6/3, "Protecting Sensitive Compartmented Information Within Information Systems," 5 June 1999.

KEYWORDS: Information Assurance, disk, data storage, multilevel, security, encryption

N05-061 TITLE: Next Generation Controlled Impulse Ejection System

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop an ejection system that is capable of delivering a variable selectable impulse for ejecting underwater submarine launched acoustic countermeasures.

DESCRIPTION: The gas generator currently used by the navy is an ammonium perchlorate grain propellant that delivers a large impulse, sufficient to launch the largest countermeasure at the greatest launch depth. Unfortunately this impulse is far greater than required for all other devices and launch depths. A programmable, variable ejection system would significantly reduce shock and stress requirements on existing and next generation countermeasures.

PHASE I: Develop, document and demonstrate the variable ejection system with a maximum impulse/minimum time duration equivalent to that of the MK 77 gas generator.

PHASE II: Develop, document and demonstrate an ejection system that is linearly variable from peak MK 77 gas generator impulse profiles to less than 25 percent full impulse values. This variant shall meet the physical dimensional constraints specified in MK 77 drawings and specifications. This variant shall be capable of meeting the shock, vibration, temperature, storage, and shipping requirements as specified in WS 27294.

PHASE III: Demonstrate a functional, remotely programmable (via cabling), variable impulse, ejection system that shall meet all physical interfaces and space constraints as specified in MK77 drawings and specifications. Device shall be capable of passing all Hazard Assessment Tests For Non-Nuclear Munitions (MIL-STD- 2105).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Development and refinement of controlled impulse/thrust would have significant applications in commercial space and satellite applications.

REFERENCES:

1. Critical Item Product Fabrication Specification for the Generator, Gas MK 77 MOD 0 (WS 27294)

KEYWORDS: MK 77; Gas; Generator; Propellant; Impulse; Countermeasure

N05-062 TITLE: Multiplexed Optical Fiber Sensor Arrays for Submarine Atmosphere Analysis

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Enable the efficient operation of all aspects of the submarine atmosphere control system by using Multiplexed Optical Fiber Sensor Arrays to monitor the atmosphere quality throughout the ship and providing control input to the ship's ventilation system, heating and cooling systems, oxygen generator, carbon dioxide removal system, carbon monoxide/hydrogen processing system and trace contaminant removal system.

DESCRIPTION: Existing submarines employ a centralized atmosphere monitoring system. Air samples are pumped from various locations in the ship to a central laboratory grade mass spectrometer/IR carbon monoxide analyzer. A watch-stander cycles a selector valve through all the sample locations and waits at each location for the sample to arrive from the source and react within the analyzer. He then manually records the findings from each location and reports to the chain of command, where a decision is made to adjust the operator of the atmosphere regenerating equipment. Adjustments in ventilation to spaces are also accomplished manually. The atmosphere analyzer is a \$1M+ device that requires significant maintenance and specialized operator/maintenance training. The new optical fiber sensor arrays would take advantage of a property that causes the glass to change color in the presence of certain gasses. Rather than pump air samples across the ship, severely impacting the potential for modular design, atmosphere analysis for major constituents is done in place, and the signal from the analyzers is added to the ship's communication backbone. Atmosphere control equipment is enabled/adjusted based on that signal, ventilation is lined up to optimize air quality throughout the ship automatically. An analyzer for long-term health problem compounds draws a sample from a well-mixed area (fan room or equivalent) but does not cause a fail-to-sail if it is inoperative.

PHASE I: Perform and report on an evaluation of optical fiber sensor technology for application to the submarine environment. Leverage data from NASA-developed launch platform gas detection systems to minimize developmental costs for the submarine systems. Develop and document an analyzer/control system concept for insertion into the Virginia Class submarine.

PHASE II: Document and build a representative analyzer network system which interfaces with the developing ship network and in a simulated or actual work environment.

PHASE III: Design, using data and hardware evaluated in Phase II, a full-scale Multiplexed Optical Fiber Sensor Array system for the Virginia Class submarine. Include signal-conditioning devices that make the output from the array compatible with the ship's LAN, and design control algorithms for ship's ventilation and atmosphere generation systems based on data acquired from the array.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Optical Fiber Sensor technology has been, up until now, optimized for detection of combustion products resulting from a vehicle launch into space. That technology, when optimized for submarine atmosphere monitoring, will be far more easily adaptable to the commercial sector. The submarine atmosphere is conditioned to remain as close as possible to normal, outdoor air. Therefore, sensors used to evaluate it will be optimized to perform best in the area around normal air, rather than in the aftermath of a rocket launch. Strategies for securing environments in response to a terror threat often include air-tight isolation of the space; these submarine-optimized systems will be well-suited to monitoring the air in that situation.

KEYWORDS: Automation; control; submarine; analyzer; atmosphere; sensor

N05-063 TITLE: Acoustic Data Software "Intelligent Agent" Search Tool

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a software tool that will automatically search current and historical sonar data, analyze and review data points for key indicators, and alert operators to anomalies and possible contacts

DESCRIPTION: Automatic software tool that analyzes current and historical sonar data for key indicators and alerts operators to anomalies and possible contacts

PHASE I: Develop and document intelligent search and analysis algorithms that will discover and correlate sonar data. Develop intelligent algorithms that can be adjusted by operators to review and analyze specific parts of historical sonar data. Test these algorithms for effectiveness using recorded sonar data and prepare a T&E report.

PHASE II: Demonstrate the use of intelligent search and analysis algorithms in a real-time environment. Demonstrate a target motion analysis capability to determine and predict a target's current position a current speed and direction using sonar data. Develop and implement system that will alert operators to anomalies and possible contacts. Demonstrate compliance with all US Navy safety and information assurance protocols. Demonstrate that functionality of US Naval systems is no degraded due to implementation of intelligent software algorithms. Document all of the above with recommendations for a full scale system.

PHASE III: Test and prepare software intelligent agent for insertion into the Acoustic Rapid Commercial Off the Shelf (COTS) Insertion (ARCI) system using the Advanced Processing Building (APB) process. Deploy software intelligent agent with all ARCI systems. Continue to develop and modify existing algorithms and operator alert systems to increase effectiveness and functionality.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system has wide reaching commercial applications such as data mining, data analysis, data correlation, and many others. This system could be used by any commercial business that needs to analyze, review, or correlate data for certain key indicators that the business needs to review or analyze.

REFERENCES:
1. W. Frawley and G. Piatetsky-Shapiro and C. Matheus, Knowledge Discovery in Databases: An Overview. AI Magazine, Fall 1992, pgs 213-228.

2. "State of The Art" in Byte Magazine October 1995, contains three articles on Data Mining and Data Warehousing - http://www.byte.com/art/9510/sec8/sec8.htm

3. W. H. Inmon and S. Osterfelt, Understanding Data Pattern Processing QED Techincal Publishing Group, 1991, Wellesley, MA. I haven't see this book myself, but I saw Gregory Piatetsky Shapiro? describe it as "a business-oriented, nontechnical book"

4. Cheryl Gerber, Excavate Your Data. Datamation 42(9), May 1996. "Datamining could be your No. 1 strategic weapon--and source of profit--in dissecting archival information. But with its roots in machine learning, this esoteric technology takes some time to master." - http://www.datamation.com

5. Usama M. Fayyad, Gregory Piatetsky-Shapiro, Padhraic Smyth, and Ramasamy Uthurusamy, Advances in Knowledge Discovery and Data Mining. Published by the AAAI Press / The MIT Press - http://aaai.org/Press/Books/Fayyad/fayyad.html

6. Herb Edelstein, Data Mining: Exploiting the Hidden Trends in Your Data. DB2 Online Magazine. "This article, adapted from the Two Crows report "Data Mining: Products, Applications, Technology," introduces you to data mining technology and explains how IBM's Intelligent Miner can help you exploit hidden trends in your data." - http://www.db2mag.com

KEYWORDS: analysis; sonar; software; automatic; intelligent; algorithms

N05-064 TITLE: Human Interface Evaluation Methods for Submarine Combat Systems

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: The objective is to develop products that can be used to evaluate the impact of new and upgraded Human Machine Interface products against an established Combat System baseline. Products may consist of processes, software and/or hardware that can be implemented in submarine Combat Systems.

DESCRIPTION: The most common “cause" for system failures is "human error". However, systems often facilitate or create the opportunity for errors principally due to poor design. Evaluating the impact of systems on human performance and developing solutions based on those results can alleviate these problems, reduce errors, improve accuracy, reduce reaction time, and reduce excessive training. The problem is that there are no current, validated data sets on the impact of various components of the submarine Combat System (and other complex systems) on operator or decision maker performance. Since current systems do not collect the data required to evaluate the impact of products on human performance, this project will require developing methods for collecting relevant data and metrics and demonstrating their effectiveness in improving the effectiveness in improving operator performance of submarine Combat Control. However, these methods and metrics must not impact existing operational performance and must be accurate enough to detect and attribute significant changes in performance to human, software, or hardware components or the interaction of any set of components. Furthermore, as these are complex systems that perform critical functions, the data collection methods cannot deteriorate overall operational performance and must be accurate in operational environment.

PHASE I: Phase I will require developing and documenting methods for collecting relevant data and metrics and demonstrating their effectiveness in submarine Combat Control. These methods may include both subjective and objective data. They may include expert/heuristic evaluations and must include operator-in-the-loop methods. For all subjective data there must be cross-validation with objective methods.

PHASE II: The metrics and methods will be integrated and tested by application to baseline systems and proposed upgrade systems for the same set of functions. Working with developers, formative user-in-the-loop evaluations may be included, where appropriate. The entire effort will be documented with extensive T&E reports.

PHASE III: The methods and metrics developed under phase I and tested under Phase II will be sufficiently commercialized that they can be applied to a wide set of products. This methodology will be transitioned into the Advanced Processor Build (APB) testing process.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The same constraints apply in many commercial and public sector settings such as power plants, hospitals, fire fighting, etc. Thus, the development and demonstration of usability evaluation methods will help military, public safety, and commercial organizations to make decisions about which support products provide the best opportunity for performance improvement with the least likelihood of facilitating catastrophic errors.

REFERENCES:
1. DoD 5000

2. Navy Program Manager's Human Systems Integration Guide MIL-HDBK-46855A

KEYWORDS: Human Systems Integration; human performance testing; usability engineering; performance metrics; decision making

N05-065 TITLE: Submarine Non-Hull Penetrating (Wireless) Hydrophone

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace

OBJECTIVE: Develop an underwater acoustic hydrophone that does not require penetration of the submarine pressure hull to transmit its electrical signal to inboard processing and display systems.

DESCRIPTION: Rapid advances in processing capability coupled with reduced costs have allowed significant gains in submarine acoustic processing capability and allows for further improvement and modernization. However, due to the logistics, costs and safety issues, new and improved sensors, or additional sensors to support the advanced processing capabilities can not be easily added to a submarine platform. This is due to the need to carry the electrical/optical signals from the acoustic sensor exterior to the submarine hull inboard via wires (optical or electrical). A sensor capable of transmitting its acoustic data inboard the hull without wires and the subsequent need for hull penetrations, not only allows improvements in acoustic system overall performance, but could potentially save millions of dollars in installation costs while simultaneously increasing the safety and reliability of the submarine platform.

PHASE I: Perform modeling and simulation for various wireless hydrophone transmission schemes and perform limited (laboratory) acoustic testing of those schemes that appear feasible. Document modeling, simulation and testing and performan tradeoffs such as acoustic bandwidth vs. power consumption leading to a concept which should be evaluated and documented.

PHASE II: Document, design and build a prototype non-hull penetrating (wireless) hydrophone based on the results obtained in Phase I. This prototype sensor will be installed on a submarine platform and tested at sea for performance, and signature impact. Prepare and deliver a test report and analysis of the tests predict full size system capability.

PHASE III: The non-hull penetrating (wireless) hydrophone will be installed on all submarine platforms to support advanced signal and data processing algorithms currently developed under ARCI as part of the APB process.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The wireless sensor technology could be applied to any sensing environments requiring non-penetration of pressure vessels such as commercial submersibles and industrial applications in petro-chemical processing, etc.

KEYWORDS: Non-hull penetrating; wireless; hydrophone; underwater; acoustic; sensors

N05-066 TITLE: <u>Guaranteed Information Assurance in Netcentric-Compliant Information Systems</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Does not Support ACQ Program

OBJECTIVE: Develop methods and associated tools to bring about cost effective information assurance and guaranteed safety in netcentric-compliant information systems.

DESCRIPTION: The FORCENet and Net-centric Enterprise Services (NCES) concepts are transforming the way C4I and other information systems are being designed and built in the Navy. The concepts are indirectly forcing a change from prior generation stovepipes to integrated openly-architected solutions. Ample Open Architecture standards and design “recipes” are made available to the Navy and Navy contractor software engineering community to develop these new solutions. However, there is a lack of tools to assure and guarantee safety (e.g., security, information access, timing issues, requirements, etc.) in the new generation of netcentric-compliant systems. Currently, the working assumption is that each netcentric-compliant application will of course undergo its own rigorous information assurance and safety phase, before it is delivered to the Fleet. Historically, considerable R&D investment has been made in tools that accomplish safety assurance at the application level. These tools have included theorem provers, formal methods, reachability analyzers and many others. Given the difficulty of safety assurance at later stages of software lifecycle, many of these have focused on the earlier stages in the lifecycle (such as requirements engineering). While many excellent research results have been produced, it has also been demonstrated that economic and engineering difficulties generally preclude scaleable safety assurance at the application level for larger systems.

We seek tools to ensure information assurance and safety prior to final application construction or software code generation. We envision an emergence of a family of such tools, followed by their acceptance and standardization (or de facto standardization) by the community. Tools are thus sought that will bring about a disciplined approach to guaranteeing safety in large-scale netcentric-compliant systems. These tools should be applicable to a variety of programming languages used in the Navy.

PHASE I: Develop the concepts, algorithms, and architecture for a prototype tool system that guarantees a priori information assurance and safety in large-scale netcentric information systems.

PHASE II: Develop, demonstrate and test a prototype tool suite building on the results of Phase I. If possible, demonstrate the tool suite on a Navy-relevant information system.

PHASE III: Further develop and validate a productized tool suite for delivery to the Navy or DoD.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A tool suite for a priori guaranteeing safety in large-scale netcentric information systems would be of significant commercial interest to companies in transportation, manufacturing, trading and many other applications.

REFERENCES:

1. Netcentric Services: http://www.disa.mil/

2. Enterprise Software Initiative: http://www.don-imit.navy.mil/esi/

3. Open Architecture: http://www.opengroup.org/rtforum/oa_rtes/

4. FORCEnet: http://www.chinfo.navy.mil/navpalib/cno/proceedings.html

5. Michael G. Hinchey and Jonathan P. Bowen, editors, Industrial-Strength Formal Methods in Practice, Springer-Verlag, London, 1999

6. James L. Rash, C. Rouff, W. Truszkowski, D. Gordon and M. G. Hinchey, editors, FAABS, Proceedings of the 1st NASA Goddard Workshop on Formal Approaches to Agent-Based Systems, Springer-Verlag LNCS-2699, 2003.

7. M. Younis, T. Marlowe, A. D. Stoyen, G. Tsai, Statically Safe Speculative Execution for Real-Time Systems, IEEE Transactions on Software Engineering, Vol. 25, No. 4, pp. 701-721, September 1999.

8. P. Ammann, W. Ding, D. Xu, Using a Model Checker to Test Safety Programs, Proceedings of the Seventh IEEE International Conference on Engineering of Complex Computer Systems, pp. 212-221, 2001.

KEYWORDS: Information assurance, software tools, open architecture, software testing, enterprise services, netcentric computing

N05-067 TITLE: Variable Buoyancy Device for Autonomous Underwater Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Enable dynamic control of the net buoyancy of autonomous underwater vehicles with a self-contained device capable of deployment on a variety of platforms.

DESCRIPTION: Propulsion of autonomous underwater vehicles is most efficient when buoyancy can be actively controlled. Buoyancy adjustments can be used to control center of mass vertical motion and/or pitch and roll moments. For winged gliding vehicles, buoyancy also drives horizontal motion. Interest here includes large displacement (> 0.5 kg) main engines and small displacement (< 100g) trim devices operating over a depth range of 0 to 1000 meters in seawater. Important variables are efficiency, size, weight, ruggedness, scalability and cost. Sources of energy can be onboard electrical (batteries) or direct chemical conversion (e.g., phase change), and/or environmental harvesting.

PHASE I: Develop a feasibility concept for a variable buoyancy device, main engine and/or trim type, capable of deployment in current generation gliders. Technical descriptions of these state-of-the-art gliders are contained in references (1), (2) and (3). For a main engine, the projected performance should exceed that of the state-of-the-art systems described in the references.

PHASE II: Demonstrate a prototype variable buoyancy device both in the laboratory and on a glider operating in the ocean. Document in-situ performance over a representative range of real ocean environments.

PHASE III: Re-engineer the advanced prototype device for commercial production incorporating economies of scale for subsystem components.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These devices could be used in any autonomous underwater vehicle to control buoyancy, a primary variable in performance. The autonomous underwater vehicle market is projected to grow in the coming years.

REFERENCES:
1. Eriksen, C.C., et al., Seaglider: a long range autonomous underwater vehicle for oceanographic research. IEEE J. Oceanic Engineering, 26 (4): 424-436, 2001.

2. Sherman, J., et al., The autonomous underwater glider "Spray", IEEE J. Oceanic Engineering, 26 (4): 437-446, 2001.

3. Webb, D.C. et al., SLOCUM: an underwater glider propelled by environmental energy, IEEE J. Oceanic Engineering, 26 (4): 447-452, 2001.

KEYWORDS: buoyancy; autonomous, underwater; vehicles; control, gliders

N05-068 TITLE: Wet Film Thickness Sensor/Device for Navy Platforms

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Provide for creative and innovative technology to be used in developing a wet film thickness sensor/device for determining wet film thickness of paint being automatically applied to Navy platforms (ship hulls).

DESCRIPTION: The Navy is currently developing advanced automated paint application, containment and treatment technology for painting ship and submarine hulls in dry docks. This technology is capable of painting 80% of the area of a typical ship hull while capturing 95% of the paint overspray. A key consideration in this process for quality control is to monitor and adjust in real-time the film thickness of the paint being applied. Current manual methods are intrusive and require stopping the painting process while film thickness measurements are obtained. A wet film thickness sensor/device incorporated onto the painting shroud, capable of determining paint thickness, in real time or near-real time while the paint is applied, is highly desirable to enable the automated paint system to adjust speed and other parameters to maintain the desired uniform thickness. The sensor technology/device must be capable of measuring wet paint thickness applied over several layers of dried paint as described in detail below:

a. Coatings to be monitored:
5 layers of paint typically applied to below waterline hull:
2-layers of 5 ± 1 mil dry film thickness (dft) Epoxy Anti Corrosive paint (Zinc-Based, typically 70-80% solids)
3 Layers of 5 ± 1 mil dft Cuprous-Oxide Based Anti Fouling Paint, typically 60% solids.
Above waterline, Silicone Alkyd Paint applied:
2-layers of 3 ± 1 mil dft on top of the two layers of epoxy A/C paint.
Substrate is steel, typically sand-blast profiled to 2.5 ± mils.

b. Wet Film Thickness Gauge Technical Requirements:
Accuracy better than ± .25 mils (± .1 mil desired)
Cannot touch wet paint surface.
Desired that closest distance to surface while reading is ~6". If necessary, non-real-time sensor can operate closer to surface.
It is desired that it would "sense" only the thickness of the last wet layer applied, however alternative approaches such as measuring total thickness of paint over substrate both prior and post wet paint application are also possible.

Sensor measurements should not be affected by amount/composition of metal in paint (i.e. Zn, CuO_2). Measurements acquired at 10Hz.

PHASE I: Investigate/develop/design an innovative wet film thickness technology approach that is capable of measuring wet film thickness under the conditions shown above and that could be applicable for use on or with automated paint systems. Preliminary laboratory measurements should be obtained to defend and justify further development. Prepare concept documentation that will demonstrate the selected technology and provide estimates of eventual production cost and size of final sensor package.

PHASE II: Based on the results and proven feasibility/suitability documented in Phase I, design, develop and test a prototype wet film thickness sensor/device. Working with the Navy Acquisition sponsor, conduct laboratory evaluation of the prototype device and subsequently conduct field tests in conjunction with Navy automated painting evaluations to demonstrate the technology. The sensor/device will be evaluated for performance, operational compatibility, and ruggedness appropriate for field use.

PHASE III: The final sensor/device "product" will transition to the Naval Sea Systems Command and the Naval Facilities Engineering Command for implementation and further advanced development and integration. Based on the evaluations completed under Phase II, the contractor will make further modifications, improvements optimizations as required and conduct full scale field evaluations in a Navy/marine engineering environment (dry dock) or commercial facility in conjunction with the Navy customer. Additional applications to all DoD painting facilities is envisioned.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial marine shipbuilding and dry dock industry will be a primary recipient of the technology. Other commercial painting companies and industries will also benefit.

KEYWORDS: Paint Thickness Measurement; Paint Thickness Sensor; Ship Hull Painting; Film Thickness Sensor

N05-069 TITLE: Enhancing Tactical Decision-Making in Navy Seal Operations

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop a quick response, collaborative capability among Navy Seal teams for acquiring, processing and sharing updated information necessary for making faster and more accurate tactical decisions.

DESCRIPTION: Today's asymmetric warfare presents new challenges to making accurate and timely tactical decisions within the Naval Special Warfare environment. These challenges include: distributed decision-making under tremendous time pressure, agile operations with coalition forces, open-source data, information / knowledge uncertainty, and dynamic information. The capability to get the right information at the right time depends on effective information acquisition, processing and sharing among team members. The capability to provide knowledge interoperability among the necessary teams could be provided by a support tool that represents required knowledge in object-based, cognitive friendly format that is easily and quickly understood by all. This solicitation seeks novel approaches for developing a collaborative capability among Navy Seal teams for acquiring, processing and sharing updated information for making improved tactical decisions. Representative operational and delivery system considerations that may be associated with the requested knowledge building and transfer capability include:

• A small, light weight, waterproof collaboration tool that improves existing communication techniques (e.g. ViaSat e-mail, SAT COM) and current informational databases (SWAMP) within a secure communication environment

• The collaboration tool could provide communication not only between Seal teams, but with the Tactical Operation Center and the Joint Operation Center
• Real-time weather information superimposed over a map, which includes threat, target area and ingress/egress points along with GPS coordinates
• Comparison of historical data to new data including changes in target area, intelligence data, map pictures, tides/currents/phases of moon and changes in mission
• Medical information (Merck manual and Physician's Desk Reference) and access to a certified field doctor
• Survival maps relevant to the area of operation including information on indigenous plants, poisonous snakes, and local hospitals
• Easy access to mission information (e.g. GPS coordinates, satellite frequencies, phone numbers, identification codes)
• Real-time video feeds from satellites or AWACs
• Easy access to Jane's military systems and equipment information (e.g. weapons, armament, ship and aircraft profiles)

PHASE I: Demonstrate the feasibility of a knowledge building and information transfer methodology in a laboratory environment. Conduct an effectiveness analysis of proposed approach against current communication methods using a sample Navy Seal mission scenario to assess the projected enhancement in tactical decision-making.

PHASE II: Design and construct an engineering prototype to be demonstrated at the end of this phase. The prototype will be sufficiently refined in order to conduct a limited field evaluation of the prototype using the same scenario from Phase I. Metrics will be defined to assess the improvement in tactical decision-making compared to existing communication methods.

PHASE III: Refine the prototype developed in Phase II so that it can be fabricated and evaluated in small numbers by operational Navy Seal teams. At this point the prototype should be representative of the final product so it can be completely evaluated. During this phase limited number of the prototypes will be fielded with operational Navy Seals for evaluation and feedback. These field trials will constitute the basis for additional modifications as well as any subsequent procurement decision.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private-sector applications would include university-level team decision-making in oceanographic research domains.

REFERENCES:
1. Joint Vision 2010, Chairman of the Joint Chiefs of Staff, Pentagon, Washington, DC, 2002. Internet: www.dtic.mil/jv2010/jvpub.htm

2. Naval Special Warfare Web Site, http://www.sealchallenge.navy.mil/

3. Electronic Card Wall Project at MIT, Web site: http://ewall.mit.edu/

KEYWORDS: Team Collaboration; Decision-making; Information technology; Team Collaboration Tools

N05-070 TITLE: Synthesis of Alpha Aluminum Hydride an Advanced Propellant Ingredient

TECHNOLOGY AREAS: Materials/Processes, Weapons

DESCRIPTION: Over the past 20 years the Alpha Polymorph, Rhombic Cube of Aluminum Trihydride, AlH3, "Alane," has been produced and shown to be the most stable form of Aluminum Hydride. The Alane material proved to be a three-dimensional polymer, all atoms of which are linked by Al-H-Al bonds, as characterized in Proton nuclear magnetic measurements (over the temperature range 4.3-300 K,) by two spectra resonance lines with different widths. While the broad resonance is specific for AlH3 bulk material, the second one exhibits characteristics typical of hexagonal close-packed molecular hydrogen surface coverage. Alane shows significant potential as a fuel for enhancing the energetic properties of solid rocket propellants.

Concurrently, in the early 1960s' significant resources were extended in the United States to synthesize and characterize aluminum hydride (Alane) as a potential fuel for advanced solid rocket propellants. After several years of investigation, it was determined that the Alane prepared was not sufficiently stable for further development work. In the late 1990s' researchers at SRI International developed and patented1 a new process to prepare pure alpha Alane, which proved to be significantly more stable than the materials examined in the mid-1960s'.

Domestic attempts to produce large quantities of Alane have met with limited success. Current methodologies involve solvated evaporative chemical processes and produce large volumes of highly volatile chemicals as byproducts. Additionally these processes have large space requirements and are labor intensive. Moreover, they often result in the formation of a sizable percentage of the Beta phase "needle-shaped" crystals that are unstable in both mechanical and thermal environments. It appears that solvated evaporative chemical processes cannot adequately establish the molecular hydrogen surface coverage that gives the alpha form its stability.

Alternative methods of Alpha Alane preparation, crystallization and characterization are sought. Minimum 25-gm samples will be delivered to Government Laboratories for assessment and evaluation. The small batches (25 gm size) will require Materials Safety Data Sheet (MSDS) statements and shipping classifications from the preparer.

PHASE I: Synthesize 25-gm sample quantities of Alpha Polymorph, Rhombic Cube of Aluminum Trihydride, AlH_3, "Alane," and provide characterization, analysis, and delivery to government laboratories for evaluation.

PHASE II: Scaleup of the process to pound quantities for larger-scale evaluation and process research and establish parameters to define mini-pilot plant design of pure Alpha Alane (2000 pounds/year scale).

PHASE III: Transition technology to next generation propulsion and ordnance systems per appropriate PMA/PMS road maps. Provide costing and data package for pilot plan production of materials based on requirements and need. Examples include next generation RAM, Sidewinder, and AMRAM missile propulsion systems and new underwater explosive compositions for 6.25 torpedo system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: While the principle application for Alane would be the propellant and space community, potential photographic and custom synthesis applications can be envisioned. Specifically, in the area of selective reductive hydrogenation the use a stable, long-shelf life hydride has potential application. Application to the photographic industry as a replacement for silver halides can also be envisioned.

REFERENCES:
1. J. Bottaro, et al, "Preparation of aluminum hydride polymorphs, particularly stabilized .alpha.-AlH3," US Patent # 06228338, 2001.

2. ibid, "Stabilized aluminum hydride polymorphs" US Patent # 06617064, 2003.

KEYWORDS: aluminum trihydride, Alane, propellant, fuel, synthesis

N05-071 TITLE: <u>Development of a miniature, hyperspectral imaging digital camera</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

OBJECTIVE: Develop a miniature, hyperspectral imaging digital camera with discriminate analysis capabilities

DESCRIPTION: The development spectral imaging technology brings hope for increase in detection and identification of objects beyond capabilities of human eye even in the visible spectral region. Human vision is based on three color sensors. Today's digital camera can provide 120 or more bands over the same spectral region. However, not many spectral imaging cameras are commercially available, and most of them are large, with multiple attachments for data transfer and computation. There is a justified need for a miniature digital camera utilizing power of USB 2.0 data transfer rates with no custom data transfer cards, no external boxes hosting supportive electronics. The camera should be essentially self-contained. The total system should be limited to the following elements: Spectral imaging camera, power supply, and a notebook-type computer or PDA.

PHASE I: Develop a concept of a miniature spectral imaging digital camera. Study feasibility of utilizing USB 2.0 protocol for data transfer from the camera to the notebook type computer. Develop concept of a dispersive element to assure high image quality over visible and near infrared spectral range with hyperspectral capability. Research availability of high sensitivity, low power consumption detector arrays.

PHASE II: Develop spectral dispersive element as described in Phase I. Develop a miniature camera with efficient visible array detector. Develop supportive electronics utilizing a fast data transfer protocol. Integrate the elements into a portable system. Demonstrate its performance for discriminate object detection. Explore integration of hyperspectral camera system onto an Unmanned Air Vehicle.

PHASE III: Initiate production efforts to build and produce the miniature, hyperspectral imaging digital camera. Prepare production design package and user manuals.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Skin care, pharmaceutical, cosmetic, paint, color identification, paint inspection, inspection for corrosion, person identification, computer graphics enhancement, agricultural crop inspection, environmental soil erosion detection, forest infestation early detection.

REFERENCES:

Sea Power 21: Enabling MCPs

- Detect/ID Targets
- Provide Cueing & Targeting Information
- Sensor Management & Info Processing
- Special Operations/Visual/EO Sensors
- Assess Engagement Results

KEYWORDS: Hyperspectral, imaging, miniature digital camera

N05-072 TITLE: <u>Portable Infrared Monitor for in-field identification of chemical unknowns</u>

TECHNOLOGY AREAS: Chemical/Bio Defense, Sensors, Electronics

OBJECTIVE: Develop a hand held spectral monitor for identification of unknown chemicals. The light-weight portable device should provide enough spectral resolution to identify unknown chemicals by searching spectral libraries of known chemical compositions for comparison.

DESCRIPTION: Obvious needs for field detection of chemical unknowns combined with development of miniaturized computational technology has created possibility for development of miniaturized analytical devices. The current technologies are used on bulky infrared spectrometers operated by notebook-type computers. Although these devices are much smaller than the established laboratory spectrometers, they are still not portable nor simple enough for wide spread implementation. Recent progressive development of PDA-type computers and appearance of miniature analytical machines creates hope for a successful development of an interferometer or other spectral means based infrared spectrometer with high enough spectral resolution for identification of unknown powders, pastes, liquids residues or even gases. The device should be battery powered, modular, and controlled by a miniature computer with enough memory storage to host broad spectral libraries.

PHASE I: Conduct research into development of a battery-powered miniature hand-hand Infrared (IR) spectrometer. Investigate low power consumption IR sources, high sensitivity IR detectors and spectral dispersive elements like gratings or interferometers to provide enough spectral resolution for successful spectral library searches. Establish availability of computational power and miniaturized digital memory to build such a device.

PHASE II: Develop a laboratory model of the proposed device. Demonstrate its spectroscopic capabilities in measuring infrared spectra of broad range of materials. Transition to a hand-held format and build a prototype device. Investigate compression of spectral libraries to accommodate miniature storage mediums and effectiveness of search algorithms. Establish minimum required spectral resolution. Develop cost information and design specifications for a production monitoring device.

PHASE III: Initiate production efforts to build the measurement device in commercial quantities. Prepare transition packages for specific platform users or organizational and depot military support units.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A portable spectral monitor could be used by chemical industry for industrial hygiene application, and every hazardous material identification group. The device could be used by commercial laboratories where space and simplicity of operation of an asset. Detection and identification of chemicals is an everyday problem in broad industry areas such as pharmaceutical, semiconductor, chemical, petroleum, and others.

REFERENCES:
Sea Power 21: Enabling MCPs
Provide Cueing & Targeting Information
Special Operations/CBR Sensors

KEYWORDS: Infrared (IR) Spectrometer, Chemical Sensor

N05-073 TITLE: Advanced RF Power Amplifier Techniques

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: To increase the efficiency of RF power amplifier systems while reducing distortion of signals through the use of novel pre-distortion or other adaptive techniques. The end product of Phase II will be high efficiency, low distortion amplifiers and the analysis to model their performance.

DESCRIPTION: The current problem is that amplifiers have reduced efficiency when operated so as to reduce distortion and reduce out of band emissions. This causes excessive power consumption and a resultant heat dissipation problem. Amplifiers of interest operate in the VHF to L-band frequency ranges, using a wide variety of waveforms. The challenge is to increase the efficiency of these amplifiers while maintaining excellent signal fidelity. Because individual amplifiers are fairly large, it is conceived that novel techniques, which are adaptive and compare the input and output signals, could be used. The adaptivity can take any useful form, but might include control of the supply voltages, pre-distortion of the input signal, and re-configuration of the amplifier components. The application is to multi-stage amplifiers (3 stages) with gain in excess of 30db, and efficiency goals of greater than 60%. These power amplifiers will be utilized with a wide variety of input signal formats.

PHASE I: Phase I will result in the design and demonstration of new amplifiers with auxiliary circuitry, which demonstrates improvement in efficiency without distortion increase. The operation of the amplifier must be modeled and experiment compared with predictions. Lower power operation is permissible.

PHASE II: Phase II will start with the Phase II designs and result in fabrication of high efficiency, high power amplifiers with > 30db gain and output power > 100 W CW. The operation of the amplifier must be modeled and experiment compared with predictions. The amplifiers will be tested in a breadboard, the designs modified as required and additional amplifiers fabricated and tested. It is anticipated that three or four iterations will be necessary. The final amplifier prototypes will be demonstrated by the contractor to highlight the increased efficiency and reduced distortion, and the modeling software will be delivered, with documentation.

PHASE III: Construct, integrate, and test a high power amplifier system in an airborne test bed platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial communication systems for high data rate communications.

REFERENCES:

1. Doherty amplifier with DSP control to improve performance in CDMA operation, Yu Zhao; Iwamoto, M.; Larson, L.E.; Asbeck, P.M.; Microwave Symposium Digest, 2003 IEEE MTT-S International, Volume: 2, 8-13 June 2003. Page(s): 687-690.

2. Time domain characterization of power amplifiers with memory effects, Draxler, P.; Langmore, I.; Hung, T.P.; Asbeck, P.M.; Microwave Symposium Digest, 2003 IEEE MTT-S International, Volume: 2, 8-13 June 2003. Page(s): 803-806.

3. A Consideration of Phase Distortion in Linear Power Amplification of QPSK and Two Tone Sinusoidal Stimuli, Staudinger, Joe, 1997 Wireless Communications Conference, p. 105-109.

4. Power Amplifiers and Transmitters for RF and Microwave, Raab, F.H.; Asbeck, P.; Cripps, S.; Kenington, P.B.; Popovich, Z.B.; Pothecary, N.; Sevic, J.F.; Sokai, N.O.; IEEE Transactions on Microwave Theory and Technique. March 2002.

KEYWORDS: power amplifier; efficiency; distortion; adaptive; RF; microwave

N05-074 TITLE: <u>Advanced Wide Band RF Distribution System</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Design and build an advanced RF distribution system (RFDS) for distribution of extremely small SIGINT/ELINT/IO/EA/Communications signals to shipboard communications, electronic attack, acquisition and direction finding processing electronics. The RFDS must provide a low noise RF path from shipboard antennas to below decks processing electronics while operating in a high electromagnetic interference (EMI) environment.

DESCRIPTION: The execution of shipboard electronic missions requires acquisition and DF of signals at or near the thermal noise floor. This requires the overall system to have a low noise figure. In addition, these missions must be performed in an extremely harsh electromagnetic environment over a broad aperture: MF through UHF. This requires effective EMI mitigation.

In order to maximize available signal-to-noise for small signals the RF path (including the RFDS) will have a sensitivity defined by a minimum discernable signal (MDS) equivalent to the minimum shipboard noise floor plus the RF path noise figure. The noise figure will be <= 3dB (including the RFDS) above 110 MHz and <= 3 dB plus ambient cosmic noise below 110 MHz.

There are three approaches to dealing with EMI in the RFDS: 1) EMI tolerance, 2) EMI rejection, and 3) EMI avoidance. EMI tolerance is achieved through high spurious free dynamic range (SFDR) and high power handling capable. EMI rejection is achieved through extremely high-Q (>100,000) notch filters. EMI avoidance is achieved through creative tuner scanning. The first two EMI handling approaches are requirements while the third is desired.

• The SFDR threshold is 110 dB with a goal of 140 dB. The RFDS will capable of operating with input signals of +33 dBm (above 30MHz) and 40 dBm (30 MHz and below).

• The notch depth is threshold 40 dB with an objective of 60 dB (width to be defined). Band-reject and High/Low pass filters may be included in the design if deemed necessary.

• EMI avoidance schemes must adhere to accepted POI/POR requirements.

The RFDS will provide acquisition as well as DF paths. The accuracy of the DF algorithms will not degrade with the insertion of the high-Q filters. The DF techniques will provide both ground-wave and sky-wave MF/HF Bands. In the V/UHF bands N-channel DF techniques are the goal. While current input configurations are acceptable, this should not be a constraint on the design of the system.

The size and weight should be form-fit (or less) of the current system, operate on 120 VAC/60 Hz, and tolerate temperature ranges of -30F to 140F for external components (if any) and 30F to 120F for internal components.

PHASE I: Develop basic technology concept and prove concept feasability.

PHASE II: Design and construct an engineering prototype to be demonstrated at the end of this phase. The demonstration will include preliminary field tests.

PHASE III: Refine the prototype developed in phase II so that it can be fabricated and evaluated by operational forces. The refined prototype should be sufficiently close to production models so that field tests will demonstrate the operational benefit of the new technologies. These field trials will be the basis for additional modifications as well as any subsequent procurement decisions.

PRIVATE SECTOR COMMERCIAL POTENTIAL: For civilian uses, this technology can be used to provide situational awareness for a variety of homeland security applications such as border monitoring, port security, high value (power plants, chemical plants, water plants, etc.) facility protection. Other civilian applications include acquisition and location of cell phones and mobile emergency signals for quick response.

REFERENCES:
1. "Digital Techniques for Wideband Receivers" 2nd Edition, James Tsui, Artech House, May 2001 2) "Superconductor technology for wireless networks" Stephen M. Garrison, Mobile Radio Technology, Sep 1, 1997.

KEYWORDS: RF distribution, low noise, direction finding, electronic attack, communications,EMI, high-Q, wide band

N05-075 TITLE: <u>High Speed (15 kts) Long-Length Fiber Optic Deployment System</u>

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

OBJECTIVE: To develop a long length (20 km+) expendable optical fiber optic payout spool for use in high speed (15 knots+) deployable undersea communications, sensor, and weapon devices. Current developmental approaches using this technology (e.g., submarine-launched camera buoys, the ADS undersea surveillance system, and torpedo tethers) have been limited in deployment speed and length or are unaffordable in a production system. There are many vulnerabilities in the capability of deployed optical fiber in an undersea environment such as strain, disabling kinks, hydrogen darkening, fishing activity, and hostile (or curious) marine creatures. There are also many challenges in the spool winding and undersea deployment of this fiber at high speed.

Current solutions rely on COTS fiber and other cable materials that have been in use for decades. Most spool designs predate current computer capabilities. There is potential for significant improvement in capabilities by utilizing new materials and computer modeling of the hydrodynamic environment.

In addition, consideration for marine life must be made after the fiber is deployed and abandoned in the sea. A fiber material that would breakdown into harmless components after use would be of high interest to both the military and academic (oceanography research) community.

DESCRIPTION: Submarines do not have the capability to transmit in the RF domain at any significant data rates while traveling below periscope depth. Submarines traveling at tactically significant speed and tactically significant depth are unable to participate in full FORCEnet/Sea Power 21 Network Centric Warfare operations. To give the submarine the additional capability of two-way communications while submerged, a tethered expendable communications buoy using a high speed long length fiber optic payout spool can be used. The buoy must be deployed using the 3-inch launcher; the launcher can be used to eject devices at submarine speeds up to about 10 knots. After launch, the submarine can increase its speed to transit the area. The opening of this launcher is slightly recessed from the outer hull and a lifting body "kites" the buoy away from the flow into the propeller. The fiber needs to be designed to mitigate the hydrodynamic issues arising from deployment and accent of the buoy. The goal of the expendable buoy system is to provide a submerged submarine two-way communications while traveling at an optimum combination of speed and time duration of the communication.

PHASE I: Explore and define innovative approaches to providing submarines with a long fiber optic link to the ocean surface. The size constraints of an expendable buoy, type of fiber, speed of the submarine, and fiber length must all be taken into account. Design a fiber deployment system to be compatible with a submarine launched 3-inch tethered expendable buoy meeting the goals in the description. Provide analysis of optical fiber "cable" and mechanical system to support the final design. Show how this design will allow the buoy to meet the system goals. The design must address the following risks:

Optimum design for the fiber pack.
Fiber mechanical strength specifications.
Maximum allowable fiber attenuation.
Spool design.

PHASE II: Design, build and test a prototype of the optical fiber deployment system to fit in a 3-inch buoy and perform an experimental demonstration of cable deployment in an at-sea test. Determine the maximum tether load that the fiber optic cable can support. Demonstrate that the fiber and spool meets the design specifications.

PHASE III: Transition production to a low cost production design system. Provide ten units for at-sea use in a tethered expendable buoy.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The oil exploration industry routinely utilizes undersea sensors. Although deployment speed is not typically a concern, the requirements for length, robustness, and environmental safety of the deployed optical fiber is similar to that of the military application.

KEYWORDS: fiber; optical; payout; buoy; submarine; tether

N05-076 TITLE: <u>Cost-Effective Mission Planning for Persistent Surveillance of the Littoral Physical Environment</u>

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

OBJECTIVE: Develop a cost-effective system consisting of a long-life, adaptive sampling capability to characterize the ocean and seabed properties in littoral areas with sufficient accuracy to enhance the performance passive tactical and surveillance sensors as well as monitor and manage Exclusive Economic Zone (EEZ) resources and support commercial exploitation and infrastructure development of seafloor and marine resources.

DESCRIPTION: Driven by national security interests, our Navy needs to operate in littoral regions around the world for the foreseeable future. There is also an increasing need for our Navy to align its tactics directly to the dynamically changing conditions of the physical environment that characterize the littoral regions of the world. This topic, therefore, addresses the need for Navy to measure, describe and understand physical ocean properties on space and time scales that affect the tactical performance of acoustic and non-acoustic sensors and USW missions in littoral operating areas covering a few hundred square nautical miles in extent.

Gaining sufficient knowledge of the physical environment properties that describe important littoral areas are quite challenging using today’s normal surveying techniques. The methodology developed should provide a means to select the critical parameters to be measured, to define necessary accuracy of each and define the minimal sampling density needed. This topic is specifically aimed at developing the architecture for a cost effective adaptive environmental sampling with the necessary assimilation, optimal interpolation, or data fusion of the measurements at enough locations and times to support accurate environmental descriptions of the marine environment. Defining the optimum sensor mix, deployment scheme and sampling strategy are key elements of this initiative. The goal is the optimal use of commercial-off-the-shelf (COTS) sensors and/or USW sensors that are currently or soon to be in the Navy inventory.

PHASE I: Develop a conceptual design that provides an adaptive sampling architecture in terms of both a system and technical architecture. Include a planning module and a data distribution capability to link the most important physical ocean environment properties to operational Navy Meteorological and Oceanographic (METOC) data fusion and production centers. The adaptive sampling system must include the spatial and temporal distribution of measurements of the physical environment with estimates of data delivery latency and the uncertainty associated the parameter products provided to the users.

PHASE II: Build the prototype system and test its capability for sampling the littoral environment. The prototype sampling system must include human system interface (HSI) considerations. Demonstrate the value of the proposed environmental sampling capability with the use of performance metrics. Modeling and simulation techniques should be used as a means to evaluate and substantiate the viability of the proposed capability using representative datasets of littoral environments, actual COTS sensor performance characteristics and realistic characteristics of sensor-deployment platforms.

PHASE III: The Phase II prototype capability will be transitioned and integrated into the Navy's Tactical Environmental Support System/Navy Integrated Tactical Environmental
Subsystem (NITES). The NITES is a program of record (ACAT IV) within PMW 180 and the successful implementation of a system to address this topic will contribute to the development of a Rapid Environmental Assessment component.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial potential of this SBIR effort is extensive. Some applications include commercial fishing, ocean quality monitoring, and marine mammal monitoring. Effective fishery management in coastal waters will require smart cost effective adaptive monitoring techniques. The technical solutions for adaptive environmental sampling would support the evaluation and management of resources in the Exclusive Economic Zone (EEZ) as well as supporting the petroleum industry infrastructure development offshore.

REFERENCES:

1. Naval Transformation Roadmap 2003

2. The Navy Unmanned Undersea Vehicle (UUV) Master Plan

3. Task Force ASW Warfighting Strategy and Concept of Operations for Anti-Submarine Warfare, CNO Sea Shield – ASW (DRAFT), 26 April 2004.

4. Universal Joint Task List; Chairman, Joint Chiefs of Staff Manual 3500.04C

KEYWORDS: Optimal sampling, mission planning, environmental sensors, littoral environments, data assimilation, optimal interpolation, and data fusion

N05-077 TITLE: Station-Keeping Gateway Buoy ("Gatekeeper")

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

OBJECTIVE: Develop and demonstrate a mooring-less sea-surface buoy suitable for supporting Radio/Acoustic COMmunications (RACOM.) This buoy would function as a "gateway" between Undersea FORCEnet acoustic communications and the mainstream Radio Frequency FORCEnet intrastructure -- with the purpose of enabling seamless two-way network connectivity to undersea platforms. Since in-field maintainence of the deployed buoy would put Navy personnel at risk and compromise the stealth nature of the operation, the buoy needs to retain its geographical location, recharge its batteries using resources available on the ocean surface, and be remotely monitored and controlled by personnel. Adequate power storage capacity must be provided to enable 24/7 RF and acoustic communications reception and at least 3 hours of active acoustic and RF transmission per day. The buoy needs to maintain its position on-station and operate for a period of at least three months after initial deployment.

DESCRIPTION:

PHASE I: Prove the feasibility of a deployable autonomous surface platform concept for persistent, unmoored station keeping in open ocean and littoral ocean locations.

PHASE II: Develop and, in conjunction with US Navy Undersea FORCEnet experimentation, demonstrate prototypes incorporating microprocessor, energy harvesting (e.g., solar, wave), GPS, acoustic modem (e.g., telesonar), line-of-sight radio modem (e.g., FreeWave), satellite communications modem (e.g., Iridium), and navigation safety features (e.g., flasher, radar reflector).

PHASE III: Support Navy demand for Undersea FORCEnet gateway buoys. Commercialize the buoys for meteorological and oceanographic data collection and telemetry.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Uses of such a product include location marking, offshore weather sensing, and oceanographic sensing. The mooring-less design eliminates the need for tailoring an anchor line for a particular water depth and current regime, and results in a ready-to-deploy package suitable for most ocean locations.

REFERENCES:
1. Front Resolving Observational Network with Telemetry (FRONT), O'Donnell, J., et al., ONR Report, www.onr.navy.mil/sci_tech/ocean/reports/ docs/nopp_funded/01/bcbodonn.pdf

2. Development of a Small, Multi-Purpose, Autonomous Surface Vessel, Leonessa, A., et al., ONR Report, www.onr.navy.mil/sci_tech/ocean/ reports/docs/om/03/omleones.pdf

KEYWORDS: buoy; station keeping; gateway; FORCEnet; Seaweb; racom

N05-078 TITLE: Adaptive Anti-Jam Radio

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: This SBIR targets adaptive spectrum management in the anti-jam (AJ) applications – to investigate and develop a flexible NAVSTAR Global Positioning System (GPS) AJ radio enhancement utilizing adaptive antenna techniques.

DESCRIPTION: GPS vulnerability to attack has been the subject of many investigations through the last several years reflecting increasing awareness by the numerous systems and mission areas dependent on GPS. Protection available with current technologies may not be sufficient to preserve GPS navigation. This SBIR targets a concept of GPS relay via adaptive AJ links when GPS is vulnerable to the jamming interference. The GPS navigation information via the adaptive AJ link will be acquired from UAV or other cluster stations in non-jamming ground zones. In addition, the adaptive AJ radio is capable of: (1) allocating the transmitted signal spectrum to the available spectrum slots when sensing the existence spectrum, and (2) mitigating multipath, multi-access interference (MAI), and co-channel interference (CCI) (adaptive AJ radio enhancement). This SBIR will focus on the integration architecture of Adaptive AJ links, dynamic spectrum allocation, and the adaptive AJ radio enhancement.

PHASE I: Investigate and develop a conceptual architecture of adaptive anti-jam radios to address GPS AJ radio enhancement utilizing adaptive antenna techniques in mobile communications environments. The Adaptive AJ Radio must be capable of: (1) high AJ performance against intended and unintened signals, (2) mitigation of multipath, MAI, and CCI, and (3) spectrum reuse and coexistence with other signals utilizing dynamic sprectrum allocation techniques or other means.

PHASE II: Develop the algorithms and methodology needed to implement the Adaptive AJ Radio with AJ capability, resilience to fading, MAI and CCI mitigation. Develop a model of the Adaptaive AJ Radio and a Concept of Operation. Perform a concept simulation using the GPS Antenna system-1 (GAS-1) antenna configuration, and/or another relevant array configurations.

PHASE III: If the Adaptive AJ Radio is found to enhance communcations security, and to be cost effective and practical, the Adaptive Anti-Jam Radio would transition to applications throughout the GPS Program. This would entail applications throughout DoD as GPS is a joint program. The mitigation of GPS jamming and other interference effects is a high priority thorughout DoD and the civilian sector. The NAVWAR Program could use the Anti-Jam Radio to mitigate jamming in littoral regions where vulnerability to jamming is the greatest.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The Adaptive AJ Radio would also have numerous applications in the private sector as the use of GPS has proliferated throughout the civilian world. In addition to the intended GPS applications, the concept of an Adaptive AJ Radio would have applications in other areas of communications, and in wireless networking.

REFERENCES:
1. Pattan, B., 'Robust Modulation Methods and Smart Antennas in Wireless Communications', Upper Saddle River, New Jersey: Prentice Hall, 1999.

2. Compton, R.T., 'Adaptive Antennas, Concepts and Performance'. Englewood Cliffs, NJ: Prentice Hall, 1988.

3. Sklar, B., 'Digital Communications, Fundamentals and Applications'. Upper Saddle River, NJ: Prentice Hall, 2000.

KEYWORDS: Adaptive; Anti-jam; GPS; antenna; spectrum.

N05-079 TITLE: Adaptive Gridding in Complex Physical Environments to Reduce Uncertainty

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: Develop an adaptive, irregular, point-selection process so that accurate sensor system performance predictions across large three dimensional grids in complex environments can be computed using 20-100 times fewer model runs than uniform regular grids of the same mean uncertainty. The algorithm should be capable of handling all three spatial dimensions, range, azimuth, and several sensor setting or system parameters.

DESCRIPTION: Some modeling and simulation algorithms are too slow for tactical use when performing underwater environmental and acoustic energy propagation calculations for littoral regions. This inefficiency can drive a user to implement fast, but less accurate, algorithms. This inefficiency is partly caused by the complexity of each set of numerical computations that are required to realistically describe the underwater environment between the sensor and target. However, the overwhelming cause of this inefficiency is an order-of-magnitude (or more) increase in measurement sampling density required for littoral regions to achieve the same mean uncertainty for a similarly sized open ocean area.

Many Naval sensors and systems (e.g., simulation and management of network communication nodes, prioritization of environmental data acquisition, etc.) likewise often encounter complex physical environment conditions within the battlespace they operate. Therefore, an algorithm that is independent of the sensor or system performance model is required. Many national security missions are time-sensitive, so fast-running algorithms that can provide full-field solutions with realistic uncertainty assessments are preferred. Missions planned for hostile areas typically are data sparse and require unique (sometimes covertly-measured) sets of environmental data. Hence, algorithms that use these unique sets of environmental data with acceptable uncertainty are also preferred. The environmental effects on specific Naval sensors and systems tend to be quite different from one another. These differences in environmental effects in the real physical environment often translate to the use of different techniques for interpolating the physical environmental conditions that are used in modeling the environmental effects on each sensor and system. An algorithm with an independent interpolation approach is thus preferred.

The sampling algorithm must provide relevant estimates of the mean and variance of the uncertainty associated with sensor and system performance predictions and automatically and reliably terminate whenever user-selected values of uncertainty are reached. All tests for accuracy of the algorithm must be based on computations using Navy-standard models at a large number of randomly selected off-grid locations. All tests for computational speed must start at the moment of mission definition (i.e., the instant the operator begins to initialize the algorithm with a set of data); use the same (or identically configured) off-the-shelf PCs; and, end when the predetermined value(s) of uncertainty is (are) reached.

This algorithm, description, designs and supporting documentation should be sufficient to convince qualified engineers that the proposed concept is technically feasible.

PHASE I: The Phase I algorithm will be tested using 3-D (latitude, longitude, and azimuth) sonar predictions, and it should be developed enough to achieve at least a five-fold increase in computational speed (i.e., a five-fold reduction in the number of acoustic model runs) with an uncertainty of less than 0.2 dB when benchmarked as outlined above. The algorithm, description, or design and supporting documentation for the Phase II proposal should be sufficient to convince qualified engineers that the proposed concept is technically feasible and likely to achieve the Phase II goals.

PHASE II: The Phase II algorithm should: a) be at minimum 4-D; b) be capable of achieving at least a 20 times increase in computational speed with an uncertainty of less than 0.2 dB when benchmarked for sonar predictions as outlined above; and, c) provide interim characterizations and estimates of uncertainty on demand. A Sea Trial demonstration interfacing with a Navy tactical decision aid (TDA) that requires accurate underwater acoustic characterization must be included. The Phase II algorithm must also be tested for fitness for network simulation/management and data acquisition prioritization. The algorithm, description, design and supporting documentation for the Phase III proposal should be sufficient to convince qualified engineers that the proposed concept is technically feasible and likely to achieve the Phase III goals.

PHASE III: The Phase III algorithm must: a) be at minimum 6-D; b) be capable of achieving a hundred-fold increase in computational speed with an uncertainty of less than 0.2 dB when benchmarked for sonar predictions as outlined above; c) provide interim characterizations and estimates of uncertainty automatically at user-supplied intervals; and, d) be capable of exploiting previous computations if the mission definition is perturbed during the test. In addition, the algorithm should be capable of integrating external priorities (i.e., able to adapt to requirements for higher resolution in user-specified sub areas). At least one at-sea Sea Trial demonstration interfacing with a TDA that requires acoustic characterization and one real-time trial managing a data network are required. A plan for transition of the algorithm to operational Fleet forces and/or to commercial applications is required.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The algorithm should have utility in any commercial sector where computationally expensive calculations are required in large numbers (e.g., geophysical models used by mineral and oil extraction industries, communications network simulation, etc.) or where large numbers of expensive (or hazardous) measurements are required (e.g., radiology).

REFERENCES:
1. Sterling, W.C., Goodrich, M.A., and Packard, D.J. (2002). “Satisficing Equilibria: A Non-Classical Theory of Games and Decisions”, in “Game Theory and Decision Theory in Agent-Based Systems”, Kluwer Academic Publishers, Boston.

2. Yager, R.R., Fedrizzi, M., and Kacprzyk, J., eds., (1994). Advances in the Dempster-Shafer Theory of Evidence, Wiley.

KEYWORDS: adaptive gridding, sonar performance, sensor prediction, system performance, network simulation, network management, environmental complexity, decision aid

N05-080 TITLE: Autonomous Undersea Vehicle Mission Planner for Shallow Water and Very Shallow Water Environmental Data Collection

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a mission planner for use with Autonomous Undersea Vehicles (AUVs) to optimize sampling procedures for environmental data collection in shallow water (SW) and very shallow water (VSW).

DESCRIPTION: Surf and near-shore ocean prediction models, like those in DIOPS, require accurate information about offshore winds, wave conditions and bathymetry. Procedures to collect these data are subjective and labor intensive. AUVs are being employed more and more frequently to collect near shore environmental data in support of wave and surf model predictions. There is a need for objective mission planning to utilize one or more AUVs in an efficient way and maximize the quantity and quality of collected data. For example, a) prevailing currents should be exploited in an optimal way to ensure the best coverage, and b) sampling rates, collection tracks, and sensor depths should be adapted to the existing conditions.

PHASE I: Design a mission planner that incorporates environmental conditions as well as AUV characteristics to maximize time on station or speed of data collection. The design shall be developed in sufficient detail to allow evaluation of performance and value. Build a lab version of the mission planner for use in performing sensitivity studies. Approaches should use Navy standard models and databases, as much as possible. Approaches must provide a framework concept of operations for their technique to demonstrate its impact on AUV operations. Demonstrate the value of the optimized data collection tracks compared to standard ladder-type tracks. Estimate development and acquisition costs.

PHASE II: Build and test a prototype system, with interfaces to DIOPS that can be used to determine transition potential. Both laboratory and operational testing are required. The collected environmental data must be validated by an independent process and the results used to make surf zone wave predictions. Outline transition of technique to operational Fleet forces and/or to commercial applications.

PHASE III: Transition to Special Operational Forces, to the DIOPS Program, or to commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There are a variety of commercial areas in which an accurate knowledge of offshore environmental conditions and therefore predicted surf conditions is desired. These include beach erosion studies and property reconstruction efforts.

REFERENCES:

1. R. Allard, J. Christiansen, T. Taxon, D. Wakeham, S. Williams, "The Distributed Integrated Ocean Prediction System," Proceedings of the Marine Technical Society Oceans 2002 Conference, (Biloxi, MS, 2002).

2. R.E. Jensen, P.A. Wittmann, and J.D. Dykes, "Global and regional wave modeling activities", Oceanography, Vol. 15 (1), 2002, pp. 57-66.

3. D. Wakeham, R. Allard, J. Christiansen, T. Taxon, S. Williams, "The Distributed Integrated Ocean Prediction System," Proceedings of the 7th International Workshop on Wave Hindcasting and Forecasting, (Banff, Alberta, Canada, 2002) .

4. D. Wakeham, R. Allard, "Developing an Operational Wave, Surf, Tides Forecasting System for the United States Navy Meteorology and Oceanography Community", Proceedings of the Marine Technical Society Oceans 2003 Conference, (San Diego, CA, 2003).

KEYWORDS: AUV, UUV, bathymetry, surf, waves, currents, tactics, adaptive sampling

N05-081 TITLE: High-Density Environmentally-Friendly DC Power Source

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To provide improved electrical power storage capacity (compared to existing battery technology) for expendable communication or sensor devices deployed into an undersea ocean environment without a plan for recovery after use. In addition to being environmentally friendly after being abandoned undersea, this power source must not be a safety risk to military platforms, particularly submarines, when carrying them in high quantities.

DESCRIPTION: Design and build a power storage system capable of supporting a communications device launched from a submarine. The form factor for the device is a 3" signal ejector device, such as an AN/BRT-6 communications buoy. The power storage system is not to exceed the current size and weight constraints used for the battery pack of the BRT-6, while providing approximately 5 times the power capacity. The BRT-6 has two packs of 16 "AA" size batteries and one pack of 6 "AA" size batteries. This technology is required to support future expendable gateway buoys that will be required to provide two-way RF and/or acoustic communications for an extended period of time. The new high density storage capacity cell must be subsafe and minimize the impact on the environment. Since the intended use is expendable devices, it is not essential for this storage system to be rechargable. However, a rechargable technology would be of significant benefit for some applications (e.g., devices used in training.)

PHASE I: Design a new type of electric power storage system to support current and future expendable devices launched from the 3-inch launcher. If rechargeable, the new design must be easily charged and maintain its charge while the buoy is in storage. Compare the new design with other existing power storage designs. Subsafe and enviromental issues must be taken into account. The production cost of the design must be low (e.g., under $1k.)

PHASE II: Build and test the new design to determine the power storage capacity. Show how the new design will be integrated into an existing 3-inch expendable device. Address submarine safety and environmental issues with analysis and lab testing.

PHASE III: Transition power storage system to manufacturing and low cost production. Provide 10 power storage systems to support at sea demonstrations.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Developed storage unit will have potential application to telecomunications industry, both military and commercial. New materials and methods used will open new avenues for low cost, low space energy sources. On a larger scale, the technology could be used in electric or hybrid automobile engines. The use of environmentally friendly materials in battery construction is essential for the convenient disposal of consumer products.

REFERENCES:
1. Buoy Electronics Module Assy, Hazeltine Corporation Drawing 120486

2. General Overhaul Specifications For Deep Diving SSBN/SSN Submarines (NAVSEA 0902-018-2010)

3. NAVSEAINST 5100.3B: Control of Mercury, Mercury Compounds and Components Containing Mercury or Mercury Compounds

4. OPNAVINST 5090.1B: Environmental and Natural Resources Protection Manual

5. OPNAVINST C9210.2: Engineering Department Manual for Nuclear Powered Ships

6. Naval Ships' Technical Manual, Chapter 593: Pollution Control

7. NAVSEA S9310-AQ-SAF-010: Technical Manual for Batteries, Navy Lithium Safety Program Responsibilities and Procedures

KEYWORDS: battery; power storage; energy sources; battery; high density; fuel cell; rechargable

N05-082 TITLE: <u>Secure Legacy Application Integration with NCES (SLAIN)</u>

TECHNOLOGY AREAS:

OBJECTIVE: The DoD Global Information Grid (GIG) Architecture Version 2 relies upon an enterprise “services” construct, which will be established via the DoD Net-Centric Enterprise Services (NCES) program. IA/Security is one of the nine Core Enterprise Services envision for NCES. When moving large application environments over to a Web services architecture, significant investment must be made to develop custom integration points for securely interfacing legacy platforms into the new framework (in this case NCES, which also affects FORCEnet). The major capabilities needed are IA interoperability, user or role assertion, data transformation, controllability, and Information Dissemination Management at the edge, primarily related to cross-platform synchronization and transaction persistence. This SBIR requirement centers on researching and testing the feasibility of creating a generic "gateway/translation product" in a software environment to integrate legacy systems into NCES. It's clear from the NMCI enterprise operations experience that legacy application transition and increased security requirements are complex, time-consuming and expensive endeavors that require extensive resources and communications – this requirement will get ahead of that learning curve with NCES integration and ultimately save time and funding as well as ensure GIG interoperability with FORCEnet and USN systems/applications.

DESCRIPTION: Such a "gateway/translation product" for NCES would greatly streamline and expedite the incorporation of legacy systems into NCES in both roles as providers and consumers of data. Lessons learned from implementation of the Navy Marine Corp Intranet (NMCI) identified integration of legacy systems into the network environment as a key issue. This early exploration of processes and tools would significantly enhance the NCES spiral development process and ensure cost effective transition of existing systems to the services environment.

This SBIR requirement for a generic "gateway/translation product" would include. But not be limited to, the following objectives:

1. Support for rapid development, remote implementation and flexible reconfiguration,
2. Provision of bi-directional edge transformation services that can translate between NCES Services Oriented transactions and the I/O streams available in the Legacy system in either direction,
3. Enforcement of MOU policy in both directions insuring that only appropriate transactions and content pass the legacy integration gateway,
4. Negotiation and enforcement of Information Assurance requirements defined in the MOU as information and requests pass between the systems,
5. Provision of domain specific control to both domains allowing either to modify the gateway functions under their respective control,
6. Provision of a light cross platform implementation using COTS product as the foundation, and
7. Implementation of a secure model for remote management of the device from either domain.

PHASE I: The Phase One effort would research, test, and document the feasibility of using a software environment to create a generic "gateway/translation product" for integrating legacy systems into NCES. The following areas should be investigated and addressed:

- Interoperability and IA capability across NCES and legacy systems,
- User or role assertion,
- Data transformation,
- Controllability, and
- Information Dissemination Management at the edge, primarily related to cross-platform synchronization and transaction persistence.

PHASE II: When the Phase One effort proves that the feasibility of using a gateway/translation product to accomplish the stated objectives is justified, then the Phase II SBIR Project would develop a prototype/pilot and demonstrate the "gateway/translation product" concept. The Phase Two requirement would build a prototype/pilot to create a generic "gateway/translation product" for integrating legacy systems into NCES with the specific objectives being:

- Support for rapid development, remote implementation, and flexible reconfiguration to link NCES and legacy applications,
- Provision bi-directional edge transformation services that can translate between NCES Services Oriented transactions and the I/O streams available in the Legacy system in either direction,
- Enforcement of MOU policy in both directions insuring that only appropriate transactions and content pass the legacy integration gateway,
- Negotiation and enforcement of Information Assurance requirements defined in the MOU as information and requests pass between the systems,

• Provision domain specific control capabilities to both domains allowing either to modify the gateway functions under their respective control,
• Provision a light, cross-platform implementation using COTS product as the foundation, and
• Implementation of a secure model for remote management of the device from either domain.

PHASE III: We expect the deliverable to both take a COTS direction and potentially replace other IA capabilities and devices, where we would then redirect our POM funding. The Phase III Program would provide hardening and security accreditation of the SLAIN in order to move to Operational stages.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A few mature commercial software products have already been successfully deployed in financial services applications and are well tested. The purpose of this SBIR is to assess, integrate, test out and build on the available products/capabilities providing military benefits that have already been delivered commercially. The military requirements for security, reliability and adaptability are a very good match to the product technology capabilities by delivering a secure object-based framework.

REFERENCES:
1. Transformational Communications Architecture; TCA;
IA Component of Assured GIG Architecture; JTA Memo 23 Nov. 03, JTA v6.0

KEYWORDS: NCES; FORCEnet; NCW; legacy application transition; network security; gateway/translation product

N05-083 TITLE: Cross-Domain Secure Database Access – EAL-6/PL-5

TECHNOLOGY AREAS:

OBJECTIVE: Enable new flexibility in cross-domain collaboration by developing technologies and techniques for secure read-down queries to single-level databases at or below user's security level. This will be a High Assurance database permitting data exchanged from Secret to Unclassified or SCI to Confidential. No other proposal will permit these data flows.

DESCRIPTION: A fundamental goal for cross-domain systems is to allow users to have seamless access to information at or below their current security level. A primary source of information is data residing in single-level databases within isolated security domains.

A ubiquitous mechanism for providing single-level access to database information is the use of web-based systems with active content. Server-side scripts query a database and create a page on the fly with the most recent information tailored to the user's specific needs. An example of such a scripting language is PHP. Queries are typically submitted using SQL. This technique is used in both commercial and government installations.

Difficulties arise when a user at one security level attempts to query a database at a strictly lower level. Evidence of a query can be considered a leak of information: the mere existence of a request for information may itself be confidential. Residual effects, such as the caching of query results, are potential leaks. Current architectures address this concern by replicating the contents of lower-level databases to higher security domains, thus isolating the information so that its access is undetectable by lower level users or systems. However, replication introduces a host of problems, including currency of the information, scalability to increasing numbers of security domains and increased space-weight-power requirements.

The ease and effectiveness of web-based access combined with secure and efficient cross-domain database access would enable the provision of the right information to the right user at the right time. The solution may require the creation of a secure, cross-domain-aware scripting language with explicit provisions for read-down queries and the specification of a Net-Centric architecture that supports the web services capabilities that exist in single-level deployments today. A key goal is the preservation of investment in existing single-level solutions as well as leverage for existing commercial solutions.

Any potential solution to the cross domain database query problem must be High Assurance, evidenced by being certifiable to Common Criteria Evaluation Assurance Level 6 (EAL6) [1], so that it may be used to span at least three clearance levels (Confidential / Secret / Top Secret). Any COTS components such as operating systems and application software that are used in the solution architecture must operate at a single level only. In particular, the architecture of such a system must not incorporate such COTS software into the trusted computing base (defined as all those software and hardware components which could cause a breach of the cross-domain security constraint were they to be designed, implemented, configured or operated incorrectly). It is an essential part of this SBIR topic that COTS technologies be used where appropriate, but that the use of COTS technologies does not interfere with the certifiability of the total CDS architecture. The solution must be certifiable for deployment in Secret and Below environments. Both design and implementation must use appropriate formal techniques to achieve the desired certification.

PHASE I: A study of the options for providing active content to enable secure cross-domain database access within web services architectures. The study will identify architectural options, provide feasibility and risk assessments for various approaches, and recommend a course of action. The assurance target and rationale for each option must be defensible.

PHASE II: Select the highest-ranking option and develop a design and a proof-of-concept implementation with corresponding assurance evidence. Production of C&A plans and develop evidence for external review of evaluation evidence indicative of ability to attain EAL 6.

PHASE III: Produce an operational component providing secure cross-domain database access. All certification processes will be completed and the component packaged for ready deployment within an existing certified, secure cross-domain web server.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The private sector has similar security concerns that are currently addressed via physical separation of networks and levels of information. For example, corporate human resources or financial networks may be physically isolated from the general use network for the protection of sensitive information. A cross-domain secure web server would allow safe access from those isolated domains to general information. As the commercial sector uses similar active content tools, any active content solution that works in a government environment would be directly applicable.

REFERENCES:
1. Evaluation Assurance Level (EAL) guidelines
http://niap.nist.gov/niap/events/govind-forum/proceedings/presentation-katzke.pdf,
http://www.itaa.org/infosec/presentations/nstissp.ppt

KEYWORDS: cross-domain; database; secure; certified; web server; query

N05-084 TITLE: Multi-Band Rotary Joint for Antenna Feeds/Waveguides

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

OBJECTIVE: To develop a working prototype of a manufacturable multi-band rotary joint for use with multi-band 3-axis antenna pedestals and parabolic dish antennas. The availability of new and emerging satellite and aircraft-based communications systems is requiring military users to add new spectrum bands to their parabolic dish infrastructure. However, most military (and commercial users) have limited space available for antenna systems and cannot add additional antenna pedestals. In order to utilize existing parabolic dish antennas in additional bands, multi-band feeds and multi-band rotary joints are required.

Current rotary joint designs have limitations in bandwidth, power handling capability, and bandwidth. In addition, their physical size is typically much larger than a single-band rotary joint with comparable performance.

In many circumstances, it will not be possible to backfit existing antenna pedestals (or build replacement antenna systems) with multi-band rotary joints unless the size of the multi-band rotary joint is comparable to that of a single-band rotary joint. There are many platforms on which antenna system size is a critical factor: submarines, small deck ships, ground vehicles, manpacks, and aircraft.

Although it may be possible with current technology to build compact high-performance multi-band rotary joints for particular bands, the innovation required is to develop a novel technical approach that can be scaled to many different frequency bands and can be produced at a cost comparable to current rotary joints.

DESCRIPTION: The USN submarine force requires a wide variety of satellite communications (SATCOM) links in order to accomplish specific missions. Due to the limited space aboard submarines both inboard and outboard, submarine communications systems are required to support multiple functions over a wide frequency range. This presents significant technical challenges in RF component miniaturization, which requires "state-of-the-art" technical advances and innovation to achieve the required RF performance. In particular, working in the SHF and EHF frequency bands has been risky due to the unique materials, manufacturing tolerances and complex process required to achieve acceptable RF performance. As current and future submarine communications requirements demand high data rate afforded by SATCOM links in the SHF and EHF communications bands, the emphasis has been on shrinking components and integrating a wide degree of functionality into a single product. Developing and manufacturing communications equipment with "broadband" capability is technical challenging due to the physical and electromagnetic properties of communications signals in these frequency bands. Trade-offs must be made in terms of performance, cost, and size to ensure that the design goals can be achieved. This multi-band rotary joint project, targeted toward the Submarine High Data Rate (SubHDR) X/Ka/Q-band parabolic dish antenna system, will address the technical risk and challenges in the following areas:

PHASE I: Develop technical requirements for train, cross-elevation and elevation axis rotary joints needed to support high-power Q-Band and Ka-Band transmit (waveguide center channel) and dual X-Band low-power receive (coaxial outer channel) capabilities. The performing company will be required to conduct technical analysis, design trade studies that assess performance and manufacturability. The contractor will be required to provide several design concepts and technologies, which could be leveraged for other military and commercial applications. Packaging design will be geared toward a SubHDR antenna pedestal implementation to provide a readily available test platform to support RF range and over-the-demonstrations during Phase II.

PHASE II: Develop working prototypes of multi-band rotary joints and integrate them into a SubHDR assembly. Conduct RF range and Over-The-Air performance testing.

PHASE III: Transition rotary joint design to a low-cost production design and develop a SubHDR integration back-fit program and potential forward into Advanced High Data Rate antenna design program.

DUAL USE APPLICATIONS:
MILITARY APPLICATION POTENTIAL:
1) Development of a multi-channel rotary joint would support the enhancement of the SubHDR system to provide both Q-Band and Ka-Band with a power handling capability of ~120 W (Q-Band) and ~250W (Ka-Band) for use with the Advanced Wideband System (AWS) and future Transformational Communications MILSATCOM (TCM) satellites. The enhancement of the SubHDR antenna would provide additional communications capability to the submarine without requiring installation of another communications mast or the initiation of a new acquisition program.
2) Enable additional band capabilities to existing shipboard topside antenna systems by backfitting multi-band rotary joint (and multi-band antenna feed) into ship topside antenna pedestal antenna systems.
3) Enable additional band capabilities to mobile, manpack, and aircraft parabolic dish antenna systems by backfitting a compact multi-band rotary joint (and multi-band antenna feed).
4) Other potential Military applications include multi-frequency/function ESM antennas for intelligence gathering and exploitation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Development of multi-band rotary joint and associated manufacturing techniques has application in the telecommunications industry. Applications include compact/multi-frequency band antenna designs particularly suited for commercial airline, cruise ship, and private vessel applications which provide high speed internet, video and telecommunications.

REFERENCES:

1. SubHDR Mast Group DWG # G745201-3

2. SubHDR Antenna Pedestal Group (APG) DWG # G745222-2

KEYWORDS: antenna feed; waveguide;multi-band;joint;parabolic;rotary

N05-085 TITLE: Cross-Domain Document-Based Collaboration in a Multi-Level-Secure Environment

TECHNOLOGY AREAS:

OBJECTIVE: Enable new flexibility in cross-domain collaboration by developing technologies and techniques to enable secure and certifiable sharing and editing of composite documents containing sensitive information, in collaboration environments that span multiple security levels.

DESCRIPTION: A fundamental goal for Multi-Level Secure (MLS) systems is to allow documents whose contents have varying sensitivity levels to be viewed and edited by users with varying clearance levels, while enforcing the required security constraints. However, documents tend to be in proprietary formats that require commercial off-the-shelf (COTS) software such as Microsoft Office to view and edit, and such software has no provision for multi-level security. Furthermore, the size and complexity of such software (and the operating system it runs within) makes it extremely unlikely that any potential extensions to support multiple security levels could ever be certified or accredited across clearance levels. The current approach is to sidestep the issue and apply sensitivity labels to entire documents only. Multiple networks, file servers, and web servers are constructed for each sensitivity level, and individual documents are implicitly labeled by virtue of the network they each are accessible from. Similarly, a user's workstation is attached to a network matching their clearance level. This separation-of-networks approach has many disadvantages. For example, many users have to use multiple workstations (with a consequent high hardware, space, weight and power cost), and the network infrastructure is inflexible in response to the formation of new coalitions.

The goal of this SBIR topic is to explore alternative approaches that break free of the separated network constraint, while enabling collaborative sharing and editing of documents across multiple security levels. The following example, which demonstrates the requirements, is drawn from military acquisitions, though corresponding scenarios exist in many other settings:

A complete acquisitions document should describe technical requirements, operational requirements, and timeline and contractual details. Each section of the acquisitions document is typically prepared by distinct groups of people, with final editorial control restricted to just a few key personnel. In addition, technical details may exist at differing classification levels. For example, a military satellite may use mostly existing commercial off-the-shelf components for telemetry, tracking and control, and orbit stabilization, yet key aspects of its imaging systems may be highly classified. A multi-level-secure document sharing system would allow the various sections of the acquisitions document to be edited by appropriate personnel according to sensitivity level and subject area.

Similar multi-role and multi-classification scenarios arise in many aspects of the military endeavor.

Any potential solution to the cross domain document-based collaboration problem must be High Assurance, evidenced by being certifiable to Common Criteria Evaluation Assurance Level 6 (EAL6) [1], so that it may be used to span at least three clearance levels (Confidential / Secret / Top Secret). Any COTS components such as operating systems and application software that are used in the solution architecture must operate at a single level only. In particular, the architecture of such a system must not incorporate such COTS software into the trusted computing base (defined as all those software and hardware components which could cause a breach of the multi-level security constraint were they to be designed, implemented, configured or operated incorrectly). It is an essential part of this SBIR topic that COTS technologies be used, but that the use of COTS technologies does not interfere with the certifiability of the total MLS architecture.

In summary, this SBIR requires research into solutions meeting the following technical requirements:

1. Multi-level documents: single documents may contain multiple sections of varying classification and compartmentalization.

2. Secrecy: users may never view sections of documents for which they do not have clearance or approval.

3. Editing: users may load, edit and save a document without disturbing sections of the document for which they do not have sufficient clearance and approval.

4. High assurance: the solution must be certifiable for deployment in Secret and below environments. Both design and implementation must use formal techniques to achieve the desired certification.

PHASE I: Develop a conceptual system and software architecture design to enable cross-domain document-based collaboration. A key part of the design shall be a certifiability concept that demonstrates how the proposed design can be certified to EAL6, while also enabling the use of COTS technologies such as Microsoft Word.

PHASE II: Develop a detailed design and prototype a system that enables cross-domain document-based collaboration. Identify appropriate protection profiles and complete certification and accreditation plans, with emphasis on the security target, and the process for obtaining EAL6 verification.

PHASE III: Build the cross-domain document server, and certify it to EAL6. Identify a target environment within the Navy and/or DoD, and deploy the finished, certified product.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technologies and techniques identified in under this SBIR topic have potential application in a wide range of public and commercial settings. Patient records have stringent requirements on releasability, yet multiple individuals have needs to access and update information. Similarly, universities require confidentiality of student records, and grades, again with many access roles defined. In the commercial world, inter-corporate collaboration can be significantly enhanced through the use of shared documents that limit information exposure, from confidential comments, through proprietary information, to enforcing Chinese wall style integrity policies.

REFERENCES:
1. Evaluation Assurance Level (EAL) guidelines
http://niap.nist.gov/niap/events/govind-forum/proceedings/presentation-katzke.pdf,
http://www.itaa.org/infosec/presentations/nstissp.ppt

KEYWORDS: Collaboration; Multi-level security; high assurance; COTS

N05-086 TITLE: Improved Vacuum Process for Advanced Inertial Sensors

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The objective of this SBIR is to develop improved gettering techniques for advanced inertial sensors and to demonstrate long term, stable sensor performance. Proper getters will improve inertial sensor designs by eliminating the added complexity/bulk of vacuum pumps present in some research inertial sensors. Getter materials will be researched as they pertain to the particular inertial sensor application. Sensor vacuum envelope preparation will be researched as to maximize long-term performance. Vacuum envelope feed thru design and implementation of the optimal getter package will be investigated. Life test samples will be generated to demonstrate long-term vacuum stability.

DESCRIPTION: Many present inertial sensors and future high accuracy inertial technologies in development require a high vacuum envelope or chamber. Vacuum integrity is critical in that in most cases the sensor performance is based on the interaction of low-pressure gasses or the complete absence of any foreign gaseous atoms that influence drag. Vacuum can also play an important role in thermal designs that isolate temperature sensitive sensor components. In the case of Atom Interferometer (AI) Sensors, laser cooled atoms in a Zerodur vacuum chamber are used as proof masses to sense motion or gravity. The AI concept and potential for advanced inertial sensing has been demonstrated in the lab. However, the stability and long-term performance of a laser cooled vacuum sensor has never been demonstrated. Many vacuum related issues have to be addressed for AI sensors in order to make stable and reliable laser cooled sensor packages. Some of the issues that must be addressed are: choice and implementation of the proper getter material, Zerodur preparation and packaging, getter mounting and feed thru, and the interaction of getter material with the background cesium atoms. The stability of the sensor's vacuum chamber will be paramount in ensuring long-term performance and operation in harsh environments. In the Ring Laser Gyro, RLG, the ratio of helium atoms to neon atoms and the long-term stability of the gaseous pressures are critical to ensure proper laser action and sensor performance. Since this goes beyond existing capabilities, this will require innovative R&D to provide the technology to solve these challenging problems. The work from this SBIR will supplement both FOG and RLG technology and potentially improve their performance.

PHASE I: Study getter materials and their implementation into future sensors for AI, borehole gravity sensing, and gradiometry. Outline a proof of concept design and plan to demonstrate long-term vacuum performance.

PHASE II: Implement the Proof Of Concept design. Design adequate life test samples to demonstrate long-term stability for various sensors applications discussed above. Exercise these life test samples over expected environmental ranges.

PHASE III: Productize the successfully demonstrated vacuum design and implement it into advanced sensor packages (like AI) for inertial sensing and oil exploration.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This is applicable to vacuums for advanced gravity and gradiometer sensors for use in borehole and sub surface sensing for oil deposits. The positioning of gravity sensors in boreholes for extended lengths of time will be required. Sensors based on vacuum technology will be in place for months unattended while monitoring oil reservoirs and their subsequent movement. So both inertial sensor manufacturers and oil companies would benefit.

REFERENCES:

1. http://www.rdmag.com/features/0102get.asp

2. http://www.physicscentral.com/action/action-00-4.html

KEYWORDS: vacuum stability; gradiometers; getter material; gravimeters; inertial sensors; gyroscope