NAVY
SBIR FY05.2 PROPOSAL SUBMISSION INSTRUCTIONS

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Acting SBIR Program Manager is Mr. John Williams, williajr@onr.navy.mil. For general inquiries or problems with electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST). For program and administrative questions, please contact the Program Managers listed in Table 1; **do not** contact them for technical questions. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **15 June 2005.** Beginning 15 June, you must use the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in section 1.5c of the program solicitation to receive answers to technical questions.

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

Topic Numbers	Point of Contact	Activity	Email
N05-087 thru N05-120	Mrs. Carol Van Wyk	NAVAIR	carol.vanwyk@navy.mil
N05-121 thru N05-134	Ms. Janet Jaensch	NAVSEA	JaenschJL@navsea.navy.mil
N05-135 thru N05-136	Mr. Joseph Garcia	ONR2	joseph.p.garcia@navy.mil
N05-137	Ms. Cathy Nodgaard	ONR	nodgaac@onr.navy.mil

The Navy's SBIR program is a mission-oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. 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

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 N05-121 thru N05-137 the base effort should not exceed $70,000 and 6 months with an option not exceeding $30,000 and 3 months. For topics N05-087 through N05-120 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 follow the DoD guidelines for electronic submission. It is mandatory that the **entire** technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report be submitted electronically through the DoD SBIR Submission website at **http://www.dodsbir.net/submission**.before **6:00 a.m. EST, 15 July 2005**. A hardcopy will NOT be required. A signature by hand or electronically is not required at the time of 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).

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 SUMMARY 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

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees who 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 Transaction Agreement (OTA) as a Phase II award. The type of award is at the discretion of the contracting officer.

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. The Phase II proposal should include 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.

Phase II proposals together with the Phase II Option (if required) 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 Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work the Navy may match, subject to availability, Phase III funds that the company obtains from an acquisition program. The SBIR enhancement funds must be provided by modifying the existing Phase II contract. The matching funds will be provided on a one-to four match of Phase II to Phase III funds, up to $250,000 of SBIR funds. 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.

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 15 July 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 N05-121 thru N05-137, 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 N05-087 thru N05-120, 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 SBIR 05.2 Topic Index

N05-130	Alternative Methods of Wireless Sensor Power
N05-131	Integrated Shipboard Multi-function Surveillance System
N05-132	Approach to Monitor and Assess the Quality of Sensor Data in Support of Calibration and Health Maintenance
N05-133	Advanced Structural Watertight Door System
N05-134	Portable Calibration Standards for Traceability
N05-135	Ultra-wideband Antenna Elements for Aircraft Applications
N05-136	Soot Removal From Gas Turbine Engine Exhaust
N05-137	Textile for Under Armor Blast Protection

N05-087 TITLE: Lightweight Compact Micro-Channel Heat Exchangers

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and characterize heat exchangers that utilize micro-machining technologies to form high-strength, lightweight, compact, reliable heat-transfer solutions for airframe applications.

DESCRIPTION: To date, heat removal and heat transfer in advanced military aircraft have been accomplished using plate-fin heat exchangers. As thermal loads continue to increase due to increased use of electronics and high heat loads created by next generation weapons systems, lighter weight more compact heat exchangers are needed. Recent developments in micro-manufacturing, such as lithography, electroplating, and modeling (LIGA), have allowed for creation of micro-channel heat exchangers that are lighter, more compact, and provide better heat transfer to pressure drop ratios than traditional plate-fin heat exchangers.

PHASE I: Determine the feasibility, capability, and costs for manufacturing micro-channel heat exchangers for use in military aircraft; recommend a design concept that improves upon current plate-fin heat exchangers, and provide a preliminary design for demonstration. Analytically show that the proposed concept provides the required thermal performance and meets the structural requirements as well.

PHASE II: Work with an environmental control system manufacturer or a system integrator to select an appropriate application for the micro-channel heat exchanger. Select a baseline plate-fin heat exchanger. Utilizing the concept and preliminary design developed in Phase I, detail design and fabricate a micro-channel heat exchanger with better performance specifications than the selected baseline heat exchanger for the selected application. Test the micro-channel heat exchanger to determine vibration, burst, thermal cycling, and life limits. Characterize the performance of the micro-channel heat exchanger based on the test results and compared to the baseline plate-fin heat exchanger.

PHASE III: Develop a full-scale micro-channel heat exchanger for demonstration on an advanced military aircraft, such as the Joint Strike Fighter. The micro-channel heat exchanger will be tested to the specified requirements of the aircraft and operational flight envelope. Successful full-scale demonstration of the micro-channel heat exchanger will be followed by an operational evaluation and an eventual transition to military aircraft applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The resulting micro-channel heat exchanger will be directly applicable to commercial and military aircraft and ground vehicles. In addition, many thermal and chemical systems associated with the ground transportation industry would also be improved. Enhanced thermal management of a vehicle's heat generated during combustion will increase engine performance and life, increase fuel efficiency, and lower emissions. For electric and hybrid vehicles, the thermal management of the advanced chemical batteries and electrical systems is significant.

REFERENCES:
1. Kays, W. M., and London, A. L. Compact Heat Exchangers. New York: McGraw-Hill, 3rd Edition, 1984.
2. SAE AIR1168/6, SAE Aerospace Applied Thermodynamics Manual, Characteristics of Equipment Components, Equipment Cooling System Design, and Temperature Control System Design, Issued 1994-04.
3. Jakob, M. Heat Transfer. New York: John Wiley and Sons, Vol. I (1949) and II (1957).
4. Alexander, A., Mongeau, L., Braun, J. E., and Purdue Research Foundation Lafayette, IN Div of Sponsored Programs. Performance of Straight-Fin and Microchannel Heat Exchangers in Steady and Periodic Flows. Washington, DC: Storming Media, 8 October 2001.

KEYWORDS: Micro-Channel; Small-Channel; Plate-Fin; Heat Exchanger; Heat Transfer; Thermal Management; Thermal Performance

N05-088 TITLE: Gas Turbine Engine Noise Modeling

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop a simulation and modeling tool capable of utilizing existing topographical data to define location specific aircraft noise footprints and project them over a given area to provide the magnitude of the noise signature.

DESCRIPTION: The environmental impact of Navy and Marine Corps aircraft on the community and within the air district where the aircraft are based is of concern to base commanders and weapon system teams. Bases intended to receive the JSF will need to address aircraft engine noise issues that have led to instances of litigation against military bases. This issue is related primarily to noise propagation from in-flight aircraft and flight patterns in the vicinity of the base. Modeling of noise characteristics of aircraft gas turbine engines is needed to facilitate early evaluation of environmental impact and to enable analysis of technology and methods to control noise.

PHASE I: To demonstrate feasibility, develop a model of basic/generic gas turbine engine noise production and identify pertinent parameters that have the greatest influence on noise while maintaining relevance to military aircraft gas turbine engines. Demonstrate the impact of a design or operational change on noise production.

PHASE II: Refine the model as necessary. Evaluate the accuracy of the model by comparing predictions to experimental data. Experimental data are to be obtained via sub-scale testing. Therefore prototype hardware must be fabricated and tested or access to experimental data must be otherwise obtained. Model design changes that reduce noise and verify that the model accurately predicts these reductions. Identify candidate technologies that will be evaluated at full scale.

PHASE III: Refine the model as necessary. Apply the model to a specific JSF engine or component. Evaluate the effectiveness of the technology options in reducing noise using the model for this specific application. Develop champion solution(s) for application to the JSF engine and model the impact of the candidate technology on JSF noise. Verify the capability of the model on a full-scale test.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability should be easily marketable to the JSF airframe and engine manufacturers.

REFERENCES:
1. F/A-18E/F Environmental Impact Statement Project Site (www.efaircraft.ene.com).
2. "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety." The U.S. Environmental Protection Agency, Office of Noise Abatement and Control, March 1974.
3. Federal Interagency Committee on Aviation Noise (www.fican.org).

KEYWORDS: Noise; Modeling; Gas Turbine Engine; Environmental Impact; Footprint; Propagation

N05-089 TITLE: Innovative Materials/Concepts for Grease Lubricated Bearings

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: V-22

OBJECTIVE: Significantly increase the operational life of grease-lubricated bearings without requiring re-lubrication.

DESCRIPTION: Grease lubricated bearings are widely used in both fixed- and rotary-wing aircraft. Applications include airframe-mounted actuators, driveshaft hanger supports, blowers, and numerous accessories. The drawback to using grease-lubricated bearings is that they have finite service life and must be relubricated or replaced regularly. Some bearings, such as driveshaft hanger bearings, are easily serviced due to their design and accessibility. Others are extremely difficult to maintain, requiring component removal at specified intervals and relubrication or replacement of the bearings. This increases maintenance and parts costs and reduces aircraft readiness.

The service life of grease-lubricated bearings is predicated on the operating environment. Bearing loads, rotational speed, temperature, and orientation are some of the conditions that will influence the bearing design and grease selection. Today's aircraft designs are pushing the limits of grease-lubricated bearing design and significant advances are required to meet specified operational lives and reliability goals in the future.

PHASE I: Determine the feasibility of developing advanced and innovative grease-lubricated bearings, identifying possible designs and/or materials. Characterize the concept with regards to increased operational life without relubrication, based upon data for lubricated bearings currently in service. The concept should have the ability to operate for extended periods in extreme environments without reservicing or relubrication.

PHASE II: Develop and refine the concept to include possible materials and manufacturing methods needed to produce any components critical to the concept. Document the analytical tools and methodology required in the design/manufacture of a prototype advanced bearing. Manufacture prototype bearing and develop a test plan for bench/component testing of the design concept.

PHASE III: Team with an aircraft prime manufacturer or major component/bearing supplier to manufacture and test the bearing in an aircraft application to validate and qualify the design.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A successful design would have potential uses to the worldwide commercial aviation sector, including fixed-wing and rotary-wing aircraft.

REFERENCES:

1. AS3694A, Transmission Systems, VTOL/STOL, General Requirements for.
2. MIL-D-23222 Military Specification, Demonstration Requirements for Helicopters.
3. Joint Service Specification Guide-2009, Air Vehicle Subsystems.

KEYWORDS: Bearing; Advanced; Materials; Grease; Lubricated; Reliability

N05-090 TITLE: Automated Creation of Multi-Media Training Material

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMA-280 (Tomahawk)

OBJECTIVE: Devise an innovative method for automating the production of system training material

DESCRIPTION: The creation of multi-media training material for Navy tactical systems (electronic technical manuals, training curricula, etc.) is a labor-intensive process. Technical system documents are reviewed, training source material (including pictures of displays) is assembled, the training material is created, and then the material is verified by hours spent in a tactical laboratory, to verify that the training material accurately describes the system behavior. System displays and their dynamic behavior in different situations must be presented in the training material. The behavior of display controls, such as the results of button actions, error messages, and other types of indications to the user must be described. Today there is little leverage of multi-media capabilities in the material. With each system upgrade, this labor-intensive process must be repeated to ensure that the training material is correct. Despite the many hours spent in the creation of training material, this still somewhat manual process is error-prone, due to the complexity of today's tactical systems. In addition, this material often requires manual editing and formatting to make the training material available via web sites, personal digital assistants (PDAs), or in video format to make it widely available and more useable.

This SBIR topic seeks to advance the state-of-the-art in automatic creation of training material for complex Navy tactical systems. The solution should be able to automatically create (from tactical system software and/or documentation) descriptions of system interactions with a user, including pictures of displays, descriptions of displays in various situations, and the behavior of display controls, messages, and other indications to the user. In addition, the adaptation of the training material to different media and devices to enable training anywhere and anytime should be automated. Lastly, creative approaches that support automated development of interactive training material (e.g., simulated use of the system) and hardware-intensive tasks (e.g., equipment maintenance) are desired.

PHASE I: Explore the feasibility of automating the creation of training material for complex Navy tactical systems. Address automated adaptation of this material to various media (audio/video, interactive simulation) and devices of varying sizes/resolution. Application to the training of both software (e.g., weapon system operation) and hardware-intensive tasks (e.g., system maintenance) should be addressed .

PHASE II: Develop a standalone prototype to demonstrate the automation of training material. The architecture of the prototype should be extensible to ease future [Phase III] integration with Navy processes and support of new media types.

PHASE III: Mature the prototype capability further for use in automatically creating training material for the TTWCS, which resides on surface combatants and submarines.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is tremendous commercial potential for this capability. The commercial world is faced with the same issue — creation of training material for its products still requires many hours of work. Technology to automate the creation of multi-media training material would reduce costs and accelerate commercial products reaching markets.

REFERENCES:
1. “Navy System Training Plan (NTSP), Tactical Tomahawk Weapon Control System AN/SWG-5 (V), Tomahawk Land Attack Missile Employment.” Publication Number: NTSP S-30-0201, April 2002.
2. “Navy Training Plan Process Methodology.” OPNAV Publication P-751-3-9-97.

KEYWORDS: User Training; Automation; Automated Document Production; Human Systems Integration; Human Computer Interface; Simulation

N05-091 TITLE: Handling Qualities Specification Requirements for Maritime Rotorcraft, Vertical Takeoff/Landing (VTOL) Unmanned Aerial Vehicles (UAVs), and Heavy Lift Helicopters

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Provide a technical basis for revising and tailoring the current aeronautical design standard, ADS-33E-PRF (handling qualities requirements for military rotorcraft).

DESCRIPTION: ADS-33E-PRF was developed by a small business for the U.S. Army Aviation and Missile Command Aviation Engineering Directorate primarily with land-based Army helicopter requirements in mind. The document defined handling qualities requirements in a new and innovative way as the first frequency-domain rotorcraft specification. However, naval requirements were not addressed. Unique naval technology areas that need addressing include shipboard handling qualities, VTOL UAVs, and heavy lift rotorcraft design criteria and mission task elements.

Shipboard handling quality criteria that were not addressed in ADS-33E-PRF include torque margin criteria, automatic flight control modes, and heave axis damping requirements for shipboard launch and recoveries. UAV design criteria were not addressed in ADS-33E-PRF due to the autonomous nature of their design in which pilots play no role. However, quantitative flying qualities design criteria needs to be more formally established for these vehicles to ensure safe and repeatable operations aboard ship.

More detailed heavy lift design criteria are desired in order tailor the ADS-33 specification for the heavy lift replacement (HLR) helicopter. The current version of ADS-33's cargo helicopter category needs improvement in the area of design criteria for the externally slung load with high load-to-mass ratios. Current limitations in rotorcraft design may result in inadequate ADS-33 bandwidth and phase delay in proposed HLR designs. Implications of these technology shortcomings include increased risk for pilot-induced-oscillations (PIO) and structural concerns due to aeroservoelastic instabilities. New design criteria would have to address technologies available to reduce these risks.

Innovative criteria and technical solutions developed in this effort would be incorporated into a user-friendly software package that could be used by rotary-wing handling qualities engineers to evaluate proposed designs against the new criteria. Currently, no such capability exists and widespread U.S./international government and commercial interest has already been expressed. This topic has been identified as a priority by The Technical Cooperation Program (TTCP) countries during recent conferences.

PHASE I: Review current specification version, ADS-33E-PRF, for areas needing improvement in order to address the needs of cargo category rotorcraft, maritime helicopters, and UAVs. Propose solutions to unresolved technical issues with the shipboard launch and recovery task. Develop and propose new and innovative specification criteria. Develop methods and a plan to evaluate the new criteria. Evaluation methods may include analysis, simulation, and/or flight test. Develop a Beta version of a user-friendly software package compatible with commercially available PC-based industry standards such as FlightLab, or MATLAB/ Simulink for analysis of air vehicles against new criteria.

PHASE II: Evaluate the proposed solutions. Prove utility of software package against flight test and/or simulation data.

PHASE III: Prepare a report containing proposed changes based upon analysis of Phase II efforts, including technical justification for all changes. Provide final submission of software package, and demonstrate functionality to government engineers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This software package would be a useful tool for helicopter and UAV manufacturers and government engineers as a user-friendly way to ensure compliance with US/ International military specifications, and sound design practice. Improvements in maritime rotorcraft handling qualities are a chief concern to government and commercial operators who take off and land aboard ships, oil rigs, and other floating platforms.

REFERENCES:

1. U.S. Army Aviation and Missile Command Aviation Engineering Directorate, ADS-33E-PRF, March 2000.
2. Hoh, R. H., et. al. Background Information and User's Guide for Handling Qualities Requirements for Military Rotorcraft. December 1989.

KEYWORDS: Handling Qualities; Bandwidth; Flight Controls; Pilot Induced Oscillations; UAV, Maritime Helicopter

N05-092 TITLE: Multifunctional Lightweight Electromagnetically Shielded Enclosure Technology Using Affordable Hybrid Carbon Composite Production Processes

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop affordable multifunctional electrically conductive composite material and production processing technology for innovative electromagnetic interference (EMI) shielding/electrostatic discharge (ESD) grounding concepts for aircraft high-performance, high-power electronic enclosures for F35 and F22 applications.

DESCRIPTION: Hybrid graphitic fiber composite material system technologies for electronic enclosures are an identified solution that the F35 and F22 programs are vigorously pursuing to achieve the 30%-50% weight reduction target to the state-of-the-art aluminum technology. Higher power electronics and their multifunctional requirements are driving candidate lightweight composite enclosures technology to complex, hybrid configurations that require more advanced EMI shielding approaches in these assemblies. Many of the enhanced composite material systems being developed for high power electronic enclosures are strategically integrated into a single multifunctional assembly that also meets the high EEE requirements levels that includes EMI shielding. This effort will identify candidate material systems and affordable production processes that will be integral with (not sacrificial to) the complex primary structures geometries and multifunctional assembly joining processes to provide structural integrity and EMI shielding up to 80 dB levels. The architecture of a complex enclosure's details and its final assembly will be evaluated for its ability to meet the EMI and ESD grounding performance requirements in addition to mechanical integrity and affordability. Material system candidates that include PAN/ pitch fiber materials and EEE enhancing coatings, resins, additives, nanofibers, and foils will be identified and evaluated with the best production processes such as resin transfer/compression molding, and prepare lay-up processes.

PHASE I: Determine the feasibility and provide the critical metrics of using affordable hybrid carbon composites to provide EMI shielding, ESD grounding, structural performance, and affordable producibility. Conduct coupon testing, analysis, and cost model projections for applicable materials and processes using concept designs of typical F35 or F22 enclosure subcomponents as a baseline.

PHASE II: Fabricate and test a proof-of-concept enclosure subcomponent detail and assembly joint to demonstrate sufficient EMI shielding and evaluate the material system and production process candidates in a full-scale electronic enclosure with full engineering design and analysis and material characterization support. Tool, fabricate, and evaluate the selected enclosure configuration typical of a F22 or F35 aircraft enclosure performance and environment to assess the payoff and benefits of this technology. Develop a transition plan for hardware qualification and insertion.

PHASE III: Complete production transition and component qualification. Finalize the qualification program requirements definition/plan and complete the qualification program to achieve production approval program insertion.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: All of these are issues for commercial as well as DoD platforms. Aerospace and transportation type electronic enclosures have similar requirements for electromagnetic environmental effects (EEE) shielding and corrosion resistance. Other potential applications include multifunctional composite primary structures for the vast market of commercial satellite electronic enclosures and bus structures

REFERENCES:
1. Abusafieh, A., and Tremblay, G. "Lightweight Electronic Enclosures Using Composites." SAMPE Journal, Vol. 38, No. 6, November/December 2002.
2. Tremblay, G., and Krumweide, G. "Issues to Address in Use of Composite Materials for Electronic Packaging." DASA Conference, Seattle, WA, October 1998.

KEYWORDS: Multifunctional; Electronic Enclosures/Racks; Composites; EMI Shielding; EEE

N05-093 TITLE: Prognostics and Health Management (PHM) for Digital Electronics Using Existing Parameters and Measurands

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and demonstrate new and advanced prognostic models for digital electronic boards and their components.

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

This effort will develop, demonstrate, and apply these advanced prognostic and useful life remaining models in support of the predictive part of PHM on aircraft electronic boards and their digital component elements and devices. These could be for electronic boards for electronic controls, radars, integrated core processors, and/or an avionic systems found on board an aircraft. With digital electronic boards playing a key role in the operation of aircraft electronic systems and subsystems, it is important that the user be able to accurately diagnose faults and predict failures and life remaining of these components. This will be a very difficult task because of the large amount of digital components and devices mounted on these electronic boards. New and innovative approaches, models, and methodologies will be required.

PHASE I: Define the techniques and processes needed to relate useful life remaining predictions to detectable fault conditions in aircraft electronic boards and their digital components and devices. Determine the feasibility of developing advanced models, statistical techniques, and other programs required. Develop a prototype model and supporting programs for a specific JSF subsystem application and its electronic boards. Develop an initial list of required available inputs to the models. Outline a method of extracting them from a particular subsystem and specific electronic board and define required user interfaces.

PHASE II: Demonstrate a prototype model and supporting programs for a specific JSF subsystem application and its electronic boards. Develop and demonstrate a final application for these advanced models, techniques and programs for several JSF subsystem applications, their electronic boards, and associated digital components and devices. Demonstrations will be accomplished using actual data from JSF application board designs. Assess the application boundaries, accuracy, and limitations for these modeling techniques. Develop, validate, and deliver a complete set of application modeling programs and techniques to be used on several different electronic subsystems, boards, and digital components. Provide software programs, tools, and procedures for integrating these capabilities within the JSF PHM system.

PHASE III: Finalize these models with specific JSF subsystem electronic board applications. Transition some of these modeling programs and capabilities on the JSF program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These advanced models would be applicable in the private sector to many electronic board applications using digital components r that will be applying diagnostics, prognostics, and health management capabilities. Any results (understanding) gained from applying these failure progression rate models to particular digital electronic boards will provide a significant crossover benefit to other similar applications, commercial or military.

REFERENCES:

1. Henley, Simon, Currer, Ross, Sheuren, Bill, Hess, Andy, and Goodman, Geoffrey. “Autonomic Logistics-The Support Concept for the 21st Century.” IEEE Proceedings, Track 11, paper zf11_0701.
2. Byer, Bob, Hess, Andy, and Fila, Leo. “Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics.” Aerospace Conference 2001, IEEE Proceedings, Vol. 6, pp. 3095-3103.
3. 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: Diagnostics; Prognostics; Modeling; Useful Life Remaining Predictions; Prognostics and Health Management; Failure Prediction

N05-094 TITLE: Embedded Health Monitoring for Propulsion Control System Actuators and/or Self-Test of Dynamic Actuator Characteristics

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: To detect impending actuation system faults by monitoring with models and/or embedded, high temperature capable sensors.

DESCRIPTION: The complexity and precision of control system components required for advanced military aircraft are driving increased life-cycle cost. This cost creep results from the need to cater to latent (undetectable) degradation of control system component dynamic performance during prolonged operation. We are seeking embedded health monitoring sensors for propulsion control system actuators and/or self-test of dynamic actuator characteristics. Developments of dynamic self-testing techniques are of particular interest to ensure bandwidth and phase loss characteristics are maintained within control system required tolerances.

PHASE I: Determine the feasibility of detecting impending actuation system faults by monitoring with models and/or embedded, high-temperature capable sensors. Recommend a design concept that takes life-cycle cost impact into consideration and prepare a preliminary design. Mitigate key design risks with a laboratory demonstration.

PHASE II: Detail design and fabrication of prototype sensors and interfacing electronics incorporating the recommended design concept, their integration into a representative actuator, followed by integration and bench test in an environment representative of the flight and propulsion control actuators in a supersonic aircraft. Demonstrate on a suitable propulsion system 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. Follow-on applications to propulsion systems for more conventional air vehicles are also possible due to the operational benefits of effective means of monitoring and compensating for actuator deterioration.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This development is expected to provide benefits for commercial aviation propulsion and flight control, particularly acquisition and maintenance cost reduction and fewer dispatch delays due to unexpected actuator failure.

REFERENCES:

1. Rausch, R., Viassolo, D. E., Kumar, A., Goebel, K., Eklund, N., Brunell, B., and Bonanni, P. "Towards In-Flight Detection and Accommodation of Faults in Aircraft Engines." AIAA 2004-6463, AIAA 1st Intelligent Systems Technical Conference, Chicago, IL, 20-22 September 2004.
2. Fantuzzi, C., Simani, S., and Beghelli, S. "Robust Fault Diagnosis of Dynamic Processes Using Parametric Identification with Eigenstructure Assignment Approach." TuA06-2, Proceedings of the 40th IEEE Conference on Decision and Control, Orlando, FL, December 2001.
3. Demetriou, M. A., and Polycarpou, M. M. "Fault Detection and Diagnosis of a Class of Actuator Failures via On-Line Approximators." Proceedings of the 36th Conference on Decision and Control, San Diego, CA, December 1997.
4. Dixon, R., and Pike, A. W. "Application of Condition Monitoring to an Electromechanical Actuator—A Parameter Estimation Based Approach." Computing & Control Engineering Journal, April 2002.
5. Patton, R. J., Chen, J., and Nielsen, S. B. "Model-Based Methods for Fault Diagnosis: Some Guidelines." Transaction of the Institute of Measurement and Control Vol. 17, No. 2, March 1995. http://www.foster-miller.com/projectexamples/t_dp_nonlinear_dynamics_chaos/aircraft_flight_control_actuator_prognostics.htm
6. Garg, S. "Controls and Health Management Technologies for Intelligent Aerospace Propulsion Systems." NASA/TM—2004-212915; AIAA-2004-0949, February 2004.
7. Byington, Carl S., Watson, Matthew, and Edwards, Doug. "Data-Driven Neural Network Methodology to Remaining Life Predictions for Aircraft Actuator Components."

8. Karpenko, M., Sepehri, N., and Scuse, D. "Neural Network Detection and Identification of Actuator Faults in Pneumatic Process Control Valve." Proceedings of 2001 IEEE International Symposium on Computational Intelligence in Robotics and Automation, Banff, Alberta, Canada, July 29-August 1, 2001.

NOTE: Some of the referenced papers address actuator degradation/deterioration, as opposed to "faults" (locked or ineffective) and all tend to employ analytical techniques at the system level to deduce and identify degradation/faults. Thus none directly address the prime concern of this solicitation – loss of precision and stability of control due to deterioration of actuator dynamic behavior outside design specifications and maintenance limits. More specific actuator/subsystem (versus system level) model and sensor based approaches, likely tailored to FMECA and endurance test and service findings on degradation modes, may be more effective and economical.

KEYWORDS: Propulsion; Control; Actuator; Sensor; Degradation; Dynamic

N05-095 TITLE: Talk Through Audio Technologies for Navy Hearing Protection Devices

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop a system that can be used in high noise environments, greater than 85 dB(A), to increase face-to-face communication intelligibility and improve situational awareness. The hearing protection system must reduce time weighted average (TWA) noise exposure to less than 85 dB(A) for an eight-hour period and enhance the user's ability to localize sound sources.

DESCRIPTION: High noise environments increase the difficulty of face-to-face communication. Further, understanding the sound signals that are available in the environment for maintaining situational awareness becomes more difficult as background noise level increases. Translation of the overall ambient level to lower levels is a method of reducing noise exposure and improving the listener's ability to extract pertinent or useful information. The user's ability to control the ambient level that reaches the ear allows for optimum level adjustment, which in turn provides the best intelligibility and awareness of surrounding sounds. Providing hearing protection for the individual at the maximum obtainable level and electronically adjusting the ambient signal level that reaches the ear is a way of protecting the user while providing audio information in a controlled manner.

PHASE I: Determine the feasibility of developing hearing protection for users that enhance their ability to communicate and maintain their auditory situational awareness. Design alarms that will signal users when noise exposure for daily dose is exceeded.

PHASE II: Develop prototypes that can be tested in the laboratory and in an operational environment for suitability of factors that include speech intelligibility, situational awareness, sound localization, comfort, and ergonomic improvement. Complete environmental testing to assure compliance with MIL-STD-810 and military requirements. Develop training guides for the basic users and maintainers.

PHASE III: Develop prototypes that can be tested in the laboratory and in an operational environment for suitability of factors that include speech intelligibility, situational awareness, sound localization, comfort, and ergonomic improvement. Complete environmental testing to assure compliance with MIL-STD-810 and military requirements. Develop training guides for the basic users and maintainers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The use of circumaural hearing protectors and communication earplugs is widespread among industrial workers. The benefits of natural hearing restoration can be transferred to virtually any industrial users of hearing protection device technologies.

REFERENCES:
1. "War Fighter Hearing Protection". Military Audiology Association http://www.militaryaudiology.org/newsletter05

2. "War Fighter Hearing Protection: Communication Enhancement and Protection System." U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), 51-005-0504, http://chppm-www.apgea.army.mil/documents/FACT/51-005-0504

KEYWORDS: Intelligibility; Sound; Protective; Headgear; Hearing Protection; Ambient

N05-096 TITLE: Advanced Preform Approaches for Complex-Shaped CMC Cooled Turbine Components

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop approaches for improved shaping of high fiber fraction architecture preforms for complex-shaped ceramic matrix composite (CMC) turbine components.

DESCRIPTION: Issues continue to arise in the implementation of 2D and 3D woven preforms of continuous-length ceramic fibers as reinforcement for complex-shaped CMC turbine components. In regard to rapidly changing component cross-sections, current preform geometries are typically less versatile than those available with metal castings. Also, in regard to component wall thickness, current preform shapes are being limited by fiber-tow dimension and minimum 2D or 3D woven cross-sections. In addition, both 2D & 3D woven structures are corner or edge radii limited due to tow size and fiber bend limits. Further, in the more economical 2D structures the inherent use of fabric begets low interlaminar strengths, even when fiber strengths are high.

This solicitation seeks novel fiber preforming approaches that minimize as many of the above issues as possible while still resulting in the preform having continuous-length high-temperature high-performance interface-coated ceramic fibers. The use of non-woven and/or woven architectures is of interest. The final preforms should be capable of reinforcement of structural components in gas turbine hot sections, especially 2600oF stationary airfoil structures. Such CMC structures would closely substitute for metal cast structures, but not necessarily be shaped exactly the same. The goal CMC applications are expected to be vanes and outer shrouds of rotors, in both cooled and un-cooled (solid) configurations made from one-piece or two-piece fiber preforms.

PHASE I: Determine the feasibility of developing a low-cost CMC Materials & Process (M&P) process for hollow thin-wall (0.10 inch) structures with the following features. High-confidence tensile strength of the CMC normal to the hollow wall plane. Sharp edges shapes (0.010 inch), representing vane trailing edges. Sharp fillet radii (0.010 inch) of 90-degrees or greater at the ends of the hollow wall with ends of hollow walls capable of immediate transition to up to one-half inch wall thickness, representing the transition of vane airfoil to its outer bands. Deliverable items should include shape forming demonstration coupons representing appropriate processes and geometries, for example a flanged thin wall cylinder. Deliverable data should further include bare fiber elevated tensile strength. Also include metrics on projected finished part process costs, a status of M&P costs, and a plan to be undertaken in Phase 2 to reduce or control costs.

PHASE II: Demonstrate the fabrication processing of prototype turbine vanes and/or shrouds, perform performance and durability tests on the finished parts, and evaluate the potential for reducing or controlling production costs. The CMC materials and M&P processes need to be shown as domestically produced or sourced in order to support future defense system production. Coordination of a program, in this phase, with U.S. turbine engine OEM's, may be helpful in selection of prototype requirements and Phase III transition planning.

PHASE III: Conduct a full-scale demonstration of a manufactured component in a JSF engine.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential commercial applications generally include high temperature components for commercial aerospace and ground-based applications.

REFERENCES:

1. ASM Handbook, Vol. 21. ASM International, Materials Park, Ohio, 2001, pp. 59, 69, 373, 434, 536, 589, 668.
2. Comprehensive Composite Materials. Elsevier Science Limited, Oxford, UK, 2000, Chapter 23 in Vol. 1 and Chapters 10 and 11 in Vol. 6.
3. MIL-HDBK-17, Volume 5, Ceramic Matrix Composites.
4. ASTM Standard Designation: C-1468-00; Standard Test Method for Transthickness Tensile Strength of Continuous Fiber Reinforced Advanced Ceramics at Ambient Temperature.

KEYWORDS: Ceramic; Composite; Preforms; Continuous-Fibers; Non-Woven; High-Temperature

N05-097 TITLE: Control System Approaches and Experimental Techniques for Unmanned Aerial Vehicle (UAV) Upset Recovery

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Develop methodology to enhance the ability of UAVs to recover from out of control flight induced by severe turbulence upset or intentional maneuvering to evade weapons or other hazards.

DESCRIPTION: Upsets can result from several possible conditions: gusts, turbulence, burble, icing, air wake from a ship superstructure or near buildings, or extreme maneuvers to avoid hazards or attack a target. Semi-autonomous and autonomous UAVs will need to have the ability to recover from upsets in order to meet flight safety and survivability goals. Innovative control system designs, simulation tools, and experimental test techniques to evaluate the ability of the UAV to recover are sought in order to improve the recoverability of the platform through aircraft design and/or control law changes. Specific technologies of interest in this SBIR are: design guidelines for UAVs to enable upset recovery, novel analytical and experimental techniques to simulate environmental upset, advanced outer-loop control law architectures to recover from upset and autonomously replan trajectories, and cost-effective simulation tools to expedite development and validation of UAV upset recovery control laws.

The proposed research advances the state of the art via three technical objectives. First, the proposed research advances the state of the art in outer-loop control for autonomous vehicles. For manned or remotely piloted systems, designing outer-loop control algorithms to account for upset recovery is unnecessary because a human pilot is ready to take over control in case of upset. Therefore, this research would define the UAV control algorithms necessary to emulate the upset recovery actions of the human pilot. Second, this research strives to develop novel and cost-effective simulation tools and experimental techniques. Two important advantages of UAVs are that they can potentially be used in place of manned systems to fly in high-threat environments and severe environmental conditions. Because of these emphases, simulation tools and experimental techniques should be developed to construct design guidelines and validate the design of UAVs and their upset recovery algorithms to perform in these environments. Finally, the proposed research advances the state of the art in autonomous control. Control logic must be developed for non-expendable autonomous air systems to automatically recover from upsets, replan flight path segments, and resume the mission while minimizing or eliminating involvement from the human operator. The proposed research would improve the "intelligence" of the UAV and hence its survivability and safety.

PHASE I: Investigate novel approaches to upset recovery incorporating design improvements (e.g., new control effector concepts), and control system enhancements (e.g., novel outer-loop control law architectures). Define UAV critical operating environments. Conduct an analytical study of the effectiveness and feasibility of these approaches to include preparation for a wind-tunnel demonstration in Phase II. Develop wind tunnel test techniques and test plans to evaluate UAV upset recovery techniques. The plans should include available facilities in which to conduct the tests and complete methodology for carrying out the tests and analyzing the results. Report on the results.

PHASE II: In Phase IIA, conduct wind tunnel tests, simulations, and/or other analyses to demonstrate the most promising experimental techniques and control system innovations developed in Phase I. Develop upset recovery control algorithm methodology. Incorporate upset recovery control algorithms into UAV testbed (platform chosen should be non-proprietary and highly re-usable). In Phase IIB, conduct hardware-in-the-loop simulation and/or in-flight experiment(s) validating upset recovery experimental techniques and control algorithms. Develop software tools (preferably MATLABTM toolbox) to automate upset recovery capability in UAVs. Compare flight results to simulation and update math models as appropriate. Prepare Phase II final report.

PHASE III: Transition technology developed in Phase II to a prototype or production UAV. Additional applications should include autonomous UAVs and passenger aircraft for broadest commercial application. Report on the results.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercialization of the control system approaches and test techniques for use by DoD and its partners has great potential with the current interest in UAVs and UCAVs by all branches of the military. In the future, UAV aircraft will likely find commercial applications and regularly fly in commercial air zones and over populated areas. Before such applications can happen, the public will look for some assurance that these vehicles have as good a safety record as manned aircraft. Upset recovery will likely be one of these requirements. Additionally, commercial UAVs are being sought to fly in environments with large upset potential including over forest fires and in tropical storms. The technologies developed in this SBIR will be valuable to the UAV designer and to aviation as a whole.

KEYWORDS: aerodynamics, stability, flight controls, safety, survivability, autonomous control

N05-098 TITLE: Innovative Approaches For Enhancing Interlaminar Shear Strength of Two-Dimensional (2D) Reinforced Ceramic Matrix Composites (CMCs)

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and demonstrate effective low-cost methods for improving interlaminar shear strength of 2D CMC's.

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 (2D) woven CG Nicalon fabric reinforcement, which is coated with a BN interface coating. 2D CMC components have been found to be life-limited in high thermal gradient environments due to inherently low matrix dominated interlaminar shear strengths. 3D fiber architectures offer the promise for increased durability by enhancing the interlaminer and through-thickness mechanical properties; however, their implementation may be cost prohibitive.

PHASE I: Develop efficient low-cost approaches for improving the interlaminar shear strength of 2D CMC's. Demonstrate the feasibility of applying one such approach by fabricating and testing coupon specimens.

PHASE II: Provide practical implementation of a production-scaleable process to implement the recommended approach developed under Phase I. Evaluate the approach through the fabrication and testing of a sufficient quantity of material property test coupons. Develop a 2D reinforced design for a CMC propulsion component and fabricate the part using the recommended method for improving the interlaminar shear strength.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Advanced CMC propulsion components have the potential to transition to the commercial aircraft market for weight reduction and enhanced life expectancy. The resulting fabrication 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.

KEYWORDS: Ceramic Matrix Composite; Two-Dimensional Reinforcement; Propulsion Systems; Interlaminar; JSF; Cost Reduction

N05-099 TITLE: Report-to-Track Data Fusion

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Investigate the potential benefit of a report-to-track fusion system over a track-to-track fusion system.

DESCRIPTION: Data fusion is critical to many Navy missions and platforms. In order to effectively execute their missions, platforms such as the E-2, MH-60 and JSF require highly reliable tracking and classification of air platforms within a tactical region. Track-to-track (TTT) fusion systems are typically considered a sub-optimal approach to fusion because information is combined at the track level after it has been processed and filtered. However, TTT fusion does offer some advantages and is being investigated as a method for providing the tracking picture for some of these platforms. The purpose of this effort is to investigate the potential benefit of a report-to-track (RTT) fusion system over a TTT fusion system. This effort will first focus on the benefit of using a more sophisticated RTT fusion algorithm for a single radar sensor and then begin to merge in more sensors and sources into the developed methodology. Early work will involve developing a software test bed to create representative sensor/source data and then study how to best combine this data into tracks. The government will provide any information required to make sure that the simulated data is representative. Once the baseline test bed is implemented, the effort will initially focus on radar data. As the methodology to fuse the radar data develops, the effort will incrementally add in other sources to the algorithm process and extend the analysis. The final algorithm will produce tracks using reports from all sources investigated.

PHASE I: Given a set of radar characteristics and a tactical scenario, develop a software test bed that will create representative radar data and study how to best combine that data into tracks. Studies should look at how the tracking is affected as the probability of detection diminishes or the probability of false alarm increases, etc.

PHASE II: Incrementally add other sources of data and extend the analysis with additional scenarios. Work with Navy program offices to refine the sensor characteristics. Compare the final RTT algorithm with TTT fusion systems currently being developed. The comparison shall be made using a set of Navy generated metrics. Provide results and briefs to interested customers.

PHASE III: Work with Navy customers and their primes to identify and mitigate any software transition issues, i.e., real-time performance, etc. Participate in technical meetings to promote the developed algorithm.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this program will have application to any commercial activity that shares data generated from multiple sources over a distributed environment.

REFERENCES:
1. Waltz, E., and Llinas, J. Multi Sensor Data Fusion. Boston, CT: Artech House, 1990.
2. Pawlowski, A., and Gerken, P. "Simulator, Workstation, and Data Fusion Components for Onboard/Offboard Multi-Target Multi-Sensor Fusion." Presented at the 17th IEEE/AIAA Digital Avionics Systems Conference, Seattle, WA, November 1998.
3. Malkoff, D., and Pawlowski, A. "RPA Data Fusion." Presented at National Symposium on Data Fusion, Monterrey, CA, March 1996.

KEYWORDS: Data Fusion; Tracking; Report-to-Track; Track-to-Track; Tracking Algorithms; Software Test Bed

N05-100 TITLE: Scanning of Laser Drilled Small Holes

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop a system that can scan laser drilled small holes; collect, analyze, disposition data, detect and compensate offsets as required to bring the drilling process back into control.

DESCRIPTION: Laser and vision systems are required that can scan angled, round, shaped, through holes, and blind holes during a hole drilling process; analyze the process for deviations from specifications; and provide real-time corrections to the production process, and avoid the need for special lighting/positioning. Current laser and vision systems require special lighting and positioning to perform this function. Associated software algorithms to collect, analyze, and determine actual location and size need to be optimized. The overall scanning system must be able to communicate, in real time, any required changes to process parameters to ensure the drilling process is under control and producing quality holes.

PHASE I: Demonstrate the engineering, manufacturing, and economic feasibility of a new process. Additionally, perform a detailed process assessment to minimize or eliminate downstream operations. Construct an economic model of the new manufacturing process to quantify potential savings and cost drivers and their respective influence on overall hole drilling process economics.

PHASE II: Demonstrate that the scanning process selected will improve the overall quality of the manufacturing process as well as reduce cost and cycle time. Describe and demonstrate tooling and processes to produce full-scale prototypes and to establish process reproducibility under relevant production conditions. Develop and demonstrate software algorithms to collect, analyze, and determine actual location and size. Validate the potential cost savings and cycle time reductions of the demonstrated processes.

PHASE III: Test and evaluate the new scanning and control system in an aerospace industry production line providing components for the F135 and F136 engines. Validate commercialization plans and qualification requirements to offer these new techniques to the aerospace industry for production, transition, and qualification.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed approaches should have broad commercial applicability due to the large number of commercial airframe engines that also require a large number of holes to be drilled economically.

REFERENCES:
1. Ready, John F. Industrial Applications of Lasers. San Diego, CA: Academic Press, 2nd Edition, 1997.
2. Baxter, Richard. "Turbine Drilling." Industrial Laser Solutions, Vol. 17, No. 2, p. 16.

KEYWORDS: Optical Scanning; Vision Systems; Holes; Laser Drilling; Gas Turbine Engine; Sizing

N05-101 TITLE: Low-Cost-Lightweight, Low-Pressure-Drop Engine Inlet Filtration System for H60/H-1 Helicopters (T700 Engines)

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: MH-60R

OBJECTIVE: Identify and develop innovative, low-cost, lightweight, inlet air filtration system for T700 engines on the US Navy’s H60 (Seahawk) Helicopter series and the US Marine Corps’ H-1 (Cobra), Helicopter Series.

DESCRIPTION: Currently, no suitable engine inlet air filtration system exists for the new Navy Seahawk Helicopters (MH-60S and MH-60R) and the new Marine Corps H-1 helicopters (AH-1Z and UH-1Y). These aircraft have two engines with two nacelles. The Army is currently in the process of qualifying an Inlet Barrier Filter (IBF) System for the H60 Blackhawk aircraft (see reference 1) which are similar to Seahawk aircraft. However, the Navy faces significant challenges in employing these systems on Navy's new H-60 Seahawks due to engine power loss and weight increase associated with them. This poses a significant constraint given the higher power requirements for the Seahawks. For the USMC series H-1 helicopters the Army Blackhawk IBF system is not suitable due to size and interface constraints.

Innovative technologies are sought that could provide a lightweight (less than 100 lbs per aircraft), low-cost (less than $100k per aircraft), field maintainable system that would filter air entering aircraft engines. The filtration system must handle airflow of up to 12 lbm/sec per engine with a desired pressure drop of no more than 10 inches of H2O across filtration system (i.e. ambient to nacelle engine inlet). This system must be capable of filtering out at least 95 percent of media associated with Albert Champion (AC) coarse, and AC fine specification sand. The system must be modular to allow easy field removal where missions don't require it. The installation and removal should be accomplished with minimum specialized tools. The system should also be field maintainable.

The sizes of the interface nacelle inlet areas (air wetted) is approximately 140 sq. inches for H60 helicopter, 172 sq. inches for AH-1Z helicopter and 126 sq. inches for UH-1Y helicopter. Further details of inlet geometry for interface will be provided during phases II and III detail development. For reference, photos/drawings of the helicopters and inlets are enclosed (see reference 2). The system design should have external profile to minimize helicopter and engine performance impacts (i.e. lift, drag, engine operability, and flying qualities). A bypass system is required for a clogged filtration system condition. The system must be flight worthy and be able to withstand aerodynamic loads from rotor downwash and aircraft speeds of up to 210 knots.

PHASE I: Define innovative concepts for a lightweight, low cost system for inlet air filtration on H60/H-1 aircraft. Determine feasibility of the system through laboratory characterization and mock-up test of the proposed system(s) that demonstrate the performance objectives listed above. These results shall be documented in a report, which shall also include proposal for phase II effort for flight test.

PHASE II: Produce prototype(s) for fit check, ground tests, and flight tests to demonstrate system performance. Provide support for airworthiness qualification of prototype, flight test, data acquisition and data analysis.

PHASE III: Provide support in System Design & Development (SDD) effort to develop production representative systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Air filtration systems have wide reaching implications for helicopters, both military and commercial, as well as marine and power plant gas turbines.

REFERENCES:
1. Army System Spec for UH-60 (Blackhawk) Inlet Barrier Filter System
2. Photos/drawings of H60S, AH-1Z, and UH-1Y helicopters and inlets will be posted on SITIS: http://www.dodsbir.net/sitis/.
3. MIL-STD-810F, Environmental Engineering Considerations Laboratory Tests.
4. MIL-STD-882D, Standard Practice for System Safety

KEYWORDS: Filter; Inlet; H60; H-1; T700 Engines; Low Pressure

N05-102 TITLE: Low-Cost Power Source (Thermal Battery)

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Develop and fabricate a low-cost power subsystem suitable for use in a tactical weapon.

DESCRIPTION: This SBIR addresses the development of a low-cost power source that provides an output of 56 Vdc. Activation time must be1.0 seconds or less. The battery must be capable of supplying a constant 7A after activation for the first 680 seconds and 8.5A during the last 120 seconds. It must be capable of supplying 49 A for 2.0 seconds within the first 3.6 seconds of activation. In addition, the power source must sustain 35 A pulses of 0.5 second duration at every 10 second interval between 3.6 and 800 seconds. The battery should be no greater than 4.25 inches in diameter and not longer than 9.4 inches. The subsystem must be capable of meeting all NAVSEA S9310 safety requirements as well as Air Force Explosive Atmosphere requirements. The power source has a cost threshold of $1,200 with an objective of $900 at an annual rate of 500 units. The cost includes mounting bracket and MIL-C-38999 connector. The design goal should be compatible with a 1,000 unit per year surge capacity and must emphasize producibility, reliability, and affordability.

PHASE I: Develop a power subsystem design concept source that will provide 6,000 Ampere-seconds at 56 +12, -6 volts over an operating life of 800 seconds with a storage life of 21 years The design concept must meet all requirements stated above.

PHASE II: Finalize the design, fabricate, and test the selected battery concept. Build and test enough prototypes to ensure the potential of meeting a reliability performance of no less than 0.9988 over the entire environment. This includes the environments under transportation, storage, and deployment. Initiate producibility studies of the design along with production planning and design to cost analysis.

PHASE III: Build 40 production representative units that will be used by the Government for flight test, environmental qualification, and safety testing. Perform corrective action redesign necessitated by failures found during the above testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this effort should be applicable to any system that requires a low-cost high-capacity thermal battery.

REFERENCES:
1. NAVSEAINST 9310.1B, Naval Lithium Battery Safety Program.
2. MIL-C-38999K, Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect, … Environment Resistant, DoD Index of Specifications and Standards (DoDISS) or see Defense Automated Printing Service (DAPS), eAccess database.

KEYWORDS: Thermal Battery; Power Source; Energy Source; Weapons; Decoys; Robots

N05-103 TITLE: Advanced Electromechanical Actuation System for Jet Blast Deflectors (JBDs)

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop electromechanical actuation technology to replace the legacy hydraulic actuators in the aircraft carrier’s JBD.

DESCRIPTION: Carrier aviation is dependant on the ability to launch and recover aircraft and to conduct safe operations on the flight deck. The JBD is a key component to flight deck safety. During aircraft carrier launch operations, it functions as a physical safety barrier between the aircraft engine-nozzle exhaust and any equipment or personnel that are located behind the aircraft. A JBD is installed directly aft of each catapult and consists of either four or six aluminum panels. These panels are raised from the flight deck and, in operational position, divert the aircraft’s jet blast upward. The panels become an integral part of the flight deck surface when lowered to their stowed position. The JBD currently utilizes hydraulic actuators (two for each panel) operating with a 2,500 psi hydraulic supply to raise and lower for each aircraft launch. This system uses 34 gallons per minute average hydraulic demand to maintain a 45 sec launch cycle time.

With the advent of the electromagnetic aircraft launch system (EMALS), which is planned to replace steam catapults on the CVN-78, the JBD will become the major hydraulic demand driver, using 72 percent of the total catapult system hydraulic demand. This topic seeks to develop electric actuator technology to replace the hydraulic actuators for the JBD. Expected benefits include a topside weight reduction for CVN-78 (based on removing or reducing the catapult hydraulic system) and a decrease in maintenance (based on reducing the number of mechanical sources of failure: valves, pumps, accumulators, cylinders, and piping).

The JBD application poses several technical challenges for linear electric actuators. The actuators are in a severe environment where frequent exposure to salt water spray and occasional submersion can be expected. The actuators have a very high working force and speed/power requirement relative to typical commercial linear electric actuators. The JBD cannot inadvertently fall due to a sudden loss of electrical power. Space constraints are severe due to proximity of structure and linkage. An actuator that operates at several thousand pounds per square inch would be desirable.

The following is a list of requirements and relevant technical data. Dimensions: the current Mark 7 Mod 0 JBD (6-panel) dimensions are 36 feet in length by a raised height of 10.7 feet. It raises to an angle of 50 degrees relative to the flight deck. Approximate panel weight including linkage is 6,000 lbs. The static force needed to overcome the weight of each panel is 38 Klbs. The peak force measured from actual hydraulic actuator differential pressure during operation is 60 Klbs. The mounting design force for the actuating cylinder is 98 Klbs. The hydraulic actuator design max operating force is 85 Klbs (at 3 Kpsi).

PHASE I: Prove the feasibility of an electromechanical actuation system to meet the technical issues. Develop a design and demonstrate that the system meets performance requirements. Provide defendable estimates for cost, reliability, and maintainability.

PHASE II: Develop a prototype and demonstrate. Initial testing of the system will be on subscale demonstrators progressing to full-scale system testing, which could be at the NAVAIR JBD test facilities. Testing must demonstrate performance, (to verify that the actuators have the capability to raise in five seconds, lower in seven seconds and stop and hold the JBD panels), environmental robustness, shipboard shock and vibration, and maintainability.

PHASE III: Manufacture and install, on a candidate USS Nimitz Class aircraft carrier, one electromechanical system for shipboard test and evaluation. Produce units for forward fit to CVN-78, and backfit of the entire class of in-service carriers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be a substitution for any legacy hydraulic-actuation system requiring a combination of high-speed/high-torque, high-speed/low-torque, low-speed/high-torque, and low-speed/low-torque.

REFERENCES:
1. Aircraft Carrier Reference Data Manual, NAEC-MISC-06900.
2. NAEC-ENG-7697, Structural Analysis of the Mark 7 Jet Blast Deflector Operating Mechanism for the CVAN 68.

KEYWORDS: Electromechanical Actuators; Jet Blast Deflector; Aircraft Carriers; Linear Motion; Electromagnetics; Catapult Hydraulic System

N05-104 TITLE: <u>Dynamic Simulation-Based Decision Support Concept and Modeling System for Real-Time Assessment of System Health, Diagnostics and Contingency Planning</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop an innovative decision support concept and supporting tool sets, including dynamic modeling and simulation capabilities and other techniques that would provide advanced real-time assessments of system and subsystem health. Diagnostic technologies are sought that are capable of detecting and fault isolating failures in a dynamic system environment.

DESCRIPTION: The JSF program is developing a robust and comprehensive prognostics and health management (PHM) capability across all subsystems and is highly integrated into the air vehicle and air system design. To date most of the decision support concept has been based on tool sets and modeling and simulation capabilities using stable and steady state system status rather than dynamic relationships of the systems or subsystems monitored. This decision support concept, supporting analytical tool sets and models and simulation techniques, would provide both PHM status assessments, diagnostics and contingency planning information for systems and subsystem operating in very dynamic and constantly changing operating environments. These tools sets, modeling and simulation capabilities, and associated techniques would provide on-line, real-time health status assessments and diagnostic fault detect/fault isolation capabilities. These dynamic modeling capabilities, techniques and tools sets should also be able to relate to and enhance maintenance decision support and contingency planning concepts.

PHASE I: Determine the feasibility of structuring an innovative and more advanced maintenance decision support concept supported by additional tool sets and dynamic modeling and simulation capabilities. Define and demonstrate these advanced capabilities, tool sets, modeling and simulation techniques, methodologies, and approaches. Develop a strategy for integrating the advanced capabilities, tool sets, and modeling and simulation components into the current JSF PHM architecture.

PHASE II: Develop and demonstrate a prototype or set of prototypes for these advanced concepts, tool sets, and modeling and simulation capabilities. Use actual JSF data to develop, demonstrate, verify, and validate their ability to efficiently assess improvements in PHM capabilities and performance. Assess the application boundaries, accuracy, and limitations for these modeling techniques.

PHASE III: Integrate these capabilities within a comprehensive program for verification and validation of all PHM system capabilities for the JSF application.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Any results (understanding) gained from applying these modeling and simulation techniques and other improved verification and validation techniques would provide a significant crossover benefit to other similar commercial or military applications.

REFERENCES:
1. Henley, Simon, Currer, Ross, Sheuren, Bill, Hess, Andy, and Goodman, Geoffrey. "Autonomic Logistics-The Support Concept for the 21st Century." IEEE Proceedings, Track 11, paper zf11_0701.
2. SAE E-32 Committee Documents. IEEE. Aerospace Conference Proceedings for 2001 through 2005, Track 11 PHM. http://forums.saeg.org/access/dispatch.cgi/TEAE32_pf/showFolder/10001/def/def/3f4f.

KEYWORDS: Diagnostics; Prognostics; Modeling; Failure Prediction; Forecasting; Condition Maintenance

N05-105 TITLE: <u>Novel, Low-Cost Methods for Fiber Interphase Coatings for Ceramic Matrix Composites (CMCs)</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop a low-cost alternative to existing chemical vapor infiltration (CVI) processes for silicon-doped boron nitride (Si-BN) fiber interphase coatings.

DESCRIPTION: Currently, interphase coatings on structural ceramic fibers are deposited by CVI. CVI-derived interphase coatings are a significant fraction of the total CMC cost pie. Si-BN has been shown recently to provide improved oxygen and moisture resistance when compared with pure boron nitride (BN) interphase coatings in aircraft engine environments. A uniform coating thickness for the Si-BN interphase coating is between 0.2 to 0.4 microns to optimize mechanical properties of the composite. In order to maintain protection of the underlying ceramic fiber, the interphase coatings developed should be crack-free and possess a highly smooth external surface structure. The proposed processing method should provide minimal to no bonding of adjacent fibers within the ceramic fiber tow. Another key requirement is that the method of interphase coating formation does not result in degradation of the structural ceramic fiber being coated. Demonstration of this through strength and modulus measurement of individual ceramic fibers both before and after coating is a requirement of this effort.

PHASE I: Demonstrate an alternative method (to CVI) of formation of Si-BN interphase coating on ceramic fiber tow. Verify composition and crystalline structure of the coating and perform monofilament fiber strength and modulus measurements before and after coating formation. Demonstrate coating thicknesses between 0.2 and 0.4 microns. Perform fabrication and testing of a composite plate with the new interphase coating. Perform a cost comparison between the innovative process and conventional CVI deposited Si-BN.

PHASE II: Scale up the interphase coating formation process to a level in which woven ceramic fiber fabric can be produced. Produce and test CMC panels for thermomechanical property. The matrix phase for this demonstration should be silicon nitride/carbide (SiNC). Measure and report on electromagnetic properties of the CMC panels. Include a plan for scale-up and manufacturing in the final report.

PHASE III: Complete manufacturing and scale-up of the new interphase coating processing technique as outlined in Phase II. Produce the innovative interphase coating on ceramic fiber reinforcements of varying size and morphology, i.e., woven, mat, etc.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In addition to military aircraft engines, this technology could reduce the cost and improve life cycle of CMC components in commercial aircraft engines as well as industrial turbines for energy generation.

REFERENCES:
1. "Recent Developments in the Environmental Durability of SiC/SiC Composites", NASA/CR-2002-211687; www.lerc.nasa.gov/WWW/RT2001/5000/5100dicarlo2.html.
2. High Temperature Ceramic Matrix Composites. Editors: Walter Krenkel, Roger Naslain, and Hartmut Schneider

KEYWORDS: Ceramic Matrix Composite; Interphase Coating; Chemical Vapor Infiltration (CVI)

N05-106 TITLE: Innovative and Affordable Materials/Concepts for Improving Rotorcraft Slip Ring Reliability

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: V-22

OBJECTIVE: Develop innovative and affordable materials/concepts to extend the service life of slip rings in rotorcraft.

DESCRIPTION: A slip ring is an electromechanical device that allows the transmission of power and electrical signals from a stationary unit to a rotating structure or a rotary electrical joint. Currently, slip rings are made of high electrical conductivity metals. Slip rings reside inside the propeller rotor gearbox shaft (hollow), which turns the main rotors. These devices transmit and receive electrical signals to and from the rotor head. Aside from providing electrical current to the rotor blade for icing protection, they monitor flapping and mass torque sensors.

The standard slip ring circuit consists of a pair of sintered metal sleeves on copper/graphite brushes making contact with a brass ring. Slip rings can degrade, depending upon the contact material properties, with wear and debris. Contact slip rings may have inadequate durability and may require significant maintenance.

The U.S. Navy is interested in developing new materials and/or concepts for improving slip ring durability, and therefore enhancing service life. The improved slip ring must demonstrate increased reliability with low electrical noise and low electrical resistance.

PHASE I: Demonstrate the scientific merit and feasibility of the proposed material technologies/concepts. Determine objective/threshold values in terms of data transmission rates, number of channels, electric noise levels, and wear resistance.

PHASE II: Fabricate and characterize a full-scale prototype. Demonstrate properties meeting all technical requirements. Specific properties of interest include high output voltage and current, low electrical noise, good wear resistance, and ease of maintenance.

PHASE III: Implement a full-scale demonstration of the rotorcraft platforms for possible V-22 and other rotorcraft applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of an innovative slip ring device can enable and benefit various industrial applications such as in industrial machinery-rotary sensors, robotics, heavy equipment turrets, amusement rides, centrifuges, rotating antennas, etc.

REFERENCES:

1. "Contactless Rotary Electrical Couplings," NASA Ames Research Center, NASA Tech Brief ARC-12072.

KEYWORDS: Rotorcraft; Slip Ring; Reliability Improvement; Durability; Electrical Coupling; Innovative Materials

N05-107 TITLE: Dynamic Rotor System Components Testing Technologies

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: MH-60R

OBJECTIVE: Develop and demonstrate effective, low-cost, time saving methods for testing dynamic rotor system components subjected to actual dynamic loading environments.

DESCRIPTION: Safe-Life criteria for naval rotor systems require fatigue testing of dynamic components prior to flight certification. While simple testing of individual components, such as pitch links, can sometimes be accomplished as a standalone test, it is a requirement to simulate an entire rotor system in order to replicate the actual dynamic and mechanical environment imparted on the individual subject specimen. Additionally, since high-cycle fatigue is usually the critical failure mechanism, test duration is on the order of 10 million cycles; for example, a rotor hub test usually takes at least two years from fixture build-up to component failure. Currently, each rotor system requires a unique test rig. These existing test rigs are complicated and require constant maintenance over long periods of time, making fatigue testing of rotor components inherently expensive. Therefore, there is a requirement to develop an innovative method that would enable the generation of dynamic loading conditions representative of the entire rotor system but requiring only those parts that are the test specimens. This method of load induction should be modular, reconfigurable, and of a nonmechanical nature, such as acoustic or electromagnetic excitation, so that the limitations of the current mechanical methods, i.e., wear, overheating, frequency constraints, and configuration specific designs, will be eliminated.

PHASE I: Develop efficient, low-cost approaches for inducing the complex load conditions into individual dynamic system components that are representative of the actual dynamic environment generated in a helicopter rotor system. Demonstrate this approach by inducing realistic rotor system dynamic loads into a single dynamic system component and measuring the component stress levels. Correlate the test results with available test data obtained from existing rotor system evaluations.

PHASE II: Apply the results obtained from Phase I to the evaluation of multiple components within the rotor system, enabling the introduction of realistic dynamic loads into each of the individual components within the entire rotor system. Demonstrate the validity of the approach by inducing realistic rotor system dynamic loads into a complete rotor system and measuring the critical stress and deflection levels. Correlate the test results with available test data obtained from complete rotor system evaluations. Identify how this concept can be universally applied to various rotor systems on a variety of platforms.

PHASE III: Transition the approach to other military and commercial rotorcraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A cost-effective method to test rotor system components would enable commercial rotorcraft manufacturers to eliminate the added safety factors used for analytical qualification and carve weight out of the rotor system designs.

REFERENCES:
1. Sikorsky Aircraft Document SER-14112, "CH-53 Rotor System Fatigue Life Calculations."
2. Schneider, George. "Crack Growth Analysis & Test of a Main Rotor Damper Attachment Lug." AHS Forum 60, June 2004.
3. Air Force SBIR AFRL-PR-WP-TR-2003-2077, "Eddy Current Excitation of Gas Turbine Blades in a Vacuum Spin Rig."

KEYWORDS: Dynamic Component Testing; Rotor Blade; Helicopter; Fatigue Testing; High-Cycle Fatigue; Load Induction

N05-108 TITLE: Configurable Internet Sub-Protocol for Sensor Networks and State Space Aware Adaptive Routing

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop an efficient Internet Protocol (IP) with a dynamic IP header adaptation to be standardized across communications platforms to create/establish routes and control traffic.

DESCRIPTION: There is a technology rift between the need for pulling in sensor networks into the larger Internet with all of the protocol overhead required and the inherent nature of developing smaller physical devices with limited local energy resources allocated to the communication process. This new protocol would create an alternate path for communications selecting only the fields and field lengths required for the sensor network as it is deployed. The protocol must execute on standard IP stacks and allow the device to communicate in the standard IP with fully populated header fields at any time. Any device along a routing path can be configured to act as a bridge element in the network translating between packets containing the efficient 'sub-protocol' and those with a full IP header. The discovery of the format of the sub-protocol should be addressed when nodes connect to the wireless sensor network in add-hoc manor. The protocol should be demonstrated to be compatible with IPv4 and IPv6.

GPS commonly provides precise position and synchronized timing information, however participants within a network often have a great deal of information regarding their current state. By utilizing a more thorough analysis of a node's position, velocity, and time, network protocols could be developed that anticipate changing link states, rather than reacting to them. Furthermore, it is envisioned that overhead traffic devoted to sensing and optimizing links could be kept to a minimum via analysis of physical layer information coupled with a node's informed sense of their place in a network.

PHASE I: Investigate/model the efficient Internet sub-protocol and algorithms that utilize GPS and node state information to form efficient routes. Propose this implementation on wireless sensor and platform networking devices using a standard IP stack.

PHASE II: Finalize the protocol design and prototype with a laboratory demonstration. Conduct a comparison evaluation to demonstrate improvements achieved over existing military IP.

PHASE III: Incorporate the efficient sub-protocol into commercial and DoD radios to achieve Joint Tactical Radio System (JTRS) network capabilities. Support a Ground and Flight demonstrating in existing JTRS SCA equipment of the viability of selected approach.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Smart Sensor Networks to support JTRS and airborne networks. Potential applications may exist for industrial applications as mobile security sensors. Other government uses may be for the United States border monitoring as a function of the Department of Homeland Security.

REFERENCES:
1. Joint Tactical Radio System (JTRS) Operational Requirements Document (ORD). Version 3.2 JROC Approved, JROCM 087-03, 9 April 2003.
2. Kurose, J. F., and Ross, K. W. Computer Networking: A Top-Down Approach Featuring Internet, Third Edition, Addison Wesley, May 2004.

KEYWORDS: Wireless Ad Hoc Networking; Multi-Point Sensor Networks, Sensor Network Nodes, Efficient Communications 'Sub-Protocol'; Self-Adaptation and Auto-Configuration to Network Topology Changes, Signal Processing; Networking of Data.

N05-109 TITLE: Enhancing Warfighter Performance through Predictive Model-Based Decision Aids and Adaptive Displays

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop adaptive displays and decision aids that optimize operator/team performance by dynamically capturing and using real-world information more accurately.

DESCRIPTION: Operators of current and future aviation systems are presented with an overwhelming amount of information. Among the sizable number of task requirements that are placed onto aviators and controllers are those of sustained attention and information integration. During long periods of watch, operators/teams must track, monitor, and process information that is arriving from one or more resources in the field and integrate that information according to held mental models. In addition, they must generate dynamic situational assessments and make critical decisions based on the information they receive, which may be affected by both internal and external variables. These performance requirements place the onus on designers to incorporate into operational systems strong support systems that can enhance performance under high-workload, high-stress, and uncertain conditions. Adaptive displays and decision aids are currently being developed to address these issues, with the objective of reducing the workload imposed on operators/teams and improving their mission performance.

Successful development of adaptive displays and decision aids requires that performance models be more sensitive to real-world system dynamics, and that they adequately describe performance change over time and dynamically adjust outputs as a function of that change and fluctuations in the environment. While current approaches have the capability to capture performance change, they do not do so within the context of signal detection theory and therefore cannot distinguish perceptual ability from response bias. Novel modeling approaches are therefore necessary to create optimal designs for operators that can adapt according to the individual or team's current state or level of response bias.

Development of predictive models of performance could be used by a computer-based system to organize the information in a way to maximize accurate responding by an operator and optimize his/her situation awareness. For instance, it may be that earlier detection and intervention regarding operator biases could have averted the ultimate decision to fire by operators aboard the USS Vincennes. An adaptive decision aiding system could detect patterns of bias over trials and deliver messages to the operator indicating the trend in responding. It could also use this information to organize information in an optimal fashion (e.g., setting priorities for presentation of events to minimize information overload). Further, a robust and flexible model can be adjusted dynamically on the basis of changes in the context and/or the cognitive state of the operator/team members. As relevant variables (e.g., number of aircraft, speed, distance) change during a scenario, their relative importance in determining which events are considered potential targets may require modification.

PHASE I: Demonstrate the feasibility of using the novel model(s) for performance prediction and enhancing performance by automating decisions and by dynamically changing information presentation (e.g., organization of information in the display) as a function of the changing environment. Determine specifications for a prototype.

PHASE II: Develop and validate a prototype system that will demonstrate the strengths of the model as applied to adaptive displays and decision aids by improving operator/team performance. The prototype must be sufficiently robust to facilitate Phase III work and transition.

PHASE III: Transition the new model-based prototypes to an aviation system and conduct final validation of the system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Theoretical understanding and applied solutions to human monitoring and information processing performance issues in uncertain environments would be of value in the commercial sector as well as military. Development of adaptive displays and decision aids could be directly applied to civil aviation, in which information overload and traffic management are chronic issues to be addressed. In addition, as a tool for performance assessment in complex environments, mathematical modeling techniques can be applied to other target detection domains, including airport security, homeland security, industrial quality control, threat detection in law enforcement, and ground transportation. In each case, knowledge gleaned from the current proposed work could lead to enhanced detection systems and improved performance by more accurate mapping between the mathematical model and the reality it attempts to fit. These industries could benefit greatly from display designs and decision aiding systems based upon a more descriptive and predictive models than current models for performance.

REFERENCES:
1. Campbell, G. E., Buff, W. L., and Bolton, A. E. "The Diagnostic Utility of Fuzzy System Modeling for Application in Training Systems." Proceedings of the Human Factors and Ergonomics Society, 44, 2000, pp. 370-373.
2. Hancock, P. A., Masalonis, A. J., and Parasuraman, R. "On the Theory of Fuzzy Signal Detection: Theoretical and Practical Considerations. Theoretical Issues in Ergonomics 1(3), 2000, pp. 207-230.
3. Campbell, G. E., Buff, W. L., Bolton, A. E., and Holmes, D. O. "The Application of Mathematical Techniques for Modeling Decision-Making: Lessons Learned From a Preliminary Study." Proceedings of the Fourth International Conference on Cognitive Modeling, 2001, pp. 49-54.
4. Parasuraman, R., Masalonis, A. J., and Hancock, P. A. "Fuzzy Signal Detection Theory: Basic Postulates and Formulas for Analyzing Human and Machine Performance." Human Factors, 42, 2000, pp. 636-659.

KEYWORDS: Monitoring; Display Design; Dynamic Display; Adaptive Display; Decision Aids; Sequential Analysis

N05-110 TITLE: W-Band High-Power Chirped Solid-State Transmitter

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop innovative, high power, short pulsed, low cost transmitter.

DESCRIPTION: Historically high-power solid-state MMW transmitters have utilized IMPact Avalance Transit Time (IMPATT) diodes in a power combining circuit from multiple diodes. These combining circuits use either spatial combining or MMW networks for coherently summing the signals to achieve the high powers. This invariably increases the complexity, size, and cost of the transmitter system and makes these circuit configurations not suitable for missile applications where the cost must be kept at a minimum, and small volume and weight are required to allow the transmitter to be mounted on a gimbal platform. A series or series/parallel configuration of multiple active devices in a common resonant circuit will allow a reduced volume, low-cost, high-power MMW transmitter to be developed. A custom pulse modulator is required that can supply the required voltage and current pulse to optimally bias the active devices to insure proper chirp characteristics are maintained through the transmitter operating environments.

Design Goals include: develop a 50-watt peak radio frequency (RF) output power, chirped solid-state W-Band pulsed transmitter that matches a 30:1 compressive filter response and can produce chirped pulses of several hundred nanoseconds at a pulse repetition frequency (PRF) of several hundred kilohertz. Using various solid-state active devices and/or amplifiers with a millimeter wave (MMW) combining circuit and custom modulator, design and evaluate a high-power transmitter system for active W-Band MMW missile guidance system applications.

PHASE I: Develop a design approach and feasibility concept for a low cost, flight-worthy, 50-watt peak radio frequency (RF) output power, chirped solid-state W-Band pulsed transmitter that matches a 30:1 compressive filter response and can produce chirped pulses of several hundred nanoseconds at a pulse repetition frequency (PRF) of several hundred kilohertz. Perform circuit analysis of the selected transmitter configuration(s) at W-band to validate and optimize a final high-power transmitter design approach. Provide an analysis that demonstrates that the selected design approach will satisfy the HARM missile requirements for the transmitter assembly.

PHASE II: Develop a design for a prototype transmitter will satisfy the missile and operational requirements. Develop a methodology for characterizing active device assemblies for use in a high-power pulsed transmitter with a controlled chirp profile Assess Q-factor measurements and chirp characteristics to determine the frequency tuning behavior of the active devices and their package Q-factor in the MMW circuit. Fabricate and demonstrate three prototype 50-watt peak radio frequency (RF) output power, chirped solid-state W-Band pulsed transmitters that match a 30:1 compressive filter response and can produce chirped pulses of several hundred nanoseconds at a pulse repetition frequency (PRF) of several hundred kilohertz.

PHASE III: Fabricate six flight-worthy high power pulsed solid-state transmitter units compatible with the size and weight constraints of a gimbaled MMW transmitter for an air launched tactical missile. Evaluate units over the typical HARM missile environment including missile storage, transport, captive carry, and launch. An acceptable production yield for units meeting the high-output power with a pulse fidelity and chirp profiles will be a critical performance factor. Assuming the initial six flight-worthy high power transmitters prove satisfactory during operational testing and that they have acceptable production yields, it is anticipated that larger production contracts would follow the initial Phase III contract.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There are many applications for the high-power pulsed solid-state transmitters in the commercial industry. High-power short-pulse low-cost transmitters will serve as the enabling technology for the development of monitoring and detection systems for all-weather, day-and-night operations such as millimeter-wave imaging, airport surveillance, intrusion detection, and harbor traffic monitoring. Collision avoidance systems for the automotive industry are another potential application where low-cost short-pulsed solid-state MMW transmitters are needed.

REFERENCES:

1. DeLisio, Michael P., and York, Robert A. “Quasi-Optical and Spatial Power Combining.” IEEE Microwave Theory and Techniques, Special 50th Anniversary Issue, April 2001.
2. Ohata, Keiichi. “Millimeter-Wave IC Packaging Technology-State of the Art and Future Trends.” Photonic and Wireless Devices Research Laboratories, System Devices and Fundamental Research, NEC Corporation.
3. Ying, R. S. and Kuno, H. J. "W-Band Short Pulse IMPATT Diode Development." Final Technical Report, SBIR Phase II Contract No. N68936-00--0065, December 2002.
4. Behr, W., and Luy, J. F. “A High-Power Operation Mode of Pulsed IMPATT Diodes.” IEEE Electron Device Letters, Vol. 11, No. 5, 1990, pp. 206-208.

KEYWORDS: W-Band Chirped Transmitter; Short Pulse MMW Transmitters; Solid-State Transmitters; Radar; High Power MMW Transmitter; Low-Cost W-Band Transmitter

N05-111 TITLE: Electro-Optic (EO) Feature-Based Target Combat Identification (CID)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18E/F

OBJECTIVE: Provide a real-time capability, using existing EO sensor data, to perform feature-based target CID.

DESCRIPTION: Deterministic (rather than a heuristic based) real-time processing capability is required to accomplish computer CID (when applied to existing EO and new EO data sensors on airborne platforms). The physics and science behind EO sensors are significantly different from those behind all-weather sensors. Hence the theory for such CID algorithms is different and necessitates a different class of algorithms to address these issues.

One objective is to develop an approach that is not restricted to limited angles of approach to the targets. The computational requirements for this system must be relatively small (performing the computation quickly, requiring relatively small memory for any target database, etc.) thus enabling airborne CID. As a minimum, these system functions should be capable of being performed on a standard laptop computer. It is highly desirable that the process be highly independent (far more so than the current capability of camera independence) of the camera range or orientation relative to the target. The need for more camera independence than the current processes will enable the system to be used in GPS-denied regions. One of the long-term objectives is to reduce operator workload. Another of the long-term objectives should be a highly compressed representation of the target to enable sharing the target information with other on-board systems, with off-board air platforms, as well as with ship based/ground based systems (e.g., Tactical Control Station (TCS)). This feature is required to reduce the bandwidth needed for target transmissions and to enable use of existing processing and transmission (data link) hardware.

PHASE I: Develop and demonstrate a feasibility plan for deterministic (rather than heuristic based) real-time processing capability to accomplish computer CID and to demonstrate basic algorithm capability to identify objects/targets from EO sensor data.

PHASE II: Demonstrate algorithm and developmental system can perform CID on potential targets utilizing minimal EO sensor data; develop/demonstrate that this approach is not restricted to limited angles of approach to the objects/targets; demonstrate relatively small computational requirements of algorithm and developmental system; demonstrate a highly compressed representation of the object/target to enable sharing of this information and hence reducing the required bandwidth for the object/target transmissions; demonstrate algorithm and prototype system for the CID System enables automated onboard surveillance, reconnaissance, and identification data processing. Demonstrate algorithm and prototype system target CID, onboard platform decision-making, and reduction of operator/user workload utilizing demonstration airborne or ground integration assets (i.e., TCS type asset). Demonstrate that the process is independent of the camera range or orientation relative to the object/target so that the system can be used in GPS-denied regions. Demonstrate that the developmental system performs object/target recognition and object/target identification (CID, combat identification). Demonstrate that the developmental system can assist in facility and force protection.

PHASE III: The expected transitions are appropriate 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/tools for incorporation into existing/legacy systems and platforms. The database of objects will be developed in this phase.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The facility protection capability will be beneficial to the commercial security sector, the facilities protection and identification capabilities will be beneficial to Homeland Security as well as force protection in hostile areas, and the identification capabilities will be beneficial to rescue services.

REFERENCES:
1. Gleason, R., Grosshans, F., Hirsch, M., and Williams, R. M. "Algorithms for the Recognition of 2-D 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: Real-Time Image Processing; Object/Target Recognition and Identification; CID (Combat Identification); EO Feature-Based CID; Non-Template Based Target Identification; Reduced Bandwidth; Camera Orientation Independence; EO Images

N05-113 TITLE: Securing Training Objects and Records Management

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Investigate and develop a standard framework and scripting language that would allow the enterprise authentication management infrastructure (AMI) to be deployed efficiently in protecting and auditing training assets and records.

DESCRIPTION: In the training industry, widely dispersed training audiences (particularly for Web-based content) require various levels of access control to training materials. The use of smart cards, biometrics, and other tokens as security access/user identity verification keys provides an avenue not only to deliver the right distance learning applications to the right people, but also to provide a trusted audit trail for data modifications. Various AMI systems have emerged to help organizations manage the complexity associated with deploying complex, enterprise-wide authentication schemes involving identity tokens and biometrics.

Within the training and development communities, the learning management system (LMS) has also emerged as an important product category. The LMS not only allows organizations to more effectively and efficiently manage the vast amount of metadata associated with training activities (learners, courses, transcripts, test results, certifications, skills, etc.), but also to provide a standardized run-time environment for launch and management of Web-based learning materials. The Sharable Content Object Reference Model (SCORM) and Aviation Industry Computer Based Training Committee (AICC) standards have been developed to, among other things, facilitate the integration of Web-based learning content from multiple providers into a single organizational LMS.

There is, however, no standardized way to integrate the use of these strong authentication tokens (and the AMI products that provide this functionality) with the LMS that launches and tracks training and learners. It is up to each LMS to provide its own ad hoc authentication infrastructure, leading both to unnecessary management complexity, and to underuse of the security and traceability provided by Authentication Management Infrastructure systems.

PHASE I: Determine the feasibility of applying standardized authentication tokens to the SCORM compliant training packages and determine what access controls and security scripting techniques are needed for current DoD training programs and future advanced distributed learning programs.

PHASE II: Develop a framework and a scripting language to integrate AMI features into LMS packages. Identify a SCORM compliant training package with access control and verification requirements to demonstrate adaptability. Implement security extensions to the training package for data access and user identity verification.

PHASE III: Provide a full-scale demonstration of the proposed system across several SCORM training packages with on-site test subjects in a simulated operational environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is substantial, identified need for improved auditability of training information in the pharmaceutical and medical manufacturing industries. There is also a major move within the federal government to transition from training management systems that are paper based or in fragmented computer systems to integrated, on-line Learning Management System (e.g., Navy CNET eLearning, National Park Service, Bureau of Indian Affairs, Bureau of Land Management, U.S. Fish and Wildlife Service, Federal Law Enforcement Training Center). Improved and standardized data access control will become increasingly important as the scope of these implementations broadens.

REFERENCES:

1. Sharable Content Object Reference Model (SCORM). 2nd Edition, ADL Technical Team, 2004. http://www.adlnet.org/screens/shares/dsp_displayfile.cfm?fileid=1107.
2. "Information Systems Security." Realizing the Potential of C4I: Fundamental Challenge, Chapter 3. Washington, DC: National Academy Press, 1999.
3. Rankl, W., and Effing, W. Smart Card Handbook. New York, NY: Wiley, 2000.

4. Woodall, Dorman. Adopting E-Learning: Lessons from the Government. 2003. http://www.clomedia.com/content/templates/clo_feature.asp?articleid=166

KEYWORDS: Data Access Control; Authentication; Common Access Card; Biometrics; Distance Learning; SCORM

N05-114 TITLE: Precise Targeting of Tomahawk Cruise Missile Using Low-Cost, Low-Quality Miniature Unmanned Aerial Vehicle (UAV) Sensor Data

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Tactical Tomahawk

OBJECTIVE: The objective of this innovative research is to increase the speed and agility of Tomahawk Land Attack Missile (TLAM) targeting by increasing the pool of available sensors from which TLAM targeting-quality data can be derived.

Small, low cost, sensors are proliferating across the battle-space. Due to these characteristics, these sensors will implicitly provide greater persistence and awareness across the battlefield. These small UAVs will be part of the Navy's FORCEnet [1] persistent ISR capability and their data will be utilized in accordance with DoD's Net-Centric Data Strategy [2].

This SBIR will study how to use low quality sensor data from low cost Mini and Micro UAVs, such as those employed by forward deployed Army or Marine forces or force reconnaissance teams, to employ a high-quality, high-value weapon system. Connecting Soldiers and Marines, at the forefront of the Global War on Terrorism, with a weapon system generally employed in support of National Command Authority tasking is an example of the power of a truly netted force.

Mini and Micro UAVs, commonly the size of a large bird or model planes, are performing tactical reconnaissance for front-line units who are not normally plugged in to theater-level systems or their data, e.g. Global Hawk. Based on the Miniature UAV Combat Lesson-Learned outlined in Defense Update-International Online Defense Magazine (Year 2004-Issue 2)[3], they are used for unplanned reconnaissance missions responding to opportunities. They were used in combat operations to monitor bridges and routes, in addition to classifying vehicles. They are equipped with imaging and other sensors that can be useful to detect high value and time sensitive targets, or detecting threats to friendly forces.

DESCRIPTION: The Defense Update-International Online Defense Magazine (Year 2004-Issue 2) on Miniature Aerial Vehicles [4] explains that in recent conflicts, unmanned aerial vehicles proliferated for many types of missions. UAVs are employed for missions that include intelligence gathering for tactical and theater missions as well as for Homeland Security, e.g. border patrol. One can only imagine the huge impact of this additional set of sensor data within the net-centric enterprise architecture.

The article further states that smaller UAVs, such as Mini and Micro UAVs, are developed and deployed in support of tactical units, force reconnaissance teams and other forward deployed troops. These small UAVs are used to provide over-the-hill or around-the-corner intelligence to monitor and persistently sense the battlefield. The goals of these UAVs are to furnish real-time combat information especially in hard to monitor and/or remote areas with complex terrain or dense foliage as well as provide shared battlefield knowledge and situational awareness to the entire enterprise via the FORCEnet architecture.

Sensors onboard these small UAVs can consist of either video, framing electro-optical (EO) and/or Forward Looking Infrared (FLIR) sensors used for detection of concealed enemy forces in urban, forested or other hidden areas, and time sensitive targets [5, 6].

These developments, in conjunction with research into reduced power and volume requirements, will lead to increasing persistence (through increased numbers and capabilities) in sensing the battlefield with more-readily available UAVs. The trades in size and affordability however, typically come at the cost of the precision and accuracy inherent in the low density/high demand ISR assets (e.g. U-2).

Research is needed to determine the feasibility of using the onboard sensors deployed in miniature UAVs (e.g. the US Army Future Combat System (FCS) UAV) to generate timely and precise aimpoints for targeting of TLAM. Combined with the capabilities of Tactical TLAM, e.g. the ability to loiter near a potential target area, this adaptation of net-centric operations brings together previously unconnected nodes as part of the same process. Furthermore, we should investigate the role of other than imaging sensor data (the traditional source of TLAM targeting information) to increase the number of sensors available (i.e. greater persistence and agility) and provide additional dimensions to the confidence and precision of TLAM targeting information.

PHASE I: Research mini and micro UAV sensor characteristics and define overall data processing flow within the context of Forcenet and other enterprise architectures. Define minimal sensor resolution requirements to generate precise aimpoints. Also study contribution of additionally available sensor data to enhance aimpoint precision and accuracy.

PHASE II: Prototype the overall sensor processing within a proof-of-concept processing architecture approach. Optimize performance and tune algorithms and data processing based on demonstration results.

PHASE III: Integrate mini and micro UAV sensor data in net-centric enterprise computation to generate precise and timely aimpoints and communicate them to the appropriate Precision Guided Munition or loitering TLAM for strike execution.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability can be applied to the commercial market sector in a wide range of applications that require accuracy and precision, e.g. remote sensing, that may include battling forest fires, pollution cleanup, natural disaster response, and assist law enforcement activities. Coastline, harbor and border monitoring are but a few potential Homeland Security applications.

REFERENCES:
[1] http://www.chinfo.navy.mil/navpalib/policy/forcenet/forcenet21.pdf
[2] “DoD Net-Centric Data Strategy,” DoD Memorandum, dtd 9 MAY 03
[3] http://www.defense-update.com/features/du-2-04/mav-oif.htm
[4] http://www.defense-update.com/features/du-2-04/feature-mav.htm
[5] http://www.uavworld.com/_disc1/0000010b.htm
[6] http://www.vectorsite.net/twuav6.html

KEYWORDS: Sensor data exploitation, Sensor Characteristics, Precision Strike and Targeting, Imagery Exploitation, Net Centric Warfare, Enterprise Architecture, FORCEnet.

N05-115 TITLE: Miniaturization of an Optical Fiber Bragg Grating Sensor Interrogator

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: Tactical Tomahawk

OBJECTIVE: Develop a miniature optical fiber Bragg grating sensor interrogator sufficiently small and with low power consumption to be incorporated into a tactical solid fuel rocket motor.

DESCRIPTION: A significant issue in ordnance safety and reliability is determining the integrity of ordnance. For this reason, much ordnance of the future, such as tactical missile solid rocket motors, will be instrumented with embedded sensors to provide a real-time indication of system health. Optical fiber Bragg grating sensors are some of the most promising types of sensors being considered for this application, due to their light weight and immunity to electromagnetic interference. However, commercial optical fiber Bragg grating sensor interrogators are bench-sized units weighing several pounds, and are too heavy and large to be permanently attached to a tactical missile. It is believed that an interrogator that is much lighter and smaller can be built. Such an interrogator can be based on an all optical fiber technology, similar to that used in the intelligent fiber optic system (IFOS) current sensor interrogation system, or it can be based on using integrated optics. It must be capable of interrogating a single optical fiber containing five sensors, weigh less than 0.25 pounds (excluding power supply), take up less space than 5 cubic inches, and have no moving parts. The interrogator must operate over the wavelength band between 1520 and 1570 nm, have a wavelength resolution of at least 5 pm, and be able to obtain data at a rate of at least 2 kHz.

PHASE I: Determine the feasibility of developing an optical fiber Bragg grating sensor interrogator that meets all of the requirements stated above.

PHASE II: Develop a prototype of the proposed optical fiber Bragg grating sensor based on either optical fiber technology or integrated optics and demonstrate its ability to meet the requirements.

PHASE III: Install the interrogator on a tactical missile solid rocket motor and field test aboard a naval vessel. The purposes of the test are to verify that the interrogator is sufficiently robust to survive lengthy periods on board ship and to resolve issues regarding integration of the interrogator with embedded sensors and on-board communication networks.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The miniaturized interrogator will find use in health monitoring of civil structures, such as bridges and roads, and in the oil field industries. Both of these applications currently use optical fiber sensors.

REFERENCES:
1.www.photonics.com/spectra/tech/XQ/ASP/techid.684/QX/read.htm

KEYWORDS: Bragg; Optical Fiber; Sensor; Interrogator; Health Monitoring; Detector

N05-116 TITLE: <u>Low-Cost Field-Installable Fiber Optic Cable Restoration (post splicing)</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18E/F

OBJECTIVE: Develop the materials, tooling, and methodology for restoration of the mechanical structure (enclosure) of a fiber optic cable post splicing in the field. The resulting restoration kit must be lightweight and implementable by a single aerospace technician within a short period of time (e.g., less than two hours).

DESCRIPTION: A cable repair kit is needed to provide an individual with an intuitive capability to join fractured or severed fibers that have rendered an optical fiber link discontinuous or inoperable. The kit’s materials and tools must supply an entry level technician with the know how and tooling to enter a cable mid-span, prepare and secure the spliced optical fiber (already mechanically or fusion spliced to restore the sub-micron optical alignment), and environmentally seal the closure. Highly innovative new material systems and technology solutions are sought that will minimize the materials, tooling and practices necessary for restoration and maximize the transparency (look, performance, handling) to the original cable. Also, the extension of the solution to restoration of electrical connections is highly desirable.

First and foremost, the solution must restore the mechanical structure of the cable. It must be able to maintain the optical performance of the splice and survive in the environment in which the cable is installed on an aircraft, which includes exposure to the full temperature and humidity range for military aerospace as well as the full range of unusual environments like salt spray, sand and dust, pressure, and fog. It also includes the forces involved in shock and vibration. (Refer to MIL-STD-810F and MIL-STD-1344 for details on the various testing requirements.) Second, it should restore the cable size and shape as closely as possible so that it can fit into the same locations as the original cable without special support. Third, a transparent replacement for the original is highly desirable. This includes tolerating the minimum bend radius of the original cable as closely as possible. Fourth, application of the solution to electrical cable restoration would be highly desirable. There is significant side benefit if this solution results in the minimization of the materials, tooling, and training for maintenance practices required by the Fleet. Consequently, key success criteria will include cost, handleabilty, insertion loss, mechanical agility and easy of installation efficacy.

PHASE I: Evaluate the feasibility of the proposed solution, which must be low cost and provide high-performance restoration of the mechanical structure of a fiber-optic cable post slicing in the field. The proposed solution must also meet all of the stated optical, mechanical, and environmental performance objectives stated above.

PHASE II: Develop one or more prototypes of the recommended solution(s) and evaluate to determine whether they will meet the fabrication, environmental, and performance requirements. Fabricate sufficient samples of the final design for thorough evaluation.

PHASE III: Work with the Government, standards organizations, and military/aerospace contractors to commercialize the cable restoration system and facilitate the widespread use of this fiber optic cable repair techniques.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: When successful, this cable restoration kit should see application throughout the fiber optic industry. The cable restoration kit developed under this topic will be utilized to repair broken optical cables on Naval, Army, Air Force, and Coast Guard aircraft platforms as well as in commercial aviation. Technologies spawned from these development efforts can be cross-utilized in the telecommunications market place as well.

REFERENCES:
1. MIL-STD-810F, Test Method Standard for Environmental Engineering Considerations and Laboratory Test.
2. MIL-STD-1344, Test Method for Electrical Connectors.

KEYWORDS: Fiber-Optics; Splice; Repair and Maintenance; Installation Practices; Cable Repair Kit; Restoration Equipment

N05-117 TITLE: Fleet-Wide Variability for an Integrated Flight and Propulsion System

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop a methodology and toolset to quantify the impact of component dynamic performance variability across a fleet of integrated flight and propulsion control systems.

DESCRIPTION: Advanced aircraft are increasingly using propulsion systems for flight control. The flight control type specifications for an integrated propulsion system challenge the ability to guarantee dynamic performance, for full life, across a fleet of aircraft. Past field data do not support the verification of such requirements and the only performance data available must be derived from large, complex models. The size and complexity of these parameterized engine models, while locally linearizable and low order, make them averse to a standard Monte Carlo analysis of their dynamic variability. There are on the order of 10 continuously variable engine physics based parameters reflecting fleet variability. An additional source of complexity is a feedback controller selected from a fixed but large (thousands) set of candidate controllers reflecting the operating condition. Performance criteria used for variability analysis should include but not be limited to variability in dynamic and steady-state responses of thrust, control moments and forces; control of propulsion system limits; closed-loop stability margins; and propulsion system failure modes and failure rates and service life.

As a specific example, for the short takeoff and vertical landing (STOVL) variant of JSF, the engine requirements include frequency response, input-output characteristics, cross coupling levels, and hysteresis. Existing nonlinear aero-thermal models of the propulsion system can generate high-confidence representations of the propulsion system as a function of input variability parameters.

PHASE I: Evaluate the feasibility of developing a methodology and toolset to quantify the impact of component dynamic performance variability across a fleet of integrated flight and propulsion control systems. The evaluation should include the analytical feasibility assessment of a representatively complex high bandwidth propulsion control problem.

PHASE II: Demonstrate the applicability of the proposed approach on both a representative problem as well as one where an analytical solution is achievable. Representative problem must be scaleable to a full-sized integrated flight and propulsion control system.

PHASE III: Develop, validate, and deliver variability analysis on a representative simulation of a JSF STOVL fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These advanced techniques would be applicable to evaluating the dynamic variability across a fleet of any integrated flight and propulsion control system.

REFERENCES:
1. Springer-Verlag. Advanced Techniques for Clearance of Flight Control Laws. ISBN 3-540-44054-2, September 2002.

KEYWORDS: Multi-Variable Control; Dynamic Variability; Parameterized Model; Integrated Flight and Dynamic Performance; Input Variability; Propulsion Control

N05-118 TITLE: Radar Centroid Processing Algorithm with Tracker Feedback

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: E-2 Advanced Hawkeye

OBJECTIVE: Develop a new radar centroid processing algorithm that improves the measurement information extracted from the raw detection data through the use of modern estimation techniques with tracking system feedback.

DESCRIPTION: The processors in current radar systems perform centroid processing to combine adjacent active range-bearing cells to make object reports used by the tracker. When targets are closely spaced (e.g., formation flying, close-air combat, or high congestion areas), the centroid processor will combine the cells and form one "merged measurement" report. The merged measurement is effectively a biased report and, because the number of measurements is less than the number of targets, it depletes the information available to the tracking system. The result is track degradation and/or track drop. In the present approach, when forming the measurement report no prior track information (i.e., the close proximity of multiple targets) is utilized by the centroid processor. This research effort will develop a new radar centroid processing technique that utilizes feedback from the tracker (to possibly include data from other onboard and off-board sensors) that enables the processor to "break up" merged measurements and thus support a consistent track picture.

PHASE I: Develop a concept centroid processing algorithm with tracker feedback and show the algorithm feasibility through a demonstration with simulated data.

PHASE II: Fully develop the methodology and software for the radar centroid processing algorithm with tracker feedback and demonstrate its performance benefits over the existing approach using validated radar data sets.

PHASE III: Integrate the centroid processing algorithm into a hardware-in-the-loop simulator and demonstrate the capabilities in a real-time mode.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercially available surveillance radars for law enforcement and air/sea traffic control require identical signal processing capabilities.

An advanced centroid processing algorithm improves tracking capabilities and thus enhances the operator target awareness and traffic management capacity.

REFERENCES:
1. Bernstein, R. "An Analysis of Angular Accuracy in Search Radar." IRE National Convention Record, Vol. 3, No. 5, 1955, pp. 61-78.
2. 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. 649-653.
3. 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 1982, pp. 416-422.
4. Slocumb, B. J. "Surveillance Radar Range-Bearing Centroid Processing." Proceedings of the SPIE, Vol. 4473, August 2001, pp. 74-85.

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

N05-119 TITLE: <u>High Altitude Non-Acoustic Antisubmarine Warfare (ASW)</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop innovative approaches to conduct ASW search, track and localization using non-acoustic means.

DESCRIPTION: Current acoustic ASW sensors rely primarily on active transmissions to detect, track, and localize submarines. Using active emanations can alert the submarine to the presence of the aircraft and allow evasive maneuvering and/or use of countermeasures to thwart the prosecution. Non-acoustic sensors such as magnetic anomaly detection (MAD) and extremely low frequency (ELF) electromagnetics provide some capability to detect, track, and localize. However, these sensors must be operated at low altitudes or use in-water sensors. Other electro-optic concepts and technologies can be used to permit ASW prosecution from high altitudes (greater than 20,000 feet). Examples of such concepts could include use of lidar systems, multispectral camera systems, unmanned air vehicles (UAVs), or mobile underwater autonomous vehicles launched from a high-flying aircraft. Improvement to devices and technologies for these systems should be considered.

PHASE I: Develop devices and technologies to address the use of non-acoustic sensors to conduct ASW missions from high altitude. Develop initial designs and performance estimates for technology that can be used to improve these sensors.

PHASE II: Develop prototype devices or technologies identified as highest potential for success. Conduct laboratory testing to measure the performance of the devices and technologies. Some limited production and testing of the devices or technologies should be included.

PHASE III: Develop a full-up production capability of the devices or technology so that they can be used in Navy ASW systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Innovative concepts and technologies for improving non-acoustic sensing should provide increased performance in many E/O systems. Applications include atmospheric and ocean environmental monitoring for these systems. The improvements in devices and technologies could also be used for improved medical imaging and diagnostic systems.

REFERENCES:
1. Contarino, M., and Allocca, D. M. "Review of Airborne Oceanographic LIDAR." JUA(USN), Vol. 50, April 2000, pp. 461-463.

KEYWORDS: Antisubmarine Warfare; Laser Radar; Detector; Filter; Multispectral Imaging; Non-Acoustic

N05-120 TITLE: Nondestructive Measurement of Cold-Working Effectiveness at Fastener Holes

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop innovative methods/technologies for quantifying the effectiveness of fastener hole cold-working using nondestructive inspection (NDI) equipment that is portable, lightweight, and capable of mapping the residual stresses in and around a fastener hole.

DESCRIPTION: The Navy commonly uses fastener hole cold-working to enhance the fatigue life of primary structures. This process has controls that should produce residual compressive stresses around the holes that retard crack initiation and small crack growth. Unfortunately, no tool exists to quantitatively assess the effectiveness of the process. Use of the wrong expansion tool, out-of-round holes, poor hole quality, and other factors can reduce the effectiveness of the process. While the process should prevent these factors from occurring, the Navy recognizes the potential for them to creep into the process. For this reason, a tool is desired to provide a check on the process. The primary material target is aircraft aluminum with holes ranging from 3/16" to 1" in diameter.

PHASE I: Determine the feasibility of measuring and mapping residual stresses in aluminum in a small area. Volumetric mapping is preferred, but surface will be considered. The phase I substrate should be a common aircraft aluminum alloy like 7075-T6.

PHASE II: Construct a prototype and field test. The prototype should be portable, light, and capable of producing two-dimensional maps of the residual stresses on the surface of the part around the hole.

PHASE III: Implement full-scale production of the NDE devices.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of an innovative NDE device for measuring cold-working effectiveness is of interest to commercial and military industries.

REFERENCES:
1. MIL-HDBK-5
2. Kaplan, Mitchell P., and Wolff, Timothy A. "Life Extension and Damage Tolerance of Aircraft." Aviation Today, 20 December 2004, Willis & Kaplan, Inc.
3. Rice, Richard C. "Fatigue Data Analysis." Metals Handbook, Vol. 8, ASM, 1985, pp. 695-720.

KEYWORDS: Cold Working; Quality; Inspection; Residual Stress; Nondestructive Inspection; Nondestructive Testing

N05-121 TITLE: Flight Termination Systems Study for High Power Laser / Microwave Engagements

TECHNOLOGY AREAS: Weapons

OBJECTIVE: To determine a consistent and methodical approach to the design of hardening parameters that safety systems will require when subjected to Directed Energy Testing at destructive levels.

DESCRIPTION: As Directed Energy Weapons and associated testing near reality, the need for safety systems that are hardened for operation in a test environment are becoming necessary. To date the limited availability of higher energy level sources have largely negated the need for systems to ensure safety of a test. Directed Energy poses some unique problems when traditional expertise and systems used to provide for vehicle destruct and containment during a test are used as the basis for safety systems. Typical systems are vulnerable to both the heating affects of lasers and the high power microwave pulses that will be the defeating mechanisms used in directed energy testing. Current standards in use as reference criteria for safety systems do not address means to prevent failure of critical safety systems meant to protect high value assets and human life. Efforts to date have largely consisted of rudimentary measures meant to preserve current system designs without the benefit of engineering data to support use of particular methods. By no means do methods practiced to date provide for a future methodology or a systematic understanding of the effects or the means to prevent disablement of the safety systems. By use of consistent material, packaging and engineering practice, a means to augment the current standards can be formalized. It is expected that such a database of derived engineering expertise would form the basis for models that may be used to simulate the interaction of directed energy with the suite of targets, vehicles and ancillary systems used to support live testing.

PHASE I: Investigate past and current systems with projected use in directed energy testing. Assess the availability of techniques, materials and engineering of safety systems to determine possible solutions to shortfalls. Validate and develop a systematic means to assess proposed systems and provide for concept document(s) for future systems. Develop a catalog of common materials and the expected power levels necessary to cause failure. Provide for commonality documents input for current Range Commanders Council with associated concurrence from projected use areas and test ranges.

PHASE II: Validate by actual hardware test, the vulnerability or defined hardness of common systems to directed energy exposure both laser and microwave. Provide for the incorporation of methods into current Navy targets and test scenarios by issuance of common guidance and standards. Assist in the validation of models for assessment of systems vulnerability prior to hardware development for new or projected systems. Define methods for failsafe protection of critical components and associated exposure criteria with measurement instrumentation for development of industry standard incorporation of defined methods of protection. Publish and provide for addendum to current RCC-319-99 documentation incorporating revised criteria for directed energy testing safety systems.

PHASE III: Demonstrate production capabilities for hardened safety systems incorporation onto common use targets and test platforms. Provide for industry incorporation and involvement in providing for hardware with directed energy functional hardening.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These systems can be utilized by commercial, educational, and military organizations involved in pulsed-power, high-voltage, laser and general electromagnetic research and development performed with inherent risk to personnel or property caused by loss of target systems control as a function of the test.

KEYWORDS: Commonality Standards Range Commanders Council; Laser, Directed Energy, Pulse Microwave; Pulsed-Power; Laser Material Vulnerability, Electromagnetic Pulse Damage; Termination systems; Flight Safety Systems, High-Power Microwave.

N05-122 TITLE: Autonomous Aircraft Tracking Aboard Carriers

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop technologies for automatically tracking aircraft unambiguously and in all weather on the flight and hangar decks of aircraft carriers.

DESCRIPTION: The Navy needs a modernized and integrated way of tracking aircraft status and location aboard the carriers. Currently, aircraft are tracked by manually manipulating templates on flight and hangar deck scale models (the “Ouija board”). The managers of the boards continually receive their inputs from sound powered phones, “sneaker net”, or visually. This method is manually intensive and subject to numerous human errors. The Ouija board is managed in Flight Deck Control and there is no connectivity to other ship personnel. This requires other ship organizations to conduct aircraft tracking independently. There are current efforts to “digitize” the Ouija board, i.e. provide a workstation, provide network connectivity throughout the ship, and develop a user interface, but these systems still require manual input. This topic is seeking technologies to automatically obtain aircraft position and orientation tracking data, specifically aircraft identification (by aircraft type and side number), location and orientation, in real-time for all aircraft, mobile and stationary, on the flight and hangar decks. Such an automated tracking system would save workload, and result in more accurate and current data. Additionally, this topic is seeking only those concepts that do not employ a “machine vision” based approach, which is being investigated under a separate contract.

Any potential approach would have to work in the carrier environment. Challenges to an electrical/RF solution include the considerable amount of electromagnetic and radio frequency interference generated by the ship's radar, the need to control emissions and minimize the probability of detection, and ship motion. There can be up to 50 aircraft on the carrier flight deck and 25 in the hangar bays. Multiple aircraft may be taxiing at any one time. There are numerous fixed and mobile objects, including the island structure, support equipment, people and other aircraft, which could partially occlude aircraft and be a challenge for any line of sight solution. Many of these objects are metal, which could potentially cause multi-path problems. In order to provide useful information to the Aircraft Handling Officer for flight deck and hangar bay management, accuracy should be within +/- 1 foot for location and +/- a few degrees in heading orientation. Proposed approaches that require installing hardware on aircraft or the ship will be considered. Any hardware installed on aircraft must be very small and light, so that placement will not interfere with operations or require unnecessary flight qualities certification. It must survive exposure to weather, salt water, extreme heat and cold, physical contact, fuel, solvents, hydraulic fluid, and the full flight envelope of the host aircraft. Battery life must be of sufficient length; several years are desirable. Tapping the aircraft power supply is not permitted. Transmit/receive ranges should be of sufficient distance to allow the minimum number of fixed receivers to be installed on the carrier. Ranges in excess of 600 feet are desirable.

While aircraft location and orientation are the primary data desired, proposals that additionally address automatic transmission of other data required by the Ouija board will be given special consideration. This data includes: aircraft condition/maintenance status, fuel load, ordnance load, and mission.

PHASE I: Conduct a study which develops a concept for automatic aircraft tracking and assesses the feasibility of that concept. Identify technical issues related to the application, provide solutions to those issues, and prove those solutions are viable, either through analysis or lab demo (lab demo is preferred, if possible). Provide a cost assessment, including (if applicable) hardware and install costs for outfitting 12 aircraft carriers and the approximately 800 carrier-based aircraft in the Navy inventory. Provide an assessment on whether flight qualities certification would be required. Provide an assessment of predicted reliability, battery life (if applicable) and range.

PHASE II: Develop a prototype system and demonstrate the concept in an operationally representative environment. The demonstration should be with aircraft, and the environment may be a land-based facility or shipboard, depending on the complexity of the concept and its integration into the ship.

PHASE III: Conduct EMD and produce the full system as demonstrated in Phase II. A successful system could be transitioned to NAVSEA PMS-312 for retrofit to existing CV/CVN's, and PMS-378 for integration into the CVN-21 future carrier.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technologies developed under this topic could benefit a wide range of commercial applications where items need to be tracked, including warehousing and inventory management. Specific aircraft tracking technologies could be used for ground control at commercial airports.

KEYWORDS: Aircraft tracking; Inventory management; Warehousing technologies

N05-123 TITLE: A Fault-Tolerant Real-Time CORBA Naming Service

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a fault-tolerant real-time CORBA naming service

DESCRIPTION: Defense applications must be fault-tolerant; they must deliver reliable functionality even in the face of unexpected occurrences and environments. Yet in many cases these same applications must deliver real-time performance, where it is critically important that actions be performed within a certain timeframe. There is a natural tension between these two requirements: recovery from faults is bought at the price of extra execution time, impacting the ability to ensure real-time behavior.
The Common Object Request Broker Architecture (CORBA) is a prominent technology for the development of distributed systems in the defense sector and elsewhere. Efforts have been made by industry and standards

organizations to introduce both fault-tolerant and real-time variants of CORBA. To some extent the effects have been successful, but to date no one has managed to make progress on development of a CORBA variant that integrates fault tolerance with real-time performance in the same product. A CORBA naming service with real-time and fault-tolerant properties would constitute a significant innovative advancement, one which would pave the way for other CORBA technology components to follow.

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

Also, supply a plan for demonstrating that the product meets the requirements for a CORBA naming service, as well as for demonstrating that the product fulfills the goals of fault tolerance and real-time performance.

PHASE II: Use the artifacts of Phase I to develop a fault-tolerant real-time CORBA naming service. Demonstrate that the product is in fact a functional CORBA naming service. Then demonstrate that the product satisfies its requirements for delivering both fault-tolerant and real-time behavior.

PHASE III: Work with Object Request Broker (ORB) vendors to incorporate the fault-tolerant real-time CORBA naming service into a CORBA implementation featuring fault-tolerant and real-time properties. The resulting implementation should be fully functional, offering the potential for commercialization of a product that will offer considerable value for the creation of distributed applications where reliability and time-deterministic behavior are essential. Work to develop open standards for this technology, engaging standards organizations such as the Object Management Group (OMG).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The need for real-time fault-tolerant middleware goes far beyond Defense warfare systems. Such a technology would be of great value in any distributed application where both reliability and time-deterministic performance are critical as in nuclear power monitoring and coordination of railway traffic.

REFERENCES:

1. http://www.omg.org/docs/realtime/03-11-14.ppt
2. http://www.cs.wustl.edu/~schmidt/PDF/CCJ-2002.pdf

KEYWORDS: CORBA; Real-time; Fault Tolerance; Naming Service; ORB; Distribution Middleware

N05-124 TITLE: <u>Fluid diffusion resistance coatings for Radomes</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

OBJECTIVE: Design and develop suitable materials and application processes for coating tactical missile radomes to ensure that moisture does not diffuse into the system. Coatings must exhibit zero to near zero diffusion rates and prevent moisture ingress for 10 years. The coatings must withstand thermal cycling and temperature extremes of missile storage conditions and also captive carry conditions aboard fighter aircraft. Current technologies, some based on silicones, are inadequate due to degradation in service and also have diffusion rates five times greater than the requirement.

The method should be adaptable so that the coatings are applicable on the double-curved surface without stress fractures or chance of damage to allow leaking. The process needs to allow for additional coatings (paint, rain erosion and others) to adhere without degrading the bonding of these coatings.

DESCRIPTION: Diffusion resistant coatings can be used for multiple systems across multiple services. Cost for the final applied product should be considered as part of the design constraints. The preferred methods for application are spraying or dip coating to ensure a consistent thin coat. Electrical properties need to be a consideration in the development in any protective coating on a radome. Coatings will be required for both ceramics and organic polymer composites. It is not required that a single coating need be applicable to both; separate techniques for ceramics and polymers are acceptable.

PHASE I: Identify candidate coating materials. Develop coating technologies suitable for polymer composite and ceramic radome materials. Demonstrate feasibility of candidate coatings on test coupons of typical radome materials. Demonstrate feasibility of coating curved surfaces. Verify that coating process has not degraded the properties of substrate materials, and that coatings have appropriate properties. Construct a detailed development plan, which includes anticipated technology and any tradeoffs, schedule and required budgets.

PHASE II: Develop coating process for full scale radomes. Coat a number of ceramic and polymer composite radomes and conduct radome qualification tests. Conduct moisture diffusion tests. Perform coating-related tests including adhesion, erosion, and thermal cycling. Test adhesion of overcoatings (paint, etc.) to experimental coatings.

PHASE III: Scale up technology to industrial scale suitable to coating several thousand radomes. Coat a small number of production radomes and perform complete qualification tests, including RF and aerothermal tests. Perform at-sea fleet testing on the coated radomes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is extensive commercial potential in ceramic automotive, composite automotive and other systems for electronics protection from fluid diffusion.

REFERENCES:
http://www.fas.org/man/dod-101/sys/missile/
http://www.ceradyne-thermo.com/Products/Radomes.asp

KEYWORDS: radomes; coatings; diffusion resistant; ceramics; organic polymer composites; dielectric

N05-125 TITLE: Compact Towed Sonar Array

TECHNOLOGY AREAS:

OBJECTIVE: Develop a low volume, lightweight, low cost, towed line array sonar system that will provide improved operational flexibility, performance, and reliability on submarines, surface ships, and unmanned platforms.

DESCRIPTION: Towed passive sonar arrays have been used in Navy submarines and surface ships for decades. Due to minimum stowage space, the need exists for a reduced volume, towed single-line array to be deployed from submarines, surface ships, and off-board vehicles such as UUVs and USVs. The critical design parameters in the design of the new towed system are: reduced storage volume, small bending radius, low cost, acoustic performance comparable to existing Navy tactical towed arrays, left-right contact resolution capability, mechanical/vibrational noise mitigation, small “dry end” volume, reduced power requirements, and environmental operating constraints.

Present towed arrays are too large to be compatible with these requirements and a reduced diameter (0.75 in. or less) array will enable reduced storage volume and bend radius. Reduced array diameter is likely to increase the array’s susceptibility to mechanical and vibrational noise during normal operations; some type of noise mitigation processing may be required to meet acoustic performance goals. The incorporation of directional sensors in the array may be considered for left-right contact resolution and noise mitigation.

The “dry end” subsystem should include a power supply, and data receiving/formatting/processing capability. The “dry end” components must also be small volume, high reliability, low cost, and compatible with the marine environmental constraints of UUVs or USVs.

The system design should minimize power requirements for operation, since there is limited available power on small unmanned vehicles. The system should be designed to be modular in implementation. Quick removal and installation on multiple types of vehicles is required to support operational concepts.

The system should be designed to minimize overall system costs; automated array construction techniques may be considered in addition to other cost reduction methods

PHASE I: Develop a specification and candidate design concepts that addresses the towed sonar performance, the mechanical configuration, including tow cable and handling system, and signal processing.

PHASE II: Develop, build and test prototype system/subsystem designs. Designs will be evaluated and recommendations for improvements will be submitted as part of the final test report. The prototype design should demonstrate that it could meet the required performance specifications, particularly the sonar performance, size, and weight. Demonstrate the effectiveness of the prototype in a simulated at-sea environment.

PHASE III: A specification will be developed for final system design. A final system will be purchased for evaluation at-sea on board unmanned platforms, submarines, and/or surface ships. The contractor will provide Design Certification Test Procedures. These should include tension, pressure, and temperature cycling, bend over sheave cycling, and reeling cycles on a reeling test stand, as appropriate.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Offshore, “seismic” petroleum exploration: Offshore, i.e. underwater, oil exploration is frequently accomplished today using acoustic signals projected from arrays of air-guns towed behind research vessels. The acoustic pulse reflects from the stratified layers in the ocean floor and is received back at the research vessel with towed line arrays of acoustic sensors. Analysis of the returned acoustic signal indicates the presence or absence of petroleum.

REFERENCES:
1. Urick, R. J., Principles of Underwater Sound for Engineers, New York: McGraw-Hill Book Company, 1967.
2. William S. Burdic, Underwater Acoustic System Analysis, New Jersey: Prentice-Hall, Inc., 1991.

KEYWORDS: sonar; reduced diameter towed array; UUV; USV; mechanical/vibrational noise mitigation; directional sensors; automated array construction techniques

N05-126 TITLE: Low-Cost Composite Sonar Dome Window for SQS-53

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: The purpose of this topic is to develop and test innovative, low-cost composite sonar dome window materials that will replace the current rubber window material that is used for the SQS-53. The composite window is expected to have superior mechanical and acoustic properties and be manufactured at a much lower cost than the current rubber window.

DESCRIPTION: The current rubber window that houses the SQS-53 Sonar System on Destroyers and Cruisers is expensive, difficult to manufacture and has poor structural properties. Additionally, the rubber window is highly susceptible to at-sea and pier-side damage, and is difficult to repair. This topic is intended to address these shortfalls by developing, manufacturing, and testing, a full-scale composite sonar dome. A key aspect of the topic will be to optimize the acoustic and structural properties of the dome, in order to maximize structural integrity, and minimize acoustic insertion loss. A description of the SQS-53C sonar system and associated dome may be found at WWW2.janes.com under the category of Jane's Underwater Warfare Sytems. A search under the category "53C Sonar Dome" is a quick method for obtaining this information, which will provide an understanding of the sonar sytem with which this new composite dome must operate.

PHASE I: Design and develop sample composite sonar dome window materials and conduct modeling for acoustic/mechanical properties and material testing.

PHASE II: Design and build a full scale prototype composite 53 sonar dome window and conduct and document laboratory acoustic and structural tests.

PHASE III: Conduct structural, acoustic and pressure testing on the prototype composite 53 sonar dome, and develop a plan for installation aboard a Destroyer or Cruiser and support the opportunity to conduct ship-board testing. Based on results, potentially support fleet introduction.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of this sonar dome will provide the private sector with innovative composite materials that have good structural and acoustic properties. These types of materials have applications in the medical industry, oil exploration industry and in the commercial fishing industry.

REFERENCES:
1. Kinsler, L.E., Frey, A.R., Coppens, A.B. and Sanders, J.V. Fundamentals of Acoustics, John Wiley & Sons, New York, Third Edition, 1982, pp. 127-131.

2. Urick, R.J. Principles of Underwater Sound, McGraw-Hill, New York, Third Edition, 1983, pp. 367-370.

3. Jane's Underwater Warfare Systems Online Webpage (WWW2.Janes.com). Search topic "53C Sonar Dome."

KEYWORDS: Sonar; Domes; Composites; Acoustics; Arrays; Materials; SQS-53C Sonar

N05-127 TITLE: Common Reusable Open Architecture Under-Sea Warfare Mission Package Infrastructure

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop a common Mission Package Infrastructure that allows USW capability to be seamlessly reused across various surface combatants. This mission package infrastructure will be architectural and hardware independent, thus allowing integration into multiple-disparate surface ships including, but not limited to DDG, CG, FFG, DD(X), CG(X), and LCS.

DESCRIPTION: A coalition of universities, Navy laboratories, Navy fleet representatives and industry partners, are rapidly developing and fielding new and innovative USW sensor and processing capabilities through the use of a modular, open systems spiral development model known as the Peer Review Process (PRP). The PRP is a 3-step build-test-build technology development model, which quantitatively evaluates and incorporates “Best-of-Breed” capabilities, developed by the submarine, surface, surveillance, air ASW, and mine warfare communities. The “mission package infrastructure” (MPI) architecture needs to be developed in a modular fashion to isolate functional segment improvements from specific ship systems and sensor peculiarities. This isolation, in effect, will allow the signal processing improvements to be developed to well defined and behaved ‘black box’ interfaces and then re-inserted into the “mission package infrastructure” essentially as plug and play components, independent of the platform hardware and software architecture. The net result is that a significantly larger portion of the available Peer Review Process(PRP)/Advanced Processing Build (APB) investment dollar goes directly to war fighter improvements rather than to integration and reintegration efforts. This ensures a manageable way of delivering best of breed warfighting improvements across all ship types. MPI will allow the host platform to decide how tightly or loosely coupled the mission package integration will be, while maintaining an Open Architecture (OA) and Total Ship Compute Environment (TSCE) paradigm.

PHASE I: Assess and document the feasibility and utility of a Mission Package Infrastructure (MPI). Describe the selected approach to be taken in effectively and efficiently providing warfighting improvements to a range of ship classes. To maintain an OA and TSCE paradigm, investigate an approach using the Object Management Group (OMG) Data Distribution Services (DDS) standard.

PHASE II: Develop and demonstrate a prototype Mission Package Infrastructure (MPI) that seamlessly integrates USW PRP software into IPS, DD(X) and LCS architectures.

PHASE III: Fully develop, integrate and test the Mission Package Infrastructure (MPI) with the full breadth of PRP/APB technology. Complete EMD and transition MPI into the IPS, DD(X) and LCS Program of Records (PORs).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This hardware independent open architecture mission package infrastructure would be very beneficial to corporations that need to maintain the modular open systems spiral development model to remain viable. Homeland Security systems currently deployed and under development will require this modular architecture since they also consist of systems of various sensor types. This applies to harbors and ports, as well as facility perimeters (power plants, oil refineries, train yards, etc.) and other critical asset protection.

REFERENCES:
1. J. Ackenhusen, "Real-Time Signal Processing", Prentice Hall, Englewood Cliffs, NJ, 1999
2. PEO IWS, "rapid Capability Insertion Process", Version 4.1, 2004

KEYWORDS: Open Architecture; Total Ship Compute Environment; Mission Package Infrastructure; Combat System Infrastructure, Data Distribution System

N05-128 TITLE: Automated Mine Neutralization Vehicle

TECHNOLOGY AREAS: Air Platform, Information Systems, Ground/Sea Vehicles

OBJECTIVE: Develop a Near Term method for neutralization of volume and proud mines in shallow and very shallow water environments. This capability will advance the end to end organic mine countermeasures mission by neutralizing mine threats in a flexible and cost effective method.

DESCRIPTION: Rapid progress is being made in developing and fielding UUVs, airborne systems, and dedicated ships capable of searching for and locating sea mines. However, little work has been done to automate the neutralization of mines. Current fleet capability requires a manned team to enter the water and physically attach the neutralization charges to the mine, which are very hazardous to human lives. The other method requires manned team to drive a boat into the minefield and deploy a marine mammal to attach a charge. The littoral environment is difficult for vehicle operations. Poor acoustic communication, large directionally varying currents, and constantly changing bottom significantly complicate sensor and vehicle design. New technology development is needed to create low cost, small, accurate navigation and autonomous system that will robustly operate in the littoral environment. Development of a small, cost-effective automated, one-use mine neutralization vehicle would significantly decrease the risk to human life and decrease the mine warfare timeline significantly. Such vehicles would destroy mines by exploding at or near them.

The Concepts of Operation for this vehicle is envisioned to be a follow-on mission to a mine reconnaissance UUV or other sensors that would search a specified area for sea mines. Once one or more targets have been identified, the reconnaissance UUV would deploy a Mine Location Marker and survey it in place with its sonar or by interrogation, providing x-y-z distances from the marker to the objects(s). The Neutralization Vehicle would be programmed with the mine locating marker's unique identification code for homing to the marker's location, and the distances between the marker and the target. The vehicle would then be deployed from various platforms to include UUVs, USVs, manned RHIBs, over the side of ships, and from airborne platforms. The vehicle would then transit to the specified location and interrogate the marker. The vehicle would then use the marker as reference and home in on the location of the mine. The vehicle would then either explode on impact or anchor/stationkeep and wait for a detonation command. This topic would not include the development of the explosive charge or command detonation system, but the vehicles will be required to accommodate the volume and weight of an explosive charge and firing system.

The following information about the end product is given as guidance for the research and development to be carried out in the Phase I proof of concept and Phase II prototype development stages. The production version of the Mine Neutralization Vehicle will need to include the following characteristics. It should provide the ability to transit 5 miles, reacquire the Mine Location Marker, then find the target and position itself within 1 foot of the target. The Mine Location Marker is being developed under SBIR Topic N04-201, "Small Cost Effective Mine Location Marker". The vehicle should have the ability to drive directly to a specified waypoint and wait until commanded to drive to the final specified target. The vehicle shall be capable of carrying a 4"diameter x 24" long payload weighing 10-15 lbs and the vehicle shall be close to neutrally buoyant. The vehicle should be the size of 6"diameter by 42" length threshold and 5"diameter by 36" length objective and operate at water depths up to 600ft. The threshold production cost would be $25,000 per unit with a goal of $10,000 a unit.

PHASE I: Develop and document a proof of concept design and architecture for the Mine Neutralization Vehicle that provides the desired capability to transit to a general area, interrogate and locate the specified mine location marker, and home in on the target at the pre-programmed location from the marker within the required accuracy.

PHASE II: Develop and demonstrate a prototype system of the critical technologies/components including basic vehicle power, propulsion, controls, navigation, and sensors to reacquire and position near "mine-like" targets for neutralization.

PHASE III: The contractor shall conduct Engineering and Manufacturing Development (EMD) to develop a system for deployment of a mine neutralization vehicle for the Mission Reconfigurable UUV (MRUUV) or another asset. The contractor would be responsible for the development and delivery of the device to include any components to be loaded into the MRUUV, the device transceiver, and the platform transceiver for command and control. The contractor and MRUUV program personnel would jointly work on integrating and deploying the device.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Underwater salvage and oil companies could utilize this technology on the basic vehicle to return to a previous point that was surveyed execute a preplanned survey around a location.

REFERENCES:
1. SBIR Topic N04-201, "Small, Cost Effective Mine Location Marker"

KEYWORDS: mines; UUV; navigation; neutralization; acoustic communications

N05-129 TITLE: Autonomous Surface Threat Identification

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: LCS

OBJECTIVE: Develop an approach and identify key innovative technologies for an Autonomous Surface Threat Identification system that will allow ships or associated unmanned vehicles to autonomously identify when a surface threat condition exists by assessing the specific entity or entities posing the threat and the level of threat.

DESCRIPTION: A limiting factor in successful defensive Surface Warfare (SUW) operations is often the early identification and classification of a potential surface threat among a group of non-threat entities. This topic seeks innovative approaches to provide surface threat identification in an environment that contains a large amount of non-threat traffic. Technologies that can be hosted either on ship or on an autonomous vechicle are acceptable. Examples of possible approaches include weapon detection phenomenologies and behavior observation methods to alert operators of the presence of a threat and to identify specific threat platforms. Approaches may be covert or may rely on observed response to direct stimulus as necessary. Maximizing threat detection range from the host platform is a primary measure of performance. The system prototype should include all threat-determining sensors, effectors, processing, notification, and geo-location components necessary to functionally comprise a complete operational system capable of deployment from a naval platform

PHASE I: Demonstrate the feasibility of an approach to providing a surface threat identification and classification capability when the suspected threat is among a group of non-threat entities. Establish performance goals and metrics to analyze the feasibility of the proposed solution. Provide a Phase II developmental approach and schedule that contains discrete milestones for development.

PHASE II: Finalize design and fabricate a prototype system based on the design concept(s) proposed in Phase I. Through laboratory testing and characterization experiments, demonstrate the viability of the system's ability to identify, alert and specify surface threat contacts operating in close proximity to a group of non-threat contacts.

PHASE III: Work with the Navy and Industry to demonstrate design and conduct an operational test event to demonstrate successful system deployment, sensor and effector operation, threat identification, alertment, and target designation under real-world conditions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system can be applied to homeland defense, anti-terrorism/force-protection, law enforcement, and other related activities. This system could also be used to identify anomalous behaviors that could be associated with safety related events in a broad range of industries.

REFERENCES:
1. ANTI-MARITIME SOF USING INNOVATION AND SYNERGY TO SOLVE A VERY REAL AND SUBSTANTIAL THREAT, http://www.fas.org/man/eprint/anti-sof.htm.
2. Surface Warfare Threat Assessment: Requirements Definition, Technical Report 1887, SPAWAR Systems Center San Diego, August 2002, M. J. Liebhaber, B. A Feher, http://www.spawar.navy.mil/sti/publications/pubs/tr/1887/tr1887.pdf.

KEYWORDS: Autonomous; unmanned vehicle; offboard vehicle; threat; identification; and sensor.

N05-130 TITLE: Alternative Methods of Wireless Sensor Power

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop alternative methods of powering existing shipboard wireless sensors.

DESCRIPTION: The Navy is reducing shipboard manning through automation, reducing maintenance on ships and systems, and the introduction of new technology that improves crew performance. These trends are resulting in a greater reliance on a very large number of shipboard sensors across a whole spectrum of functions. From a design, construction, life-cycle cost, and maintenance perspective, wireless communication between sensors and wireless access points is very attractive since it avoids installation of large numbers of wires. However, the use of batteries to power wireless sensors remains a major maintenance impediment to their use in large numbers.

This topic seeks an innovative power source that can be readily integrated to power existing wireless sensors. The solution developed should be able to generate 10-100mW constant power, have a minimum life of 4 years and should be robust and survivable in a shipboard operating environment. Concepts should address the longevity, reliability and maintainability of the proposed power source.

PHASE I: Demonstrate the feasibility of an alternative means of providing power to existing wireless sensors. Conduct limited testing of the concept to support feasibility demonstration and recommendation for a Phase II effort. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the design and fabricate a prototype power source. Perform laboratory tests to validate the performance goals established in Phase I. Develop a plan to design, fabricate and install onboard a naval vessel.

PHASE III: Working with the Navy and commercial industry, develop and install a system on board a naval vessel.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology would have wide commercial application in manufacturing, power generation, and transportation industries that utilize large numbers of sensors and where maintenance costs and continuous operation are important.

REFERENCES:

1. Goh, Nigel. "Wireless Sensor Networks – Ubiquitous Watchdogs of the Future?" National University of Singapore. Aug. 2003. http://www.nus.edu.sg/intro/newsletter0311.shtml.
2. LaL, Amit. and James Blanchard. "The Daintiest Dynamos." IEEE Spectrum Online, www.spectrum.ieee.org/WEBONLY/publicfeature/sep04/0904nuc.html
3. Culler, David, et. al. "Overview of Sensor Networks." IEEE Computer Society. Aug. 2004. http://www.computer.org/computer/homepage/0804/GEI/r8041.pdf

KEYWORDS: power; sensor; wireless; wireless network; network

N05-131 TITLE: Integrated Shipboard Multi-function Surveillance System

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop and demonstrate an approach for an integrated multi-function surveillance system that will provide increased ship perimeter security while allowing for reduced manning for security watchstanding operations.

DESCRIPTION: Present methods of security surveillance require the dedication of trained personnel and can be time intensive depending upon the threat condition. This topic seeks to develop and demonstrate an innovative approach to reducing the present security watch-standing workload by integrating and automating various functions required to ensure full perimeter security of the ship while in port or in a moored condition.

The solution set proposed, must be able to minimize the involvement of personnel while providing the ability to:

1. Identify unauthorized personnel and security access violations as well as a means of providing alerts and communicating real-time surveillance statuses. Proposals should address the utilization of secure wireless communications for transmitting information to a portable workstation.
2. Simultaneously handle and integrate multiple inputs from sensors such as standard video, low-light video, infra-red and other optical-based sensors, ultrasound and RF-based sensors.
3. Be set up and taken down by no more than two individuals and must store compactly onboard the ship.
4. Be ruggedized and suitable for use on a navy ship and in a marine environment.

Any system developed will have to comply with all relevant DoD and Navy requirements for security, environmental ruggedness and interoperability. Maximal use of open architecture principles and open standards is desired.

PHASE I: Demonstrate the feasibility of the development of an automated multi-function surveillance system. Cost analysis and other performance metrics should be considered.

PHASE II: Develop a functional prototype system based on the concept/preliminary design developed in Phase I. Document the approach and impacts on capability, acquisition, installation, and lifecycle costs. Demonstrate security and performance approaches under multiple scenarios simulating operational conditions to evaluate capability. Provide life-cycle cost analysis and performance metrics.

PHASE III: Develop detailed commercialization plans and a form, fit and functional prototype of the surveillance system. Demonstrate and test on a Navy ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of a portable perimeter surveillance system will be of direct use to the shipbuilding and commercial maritime industries aboard ships as well as port waterfront facilities.

REFERENCES:

1. Applicable Military Requirements are Available Upon Request.

KEYWORDS: Integrated; Multi-function; Surveillance; Security System; Watchstanding; Reduced Manning

N05-132 TITLE: Approach to Monitor and Assess the Quality of Sensor Data in Support of Calibration and Health Maintenance

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop an approach and the technology to provide the capability to monitor and assess the quality of individual sensor data in order to determine if the wired and/or wireless sensor data is degraded and the sensor is in need of calibration or repair.

DESCRIPTION: The number of sensors onboard naval platforms is expected to increase significantly due to the incorporation of new shipboard instrumentation in support of automated machinery and electrical systems as well as reduced manning. As a result, sensor maintenance requirements and associated costs are expected to rise significantly. The Navy desires the ability to autonomously estimate the quality of individual sensor data in order to focus calibration and diagnostic requirements on those sensors suspected of having degraded output.

The wired and wireless sensors on the network could include measuring temperature, pressure, acceleration, voltage, current, etc. The proposed concept should be based on open architecture protocols and common hardware interface standards to insure interoperability with the multi-vendor wired and wireless sensors as well as onboard condition based maintenance systems.

The Navy will provide access to archived data relating to ship system sensor data through Maintenance Engineering Libraries and Condition Assessment Systems as needed.

PHASE I: Demonstrate the feasibility of an approach to assess sensor data quality and report suspected signal or sensor degradation. Conduct bench scale testing as appropriate.

PHASE II: Design, develop and fabricate a prototype of the approach proposed in Phase I. In a laboratory environment, demonstrate via laboratory characterization experiments as a means of validation. Using the results of the characterization experiments, refine the prototype.

PHASE III: Working with the Navy and other Industry partners, as appropriate, integrate into a Navy Condition Based Maintenance (CBM) system and demonstrate onboard ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Industries that use large sensor networks would be benefit from the ability to focus maintenance efforts and reduce the overall cost of maintaining these networks. Process control, manufacturing, and power production are just some of the businesses that would benefit greatly by this technology.

REFERENCES:

1. Cherkassky V., Mulier, F., Learning From Data, John Wiley & Sons, ISBN 0-471-15493-8.

KEYWORDS: Calibration; Sensors; Simulation; Modeling; Validation; Wireless

N05-133 TITLE: Advanced Structural Watertight Door System

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: To develop an affordable, lightweight interior watertight door system that requires significantly less maintenance and associated life-cycle costs compared to current Navy standard watertight door systems.

DESCRIPTION: This topic seeks to develop a lightweight interior watertight door system based upon the use of innovative advanced materials and structural concepts. A door system refers to the door, operating and securing mechanisms, and frame. Door systems currently in service are heavy, unreliable and very expensive to maintain over the life cycle of the ship. Structural concepts proposed should address the following concerns:

- Provide a clear-passage opening of 30 inches X 66 inches
- Be "quick-acting".
- Provide at least a 25% reduction in overall weight over a Navy standard door system, which is approximately 250 lbs. and is configured to withstand hydrostatic pressure of 15 psi (applied to the outside) and 15 psi (applied to the inside). The door design shall also have the ability to be easily modified for lower pressure rating requirements.
- Be operable by a typical sailor (5th percentile female rule applies)
- Address total ownership cost concerns (combined initial purchase, installation, operation and maintenance costs)
- Be compatible with current ship bulkhead materials and design configurations

During Phase II technology development and Phase III fleet integration, validation testing will be conducted to ensure that the proposed design meets applicable military requirements for shock, EMI, fire, vibration and sustained hydrostatic pressure. The applicabe design and validation requirements can be found online at the reference cited below. Please ignore any direct reference to the use of a specific material(s) or mechanical system(s) such as linkages, dogs, etc. as the Navy would like to encourage the small business to propose innovative alternative concepts/configurations for consideration.

PHASE I: Demonstrate feasibility of the proposed advanced door system to meet Navy needs. Provide a preliminary concept design and an associated component validation plan.

PHASE II: Finalize the design concept from Phase I and fabricate prototype panels. Validate prototype capabilities using laboratory testing and provide results.

PHASE III: Construct a full-scale prototype based on Phase II results for testing in a shipboard environment. As applicable, the small business will work with the Navy or Industry to transition the technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology developed through this project can be applied to commercial shipbuilding applications, including cruise ships, cargo/container ships, and oil platform construction.

KEYWORDS: watertight door; watertight; doors; lightweight; low maintenance; corrosion resistant

N05-134 TITLE: Portable Calibration Standards for Traceability

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

OBJECTIVE: Develop an approach and the technology to develop an innovative, ruggedized, programmable, portable, in-situ calibration and diagnostics device for use with shipboard installed sensors.

DESCRIPTION: Presently the Navy assures the accuracy of existing shipboard installed sensors (and the analog to digital circuitry associated with each sensor channel) using several individuals who utilize manual procedures and a suite of electronic and mechanical calibration standards. Due to the number of existing sensors and the manpower required, ship-wide calibration is only periodically but infrequently performed. The Navy is beginning to move toward a condition-based calibration philosophy, which focuses on conducting real-time calibration on an as needed basis with minimal impact on ship's personnel.

The Navy seeks the development of a device that will implement National Institute of Standards and Technology (NIST) traceable standards as a means of calibrating/diagnosing embedded pressure, temperature, acceleration, speed, and humidity sensors. Concepts should be portable, ruggedized for a shipboard environment, and usable by a single individual. Basing such handheld calibration-diagnostic standards on open architecture; protocols, communications, operating systems, and hardware interface standards will help ensure inter-operability with multi-vendor calibration-diagnostic equipment and future sensor developments.

PHASE I: Demonstrate the feasibility of an in-situ calibration and diagnostic device. Address equipment identification protocols and method for implementing NIST traceable standards. Conduct bench scale testing as appropriate as a means of feasibility demonstration.

PHASE II: Design, develop and fabricate a prototype of the device proposed in Phase I. In a laboratory environment, demonstrate the capabilities of the prototype(s) via laboratory characterization experiments as a means of validation. Using the results of the characterization experiments, refine the prototype(s).

PHASE III: Working with the Navy and commercial industry, develop a full-scale calibration and diagnostic device.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Industries that uses large sensor networks would be greatly interested in reducing the cost of maintaining these networks. Process control and paper pulping are just two of the businesses that would benefit greatly by this technology.

REFERENCES:
1. R. Rupnow, J. Walden, X. Yun, D. Greaves, H. Glick; "New Calibration Standards for Next Generation Ship's Monitoring Systems", Thirteenth International Ship Control Systems Symposium (SCSS), April 2003.
2. http://www.nist.gov/
3. Electronic and Mechanical Calibration Standards Available Upon Request

KEYWORDS: portable; calibration; standard; traceable; embedded

N05-135 TITLE: Ultra-wideband Antenna Elements for Aircraft Applications

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Develop and demonstrate ultra-wideband conformal or Embedded antenna elements for Naval platforms.

DESCRIPTION: The increasing demand for additional antennas competing for space on already heavily populated flight platforms continues to drive the need for solutions to the resulting electromagnetic interference (EMI) between these antennae. Given the lack of available real-estate the only viable solution is to reduce the number of antenna by increasing their functionality. In current systems conformal phase array antennas with bandwidths up to 5:1 have been introduced for application between 4 and 20 GHz. At the same time, there is an increasing need to consolidate and add functionality between 0.1 and 4 GHz. This requires the development of multifunction conformal antenna with an even greater (7:1) bandwidth possessing gain greater than -10 dBi. The development of such an antenna would enable greater functionality while reducing EMI commonly encountered in flight vehicle design.

PHASE I: Develop and conduct a bench-scale demonstration of the proposed technical principles. Generate a plan to integrate this technology into a representative flight vehicle outer mold line

PHASE II: Continue to develop and conduct a full-scale demonstration of the proposed technology on a flight vehicle mock-up in a controlled environment

PHASE III: Prepare a manufacturing plan for the final design. Provide performance and operational data. Demonstrate the technology in an operational flight vehicle agreed upon with the POC under various operational conditions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Hundreds of antennas are commonly encountered not only on military but also commercial platforms. The implementation of low frequency wideband multifunction antenna elements (and arrays) would effectively reduce interference phenomena encountered in the design of commercial vehicles where high densities of conventional radiating elements are also required.

KEYWORDS: Wideband; Low Frequency; Multifunction Antennas; Arrays; Aircraft; Ships

N05-136 TITLE: Soot Removal From Gas Turbine Engine Exhaust

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Develop and demonstrate a technology that will remove soot from gas turbine engine exhaust streams without compromising engine performance.

DESCRIPTION: Proposed tightening of the EPA standards on combustion derived particulate matter (soot), if implemented, will require more effective technologies for the elimination of gas turbine engine emissions of soot. Many Naval bases are already in areas that have been determined to be in noncompliance with the current NAAQS for particulate matter. In current research two approaches are pursued: the development of fuel additives and the redesign of the engine core. The goal of this solicitation is to develop a technology that will remove soot for the exhaust stream of the gas turbine engine, not the combustion chamber . This represents a new and difficult approach to soot reduction. This technology should not compromise the engine performance and must fit within the dimensions and weight constraints of the flight platforms for which the engine is designed.

PHASE I: Develop and conduct a bench-scale demonstration of the proposed technical principles. Generate a plan to integrate this technology into a full-scale gas turbine engine.

PHASE II: Continue to develop and conduct a full-scale demonstration of the proposed technology on a COTS or modified COTS gas turbine engine in a controlled environment.

PHASE III: Prepare a manufacturing plan for the final design. Provide performance and operational data. Demonstrate the technology in an aircraft agreed upon with the POC under various operational conditions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Aircraft engine emissions are a problem with both DoD and the commercial sector. Technologies to mitigate the formation of particulate matter form military engines should be effective in commercial aircraft as well.

KEYWORDS: Soot; Particulate Matter; Gas Turbine Engines; Aircraft; Engine Emissions

N05-137 TITLE: Textile for Under Armor Blast Protection

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop, fabricate and test a textile or other material that can be formed into clothing worn beneath existing body armor to improve protection and reduce the instance of limb separation due to blast. Must not encumber movement or flexibility, must be lightweight, and must be usable in a variety of operational environments.

DESCRIPTION: The severity of blast injury may be greatly reduced in the presence of textile materials that provide protection from limb separation/amputation due to blast overpressure from improvised explosive devices (IEDs) and other explosives. Currently, most protective efforts have been aimed at body armor which is cumbersome and primarily designed to mitigate projectile threats, not blast injury. Textiles or textile-like materials which would protect human extremities from separation due to blast would add significantly to survivability and quality of life for current and future warfighters who are exposed to explosive devices. Textile solutions would be preferred over increased body armor so that the warfighter's agility and dexterity would not be limited. As such, the textile would need to be formed into a garment that would allow full, unencumbered movement for the wearer. Additionally the garments created with this textile would need to be worn in a wide range of climates and temperatures with minimal impact on the warfighter. The goal is to protect from sub-sonic fragmentation (~700-1200 fps and 100 mg to 1.2 grams) and to reduce overpressure (OP) by ~50 PSI given the threshold pressures of lethality are ~100-200 PSI. This would decrease a large percentage of the morbidity and mortality of these injuries. The majority of IED mortality is within the 5-10 foot blast radius with direct effects of OP and large fragmentation. A material that can deform and absorb these kinetic forces would provide a much improved level of protection for our combatant forces.

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

PHASE I: Develop several material formulations that can be fabricated into coupons for testing and test material strength properties and blast resistant. Develop concepts on how materials could be integrated or woven into garments and provide analysis on design concepts.

PHASE II: Create usable prototype garments and perform extensive blast and wearability testing.

PHASE III: Define production needs for the material and produce design-ready garments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful creation of this blast resistant material would have applicability in a variety of civilian applications, including police bomb disposal units and any industry where explosion is a hazard. The properties that make this material blast resistant may also make this an ideal material to help protect against impact injuries.

REFERENCES:
1. U.S. Department of Homeland Security, Federal Emergency Management Agency
http://www.fema.gov/preparedness/resources/law_enforcement/bomb_squad_team.htm

2. Army RDT&E Budget Item Justification (R-2A Exhibit) PE #0602786A Logistics Technology Project H98
www.dtic.mil/descriptivesum/Y2004/Army/0602786A.pdf

KEYWORDS: Improvised Explosive Device (IED); Blast Protection; Materials; Body Armor; Textile, Garments, Force Protection, Combat Equipment