Office of The Secretary of Defense (OSD)
Deputy Director of Defense Research & Engineering
Deputy Under Secretary of Defense (Science & Technology)
Small Business Technology Transfer Research (STTR)
FY 2009B Program Description

Introduction

The Deputy Under Secretary of Defense (Science & Technology) STTR Program is sponsoring four topics in this solicitation, one in each of the following technology focus areas: Information Assurance Technology, Materials (corrosion) Technology, Energy and Power Technology and Unmanned Technology.

The Air Force and Navy are participating in the OSD program on this solicitation. The service laboratories act as our OSD Agent in the management and execution of the contracts with small businesses. The service laboratories, often referred to as a DoD Component acting on behalf of the OSD, invite small business firms to submit proposals under this Small Business Technology Transfer Research (STTR) Program solicitation. In order to participate in the OSD STTR Program this year, all potential proposers should register on the DoD SBIR/STTR Web site as soon as you can, and should follow the instruction for electronic submittal of proposals. It is required that all bidders submit their proposal cover sheet, company commercialization report and their firm's technical and cost proposal form electronically through the DoD SBIR/STTR Proposal Submission Website at https://www.dodsbir.net/submission. If you experience problems submitting your proposal, call the help desk (toll free) at 1-866-724-7457. You must include a Company Commercialization Report as part of each proposal you submit; however, it does not count against the proposal page limit. Please note that improper handling of this form may result in the proposal being substantially delayed. Information provided may have a direct impact on the review of the proposal. The DoD SBIR/STTR Proposal Submission Website allows your company to come in any time (prior to the proposal submission deadline) to edit your Cover Sheets, Technical and Cost Proposal and Company Commercialization Report.

We WILL NOT accept any proposals that are not submitted through the on-line submission site. The submission site does not limit the overall file size for each electronic proposal, there is only a 25-page limit. However, file uploads may take a great deal of time depending on your file size and your internet server connection speed. If you wish to upload a very large file, it is highly recommended that you submit prior to the deadline submittal date, as the last day is heavily trafficked. You are responsible for performing a virus check on each technical proposal file to be uploaded electronically. The detection of a virus on any submission may be cause for the rejection of the proposal. We will not accept e-mail submissions.

Firms with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercialize the results are encouraged to participate. Subject to availability of funds, the DUSD(S&T) STTR Program will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector. Objectives of the DUSD(S&T) STTR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results. The guidelines presented in the solicitation incorporate and exploit the flexibility of the SBA

Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

Description of the OSD STTR Three Phase Program

Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the STTR Program and will typically be one half-person year effort over a period not to exceed six months, with a dollar value up to $100,000. We plan to fund 3 Phase I contracts, on average, and downselect to one Phase II contract per topic. This is assuming that the proposals are sufficient in quality to fund this many. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes technical performance toward the topic objectives and evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector, in accordance with Section 4.3.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal in addressing the goals and objectives described in the topic. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well defined deliverable prototype or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the DoD may award non-STTR funded follow-on contracts for products or processes, which meet the component mission needs. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The small business is expected to use non-federal capital to pursue private sector applications of the research and development.

This solicitation is for Phase I proposals only. Any proposal submitted under prior STTR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior STTR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, will be invited to submit a Phase II proposal. Invitations to submit Phase II proposals will be released at or before the end of the Phase I period of performance. The decision to invite a Phase II proposal will be made based upon the success of the Phase I contract to meet the technical goals of the topic, as well as the overall merit based upon the criteria in section 4.3. DoD is not obligated to make any awards under Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract. For specifics regarding the evaluation and award of Phase I or II contracts, please read the front section of this solicitation very carefully. Every Phase II proposal will be reviewed for overall merit based upon the criteria in section 4.3 of this solicitation, repeated below:

a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.
b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

c. The potential for commercial (defense and private sector) application and the benefits expected to accrue from this commercialization.

In addition, the OSD STTR Program has a Phase II Plus Program, which provides matching STTR funds to expand an existing Phase II contract that attracts investment funds from a DoD acquisition program, a non-SBIR/non-STTR government program or Private sector investments. Phase II Plus allows for an existing Phase II OSD STTR contract to be extended for up to one year per Phase II Plus application, to perform additional research and development. Phase II Plus matching funds will be provided on a one-for-one basis up to a maximum $500,000 of STTR funds. All Phase II Plus awards are subject to acceptance, review, and selection of candidate projects, are subject to availability of funding, and successful negotiation and award of a Phase II Plus contract modification. The funds provided by the DoD acquisition program or a non-SBIR/non-STTR government program must be obligated on the OSD Phase II contract as a modification prior to or concurrent with the OSD STTR funds. Private sector funds must be deemed an "outside investor" which may include such entities as another company, or an investor. It does not include the owners or family members, or affiliates of the small business (13 CFR 121.103).

The Fast Track provisions in section 4.0 of this solicitation apply as follows. Under the Fast Track policy, STTR projects that attract matching cash from an outside investor for their Phase II effort have an opportunity to receive interim funding between Phases I and II, to be evaluated for Phase II under an expedited process, and to be selected for Phase II award provided they meet or exceed the technical thresholds and have met their Phase I technical goals, as discussed in Section 4.5. Under the Fast Track Program, a company submits a Fast Track application, including statement of work and cost estimate, within 120 to 180 days of the award of a Phase I contract (see the Fast Track Application Form on www.dodsbir.net/submission). Also submitted at this time is a commitment of third party funding for Phase II. Subsequently, the company must submit its Phase I Final Report and its Phase II proposal no later than 210 days after the effective date of Phase I, and must certify, within 45 days of being selected for Phase II award, that all matching funds have been transferred to the company. For projects that qualify for the Fast Track (as discussed in Section 4.5), DoD will evaluate the Phase II proposals in an expedited manner in accordance with the above criteria, and may select these proposals for Phase II award provided: (1) they meet or exceed selection criteria (a) and (b) above and (2) the project has substantially met its Phase I technical goals (and assuming budgetary and other programmatic factors are met, as discussed in Section 4.1). Fast Track proposals, having attracted matching cash from an outside investor, presumptively meet criterion (c). However, selection and award of a Fast Track proposal is not mandated and DoD retains the discretion not to select or fund any Fast Track proposal.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research and development has commercial potential in the private sector. Proposers who feel that their research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General informational questions pertaining to proposal instructions contained in this solicitation should be directed to the topic authors and point of contact identified in the topic description section. Proposals should be electronically submitted. Oral communications with DoD personnel regarding the technical content of this solicitation during the pre-solicitation phase are allowed, however, proposal evaluation is conducted only on the written submittal. Oral communications during the pre-solicitation period should be considered informal, and will not be factored into the selection for award of contracts. Oral communications subsequent to the pre-solicitation period, during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness. Refer to the front section of the solicitation for the exact dates.

Proposal Submission

Proposals shall be submitted in response to a specific topic identified in the following topic description sections. The topics listed are the only topics for which proposals will be accepted. Scientific and technical information assistance may be requested by using the SBIR/STTR Interactive Technical Information System (SITIS).

It is required that all bidders submit their proposal cover sheet, company commercialization report and their firm's technical and cost proposal form electronically through the DoD SBIR/STTR Proposal Submission Website at http://www.dodsbir.net/submission. If you experience problems submitting your proposal, call the help desk (toll free) at 866-724-7457. You must include a Company Commercialization Report as part of each proposal you submit; however, it does not count against the proposal page limit. Please note that improper handling of this form may result in the proposal being substantially delayed. Information provided may have a direct impact on the review of the proposal. The proposal submission Web site allows your company to come in any time (prior to the proposal submission deadline) to edit your Cover Sheets, Technical and Cost Proposal and Company Commercialization Report. We **WILL NOT accept any proposals which are not submitted through the on-line submission site.** The submission site does not limit the overall file size for each electronic proposal, only the number of pages are limited. However, file uploads may take a great deal of time depending on your file size and your internet server connection speed. You are responsible for performing a virus check on each technical proposal file to be uploaded electronically. The detection of a virus on any submission may be cause for the rejection of the proposal. We will not accept e-mail submissions.

OSD STTR 09B Topic Index

OSD STTR 09B Topic Descriptions

OSD09-T001 TITLE: All Organic Coating System (Conversion coating, Primer and Topcoat)

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop environmentally friendly coating systems which are free of heavy metals and to formulate flexible coating systems for aluminum and/or steel alloys that perform as good or better than the current systems.

DESCRIPTION: There is increasing pressure to remove all heavy metals (Chromium VI for example[1]) from coating systems. The purpose of this work is to develop entire coating systems that contain only organic components. These coatings need to perform as good as or better than the current systems[1,2]. There are considerable efforts underway to replace Chromium VI with Chromium III[3] (less toxic than Chromium VI) and/or electroactive polymers[4] in certain alloy systems; some of these systems still use heavy metals to achieve full corrosion protection. To date, there are no pure-organic or non-heavy metal containing coating systems that pass ASTM testing standards for corrosion inhibition. Therefore, there is a need to develop environmentally friendly coating systems which are free of heavy metals, and to develop flexible coating systems for particular alloys, which perform as good as or better than the current systems[1].

PHASE I: Formulate an all-organic coating system for one alloy (Aluminum 2024 or AISI 4340 steel for example) and demonstrate proof-of-concept by passing 500 hours of neutral salt fog testing Neutral Salt Fog (ASTM B117) and Adhesion testing under Method B of ASTM-D 3359.

PHASE II: Modify formulation and incorporate coating for other selected Alloys. Down-select coating formulations according to ASTM B117 (3000 hours neutral salt fog Testing). Successfully coat non-critical parts with this new system and demonstrate adhesion under Method B of ASTM-D 3359

PHASE III: Provide several kilograms of material. Test formulations and alloys in outdoor exposure test using ASTM D1014. Provide samples to Army, Navy, Marines or Air Force for testing on non-critical components and for Reparability under ASTM D3359.

COMMERCIAL POTENTIAL: Metal free-corrosion inhibiting coatings will be available for commercial use.

REFERENCES:
1. “Minimization of Hexavalent Chromium in Military Systems”, Memorandum from John J. Young Jr., The Undersecretary of Defense, Washington D. C. April 8th, 2009

2. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=18599

3. http://www.techlinkcenter.org/techlink/pdf/featured_successes/TCP_Safer_Metal_Coating.pdf

4. “Electroactive Polymers for Corrosion Control”, Yang, S.C., et. al. Chapter 13 p 196 ACS Book Series Symposia 843, Zarras, Stenger-Smith and Wei, eds. American Chemical Society, Washington DC, 2003.

KEYWORDS: corrosion inhibition, chromium free primers, all organic coating systems

OSD09-T002 TITLE: High Efficiency, JP-8 Fueled Refrigeration Cycles for Shelter Air Conditioning

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop and demonstrate high efficiency refrigeration cycles for mobile environmental control units that can operate on military logistics fuels.

DESCRIPTION: Military shelters currently use trailer mounted Environmental Control Units (ECUs) to provide cooling for the air inside the shelter for equipment and personnel. The cooling function is accomplished by vapor compression refrigeration systems that are coupled with diesel gensets to provide electric power from logistics fuels. Other than fueling jet engines, the largest drain on U.S. military fuel supplies in current operations comes from running generators at forward operating bases. In hot climates, ECUs consume the largest share of generated power. The vapor compression system typically operates at a coefficient of performance (COP) of about 1.6 (95°F outdoor air temperature and 80/67°F indoor dry bulb/wet bulb temperature). The diesel engine typically operates at 28% electric power output per fuel lower heating value (LHV) input, resulting in an overall fuel to cooling duty COP of about 0.45. These efficiency ratings are lower than most modern commercial and residential units due to design tradeoffs made in the name of transportability, durability, as well as more stringent ratings that take into account normal deterioration over the life of the unit. Size and weight restrictions for mobility and logistics dictate that larger heat exchangers are not a feasible option for improving performance, thus requiring the exploration of alternative refrigeration cycles. Past efforts with absorption cooling have been unable to demonstrate both competitive efficiency and compact size. Vapor jet refrigeration techniques have shown promise, although current ejector designs lack the efficiency needed to compete with paired diesel gensets and ECUs.

Due to the logistical burden of supplying fuel to units in hostile and/or remote locations, the military desires a more efficient means of providing cooling from fuel. Proposed solutions should focus on the development of innovative refrigeration cycle designs such that the overall COP approaches 0.9, on the basis of fuel LHV in and cooling duty output. Designs should not exceed the size and weight of existing trailer-mounted ECU units. For example, the current 5 ton tactical ECU (TAMCN:B0008) is approximately 50 cubic feet in volume and weighs 575 lbs. Proposals will be evaluated based on the estimated efficiency of the technique, the anticipated overall effect on logistical burden, the novelty of the approach, and the feasibility and practicality of forward deployment of the end product. Performance of components such as heat exchangers, compressors or ejectors that substantially outperform those in currently fielded military ECUs will require justification and appropriate figures of merit should be stated and clearly defined in the proposal.

PHASE I: Design an innovative refrigeration cycle that can run on JP-8 fuel and achieve 0.9 overall fuel-to-cooling-duty COP with reduced logistical burden. COP should be based on 95/75°F outdoor dry bulb/wet bulb temperature, 80/67°F indoor dry bulb/wet bulb temperature, and 43.2 MJ/kg LHV for JP-8. Validate design performance through analytical modeling or subscale demonstration of high-risk components as appropriate. Design parameters should allow a maximum of 20% derating of cooling duty at 130°F outside air temperature and 90/75°F dry bulb/wet bulb inside temperature. A detailed report containing the design concept, performance testing approach, cost estimate, and identification of risks will be prepared to enable the government to evaluate the viability of proceeding with Phase II.

PHASE II: Demonstrate a 5 ton (60,000 BTU/hr) cooling capacity system based on the concept defined in Phase I. Performance data shall be collected at a variety of outdoor/indoor air temperatures. Validate analytic models developed in Phase I and evaluate scalability of design to larger sizes (> 100 ton). Efforts should focus on the refrigeration cycle with auxiliary systems such as burners, fans, and ducting being of secondary importance.

PHASE III: Design and develop a series of militarized Environmental Control Units ranging from 1.5 to 8 tons refrigeration using the knowledge gained during Phases I and II. This series of ECUs must meet military unique requirements such as shock, vibration, and EMI.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Air conditioning and refrigeration power demands are significant consumers of power in all equatorial and mid-latitude climates. High efficiency vapor compression cycles can be used in place of most existing residential and commercial refrigeration applications, and fuel-fired refrigeration units can be used in remote locations where power is typically provided by on-site diesel generators. The current trend of increasing fuel and energy costs makes high efficiency refrigeration systems increasingly valuable.

REFERENCES
1. http://www.marcorsyscom.usmc.mil/sites/pmeps/ECU.asp.

2. http://www.pm-mep.army.mil.

3. http://www.nordicair.com/main.php?NAP_ID=19.

4. Air-Conditioning, Heating, and Refrigeration Institute Standard 210/240: Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.

5. Edwards, Tim; Harrison, Bill; Maurice, Lourdes; "Properties and usage of Air Force fuel - JP-8", Aerospace Sciences Meeting and Exhibit, 39th, Reno, NV, Jan. 8-11, 2001.

KEYWORDS: heating, ventilation, and air conditioning (HVAC); refrigeration; vapor compression cooling

OSD09-T003 TITLE: Improving Software and Data Security in SCADA Systems

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop innovative software and data protection technology that improves the security of Supervisory Control and Data Acquisition (SCADA) and Distributed Control Systems (DCS) (for convenience, hereafter referred to as SCADA systems).

DESCRIPTION: Critical infrastructure in the United States, such as power generation plants, water treatment and distribution plants, and oil and gas refineries are high-value targets for cyber attacks, in particular from disgruntled insiders, terrorist organizations and nation states [1]. These attacks are possible due to the direct accessibility of these systems from the Internet, indirectly through corporate networks that connect to the SCADA systems, and wireless LAN/WAN and modems that allow connectivity directly to remote terminal units and monitoring stations. Significant research and development of software protection and end-node security capabilities has occurred to protect critical applications in other arenas, such as high performance computing, but these technologies have yet to be applied to improve SCADA software security.

The goals of this research are to (1) design and develop a software application and data security solution for a SCADA system that prevents malicious alteration, malicious control, reverse engineering, and denial-of-service of the controlling software and process data, (2) perform a vulnerability analysis on the proposed solution [2], and (3) provide test and evaluation results demonstrating the increase in security as a result of the developed solution [3]. Proposed solutions should consider the "Three Tenets of Cyber Security" [4] as part of the design methodology [5]. The solution should provide robust security against nation state class threats while allowing the system to remain operational, reliable, and stable. Protection solutions should address the different components of a SCADA system [6], including (1) human machine interface (HMI) workstations that present process data to the human operator and through which the human controls the process, (2) remote terminal units (RTU) and monitoring stations, programmable logic controllers (PLC), and/or intelligent electronic devices (IED) that connect to the physical equipment, (3) master station servers and associated databases that gather and store data, and send control signals from the HMI workstations to the RTU/PLC/IED, and (4) communication between the different components. Solutions should support one or more operating systems in common use by SCADA systems, as appropriate for each component, in order to maximize commercialization potential (e.g., Windows and Linux for HMI workstations and master servers, and/or RTLinux and VxWorks for RTUs).

PHASE I: 1) Develop a concept to protect critical software applications running on a SCADA system. 2) Research possible vulnerabilities of the system and propose solutions for remediation. 3) Provide a minimal software prototype demonstrating the feasibility of the concept (focusing on one component of the system, such as protecting the software running on a HMI workstation or RTU, is acceptable).

PHASE II: 1) Based on the results from Phase I, refine and extend the design of the software and data security system prototype to a fully functioning solution. 2) Provide test and evaluation results on an actual SCADA system demonstrating the ability to provide improved security to that system. 3) Collaborate with government and industry working in SCADA security to ensure a transition path for the developed technology.

PHASE III DUAL-USE APPLICATIONS: The technology developed under this research topic will ensure SCADA systems are trustworthy and secure from both insider and 'over-the-wire' attacks. The DoD relies on SCADA systems that control critical infrastructure processes maintained by both defense and private industry to support its mission and operations. Commercial industry that provides services to the public, including water, electricity, natural gas, fuel, and transportation are vulnerable to malicious manipulation and alteration of critical software and data, such as those controlling SCADA systems. As a result, the technology is vital for both the DoD and commercial organizations.

REFERENCES:
1. Shane Harris, "China's Cyber-Militia – Chinese hackers pose a clear and present danger to U.S. government networks and may be responsible for two major U.S. power blackouts," May 21, 2008, http://www.nationaljournal.com/njmagazine/cs_20080531_6948.php

2. Eric J. Byres, "The Use of Attack Trees in Assessing Vulnerabilities in SCADA Systems," http://blogfranz.googlecode.com/files/SCADA-Attack-Trees-IISW.pdf

3. C.M. Davis, et al, "SCADA Cyber Security Testbed Development," University of Illinois, http://www.linklings.net/MOSES/papers/NAPS06-258.pdf

4. Software Protection Initiative, The Three Tenets of Cyber Security, http://spi.dod.mil/tenets.htm

5. Dr. Clifford Neumann, "Understanding Trust and Security in SCADA Systems," Information Sciences Institute, USC, http://www.truststc.org/scada/papers/paper7.pdf

6. SCADA, Wikipedia, http://en.wikipedia.org/wiki/SCADA

KEYWORDS: Software protection, secure communications, SCADA security, Distributed Control Systems (DCS), reverse engineering, anti-tamper

OSD09-T004 TITLE: Tools to Assess the Mission Competency of Complex Autonomous Control Systems

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

OBJECTIVE: To develop and demonstrate tools to assess the mission competency of complex autonomous control systems for particular sets of mission tasking in particular environments with particular operational constraints. The focus should be on tools that can be utilized as part of a Verification and Validation (V&V) and operational test process for a range of air, sea, undersea, and ground systems. However, the development of new mission simulations is outside the scope of this topic. Tools that focus on safety-critical issues such as airworthiness certification are also outside the scope of this topic. However, application of these tools to assist unmanned vehicle operators to better understand the capabilities of their systems for specific environments and mission tasks is within the scope of the topic.

DESCRIPTION: There is currently a significant gap between the capabilities of autonomous systems and the availability of tools to demonstrate that they can reliably complete a particular mission task. Autonomy technologies are currently being developed to enable rapid retasking and fully autonomous dynamic replanning, autonomous decision-making, and autonomous behaviors to complete mission tasks. The algorithms and software involved with these autonomy approaches can be extremely complex, and it is not usually feasible to exhaustively test them over all possible mission inputs, states, and environmental conditions. Further, these new autonomy algorithms will be performing tasks that are currently done by highly skilled operators and may use approaches that have not been incorporated in existing test and V&V processes. The state of the art in intelligent and autonomous algorithms has advanced far beyond current capabilities for analysis, Verification & Validation, and certification. Examples of this include approaches that are highly nonlinear, non-deterministic, adaptive/learning, converge in unpredictable timescales, use more natural and mixed-initiative methods to interact with humans, are implemented in a decentralized way across multiple agents, and make critical decisions based on multi-modal fused sensor information of varying degrees of reliability. The use of these technologies may be non-intuitive for operators or for other human beings sharing the same operational space, lead to complex interactions between components, mode switching problems, and poor reliability across the full range of environments and mission tasks they may be used for. It is extremely challenging to ensure reliable mission performance in all reasonably possible cases given the large space involved. Though, in the near term, it is likely that any such components would have bounded authority and that should make the problem easier to solve.

This topic will develop and demonstrate tools to assess the mission competency of complex autonomous control systems for particular sets of mission tasking in particular environments with particular operational constraints. The focus should be on mathematical tools that can be utilized as part of a V&V and operational test process across a range of different types of autonomous systems. Of particular interest are mathematically rigorous tools that can be used to make predictions of system behavior under realistic assumptions. Approaches based on developing new mission simulation systems are outside the scope of this effort. Approaches that are only valid in a particular domain, such as only for unmanned air systems, only for unmanned sea (both surface and underwater) systems, and only for unmanned ground systems are outside the scope of this topic. Finally, application of these tools to assist unmanned vehicle operators to better understand the capabilities of their systems for specific environments and mission tasks are also of interest. This should be focused on autonomous systems for air, sea, and ground systems that have the ability to make fully autonomous planning and behavior decisions, have the ability to interact with humans in a mixed-initiative way, and have the ability to interact with other autonomous systems for both heterogeneous and homogeneous systems.

PHASE I: Develop an initial version of the proposed approach for a limited set of autonomy algorithms with sufficient functionality to demonstrate feasibility and allow some limited experimentation and demonstration. Experiments with algorithms may be done with low-fidelity simulation elements to show their value on particular problems. Simulation may include some limited-complexity vehicle models, sensor models, and communications models, depending on what would be most suitable to examine the particular approach. Human interface concepts for that particular control approach may be examined in some limited way as well. Develop metrics to evaluate the system in Phase II.

PHASE II: Further develop the proposed approach for a broader set of autonomous control algorithm, mission, and environmental situations and system types in a more complex dynamic and unstructured environment and integrate them with a medium-fidelity simulation and sufficient autonomy components to conduct and report on experiments and comparison with benchmarks. If feasible, experiments may also be conducted with the use of inexpensive unmanned vehicles or other hardware. Experiments should include a focus on determining the sensitivity of the tool to a variety of factors. Revise evaluation metrics as necessary.

PHASE III: Integrate the software with a particular unmanned system control approach and participate in integrated demonstrations or testing..

PRIVATE SECTOR/DUAL USE APPLICATIONS: This capability could be used in a broad range of military and civilian security applications of unmanned systems and in other applications involving management of automated systems, such as industrial applications.

KEYWORDS: Unmanned Systems, Autonomy, V&V, Testing, Assessment