DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)
16.C Small Business Technology Transfer (STTR)
Proposal Submission Instructions

Offerors responding to DARPA topics listed in this Announcement must follow all instructions provided in the DoD Program Announcement AND the supplementary DARPA instructions contained in this section.

IMPORTANT NOTE REGARDING THESE INSTRUCTIONS: These instructions only apply to proposals submitted in response to DARPA 16.C STTR Phase I topics.

Introduction

DARPA's mission is to prevent technological surprise for the United States and to create technological surprise for its adversaries. The DARPA STTR Program is designed to provide small, high-tech businesses and academic institutions the opportunity to propose radical, innovative, high-risk approaches to address existing and emerging national security threats; thereby supporting DARPA's overall strategy to bridge the gap between fundamental discoveries and the provision of new military capabilities.

The responsibility for implementing DARPA's Small Business Technology Transfer (STTR) Program rests with the Small Business Programs Office (SBPO).

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Attention: DIRO/SBPO
675 North Randolph Street
Arlington, VA 22203-2114
sbir@darpa.mil
http://www.darpa.mil/work-with-us/for-small-businesses

System Requirements

Use of the DARPA SBIR/STTR Information Portal (SSIP) is MANDATORY. Offerors will be required to authenticate into the SSIP (via the DARPA Extranet) to retrieve their source selection decision notice, to request debriefings, and to upload reports (awarded contracts only). DARPA SBPO will automatically create an extranet account for new users and send the SSIP URL, authentication credentials, and login instructions AFTER the 16.C source selection period has closed. DARPA extranet accounts will ONLY be created for the individual named as the Corporate Official (CO) on the proposal coversheet. Offerors may not request accounts for additional users at this time.

WARNING: The Corporate Official (CO) e-mail address (from the proposal coversheet) will be used to create a DARPA Extranet account. Updates to Corporate Official e-mail after proposal submission may cause significant delays in communication retrieval and contract negotiation (if selected).

Notification of Proposal Receipt

Within 5 business days after the Announcement closing date, the individual named as the "Corporate Official" on the Proposal Cover Sheet will receive a separate e-mail from sbir@darpa.mil acknowledging receipt for each proposal received. Please make note of the topic number and proposal number for your records.

Notification of Proposal Status

The source selection decision notice will be available no later than 90 days after announcement close. The individual named as the "Corporate Official" on the Proposal Cover Sheet will receive an email for each proposal submitted, from sbir@darpa.mil with instructions for retrieving their official notification from the SSIP. Please read each notification carefully and note the proposal number and topic number referenced. The CO must retrieve the letter from the SSIP 30 days from the date the e-mail is sent.

After 30 days the CO must make a written request to sbir@darpa.mil for source selection decision notice. The request must explain why the offeror was unable to retrieve the source selection decision notice from the SSIP within the original 30-day notification period. Please also refer to section 4.0 of the DoD Program Announcement.

Debriefing

DARPA will provide a debriefing to the offeror in accordance with Federal Acquisition Regulation (FAR) 15.505. The selection decision notice contains instructions for requesting a proposal debriefing. Please also refer to section 4.10 of the DoD Program Announcement.

Announcement Protests

Protests regarding the **Announcement** should be submitted in accordance with the DoD Program Announcement section 4.11.

Protests regarding the **selection decision** should be submitted to:

DARPA
Contracts Management Office (CMO)
675 N. Randolph Street
Arlington, VA 22203
E-mail: scott.ulrey@darpa.mil and sbir@darpa.mil

Discretionary Technical Assistance (DTA)

DARPA has implemented the Transition and Commercialization Support Program (TCSP) to provide commercialization assistance to SBIR and/or STTR awardees in Phase I and/or Phase II. Offerors awarded funding for use of an outside vendor for discretionary technical assistance (DTA) are excluded from participating in TCSP.

DTA requests must be explained in detail with the cost estimate and provide purpose and objective (clear identification of need for assistance), provider's contact information (name of provider; point of contact; details on its unique skills/experience in providing this assistance), and cost of assistance (clearly identified dollars and hours proposed or other arrangement details). The cost cannot be subject to any profit or fee by the requesting firm. In addition, the DTA provider may not be the requesting firm itself, an affiliate or investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g., research partner).
Offerors proposing DTA must complete the following:

1. Indicate in question 17 of the proposal coversheet, that you request DTA and input proposed cost of DTA (in space provided).
2. Provide a one-page description of the vendor you will use and the technical assistance you will receive. The description should be included as the last page of the Technical Volume. This description will not count against the 20-page limit of the technical volume and will NOT be evaluated.
3. Enter the total proposed DTA cost, which shall not exceed $5,000, under the "Discretionary Technical Assistance" line along with a detailed cost breakdown under "Explanatory material relating to the cost proposal" via the online cost proposal.

Approval of DTA is not guaranteed and is subject to review of the Contracting Officer. Please see section 4.22 of the DoD Program Announcement for additional information.

Phase I Option

DARPA has implemented the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I companies selected for Phase II will be eligible to exercise the Phase I Option. The Phase I Option covers activities over a period of up to four months and should describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The statement of work for the Phase I Option counts toward the 20-page limit for the Technical Volume.

Commercialization Strategy

DARPA is equally interested in dual use commercialization of SBIR project results to the U.S. military, the private sector market, or both, and expects explicit discussion of key activities to achieve this result in the commercialization strategy part of the proposal. Phase I is the time to plan for and begin transition and commercialization activities. The small business must convey an understanding of the preliminary transition path or paths to be established during the Phase I project.

This is intended to replace the instruction in section 5.4(c.)(6) of the DoD Announcement.

The Phase I commercialization strategy shall not exceed 5 pages, and will NOT count against the 20-page proposal limit. It should be the last section of the technical volume and include the following elements:

1. Problem or Needs Statement. Briefly describe the problem, need, or requirement, and its significance relevant to a DoD application and/or a private sector application that the SBIR project results would address.
2. Potential Product(s), Application(s), and Customer(s). Identify potential products and applications, DoD end-users, Federal customers, and/or private sector customers who would likely use the technology. Provide specific information on the market need the technology will address and the size of the market.
3. Business Model and Funding. Include anticipated business model; potential private sector and federal partners the company has identified to support transition and commercialization activities; and the Technology Readiness Level (TRL) expected at the end of the Phase I. Also include a schedule showing the quantitative commercialization results from this SBIR project that your company expects to achieve.
4. Preliminary Phase II Strategy. Include key proposed milestones anticipated during Phase II such as: prototype development, laboratory and systems testing, integration, testing in operational environment, and demonstrations.

OPTIONAL:

- Advocacy Letters – Feedback received from potential Commercial and/or DoD customers and other end-users regarding their interest in the technology to support their capability gaps.
- Letters of Intent/Commitment—Relationships established, feedback received, support and commitment for the technology with one or more of the following: Commercial customer, DoD PM/PEO, a Defense Prime, or vendor/supplier to the Primes and/or other vendors/suppliers identified as having a potential role in the integration of the technology into fielded systems/products or those under development.

Advocacy Letters and Letters of Intent/Commitment are optional, do NOT count against any page limit, and should ONLY be submitted to substantiate any transition or commercialization claims made in the commercialization strategy. Please DO NOT submit these letters just for the sake of including them in your proposal. Letters that are faxed or e-mailed will NOT be accepted.

Please note: In accordance with section 3-209 of DOD 5500.7-R, Joint Ethics Regulation, letters of endorsement from government personnel will NOT be accepted.

Phase I Proposal Checklist
A complete proposal must contain the following four volumes. Failure to submit all four volumes will result in the proposal being deemed non-compliant.

1. Volume 1: Cover Sheet.
    a. Complete and accurate.
    b. Base and option costs are proposed separately.
2. Volume 2: Technical Volume.
    a. Does not exceed twenty (20) pages (not including the commercialization strategy or DTA). Pages in excess of the 20-page limit will not receive consideration during evaluation.
    b. Begins on page 1 and all pages of the proposal are numbered consecutively.
    c. Include documentation required for DTA (if proposed).
3. Volume 3: Cost Volume.
    a. Use the online cost proposal.
    b. Subcontractor, material and travel costs in detail. Used the "Explanatory Material Field" in the DoD Cost Volume worksheet for this information, if necessary.
    c. Costs for the base and option are clearly separated and identified in the Cost Volume.
    d. If proposing DTA, cost submitted in accordance with instructions
4. Volume 4: Company Commercialization Report
    a. Follow requirements specified in section 5.4(e) of DoD Program Announcement Instructions.
5. Submission
    a. Upload four completed volumes electronically through the DoD submission site by the announcement closing date.
    b. Review submission after upload to ensure that all pages have transferred correctly and do not contain unreadable characters. Contact the DoD Help Desk immediately with any problems.
    c. Submit proposal before 6:00 A.M. on the announcement closing date.

Phase I Evaluation Criteria
Phase I proposals will be evaluated in accordance with the criteria in section 6.0 of the DoD Program Announcement.

The offeror's attention is directed to the fact that non-Government advisors to the Government may review and provide support in proposal evaluations during source selection. Non-government advisors may have access to the offeror's proposals, may be utilized to review proposals, and may provide comments and recommendations to the Government's decision makers. These advisors will not establish final assessments of risk and will not rate or rank offeror's proposals. They are also expressly prohibited from competing for DARPA SBIR or STTR awards in the SBIR/STTR topics they review and/or provide comments on to the Government. All advisors are required to comply with procurement integrity laws and are required to sign Non-Disclosure Agreements and Rules of Conduct/Conflict of Interest statements. Non-Government technical consultants/experts will not have access to proposals that are labeled by their offerors as "Government Only".

Phase II Proposal
All offerors awarded a Phase I contract under this announcement will receive a notification letter with instructions for preparing and submitting a Phase II Proposal and a deadline for submission. Visit http://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program for more information regarding the Phase II proposal process.

DARPA STTR 16.C Topic Index

DARPA STTR 16.C Topic Descriptions

ST16C-001 TITLE: Multiplexed Biofiltration of Volatile Organic Compounds

TECHNOLOGY AREA(S): Biomedical, Materials/Processes

OBJECTIVE: Develop a microfluidic platform for multiplexed biofiltration of a range of volatile organic compounds (VOCs) that accumulate in enclosed spaces as a result of metabolism, fuel combustion, and other essential processes.

DESCRIPTION: Innovative biofiltration capabilities to treat a range of VOCs in a variety of closed environments represent a critical DoD need. Effective management of air quality is essential for the optimal performance and health of those who operate in closed environments, such as underwater vehicles, air and spacecraft, and factories, for long periods of time. Gaseous contaminants—including carbon monoxide, carbon dioxide, methane, and other VOCs—tend to accumulate in these environments [1,2] as a result of human metabolism, fuel combustion, and other processes. Because removing sources of these pollutants is often not an option, treatment of the air is necessary to mitigate adverse performance and health effects.

Among gaseous contaminants, VOCs are of particular interest, as they represent a significant fraction of air pollutants identified by the United States Environmental Protection Agency (EPA) as hazardous [3] and have documented negative cognitive and health effects [4,5]. Biotechnological solutions for VOC treatment, in which pollutants passing through biologically active media are degraded into environmentally benign end products, are generally recognized as highly cost-effective and energy efficient [6]. Numerous species of bacteria, algae, and fungi that readily degrade VOCs have been identified [7–9].

Although traditional biofiltration technologies have many advantages, heterogeneity in the microbial community composition and distribution, excess accumulation of biomass, and low mass transfer rates of certain VOCs lead to suboptimal performance and wide variability in removal efficiencies [8,10,11]. Microfluidic technology provides a variety of promising alternatives, for example, in the form of droplet-based systems [12–16] or membrane-based microreactors [17,18]. These systems allow for exquisite control over microbial populations and offer high surface area-to-volume ratios for reduced mass transfer times and increased reaction rates. As such, microfluidic biofiltration platforms have the potential for improved performance over the current state-of-the-art, with increased efficiency, higher robustness, and more targeted control of contaminants.

This topic is focused on the development of novel microfluidic platforms for simultaneous biofiltration of multiple VOCs. These platforms must be suitable for use over extended periods of time, modular and scalable for application in spaces of different sizes, and allow for strict control over parameters internal to the device that affect biofiltration efficiency (e.g., temperature, pH, and cell density). An important requirement of any developed platform is that it be flexible, with the ability to simultaneously process multiple different VOCs as needed for different applications without altering the platform's abiotic components.

PHASE I: Determine the technical feasibility and develop an initial design of a microfluidic platform that can support encapsulation and co-culturing of multiple different microbial species for VOC biofiltration. Identify microbial systems that may be used to treat a broad range of VOCs (five or more) that accumulate in industrial and/or DoD-relevant working environments and that negatively impact worker performance and health. As a baseline for comparison, establish "normal operating condition" concentrations of at least five VOCs of interest in environments targeted for treatment, and, using existing literature and/or new data, report on the performance and health effects of these VOCs. Characterize the relevant chemical, material, and physical properties of the platform components, such as permeability to VOCs and other parameters relevant to the proposed microfluidic approach. Establish the minimum performance goals necessary to demonstrate significant improvement over existing VOC biofiltration technologies. Deliver a detailed analysis of the performance of the proposed platform for treating specific VOCs and a technical report of experimental measurements supporting the feasibility of this approach.

Phase I deliverables also include a Phase II proposal that outlines plans for the further development and validation of the platform. This proposal should include a detailed assessment of the potential path to commercialization, barriers to market entry, and candidate collaborators or partners as early adopters for the new platform.

PHASE II: Finalize the design from Phase I and initiate the development and production of the microfluidic platform. Demonstrate multiplexed biofiltration through the simultaneous treatment of multiple VOCs. Characterize the biotic components of the system available for biofiltration, such as colony forming units or other relevant metrics, and compare with state-of-the-art soil-based or other existing biofiltration technologies. Demonstrate scalability by characterizing performance in spaces of different sizes. Assess the efficiency of biofiltration in terms of reduction in VOC concentration by comparing with the baseline assessment from Phase I and with specific reference to EPA and/or other relevant guidelines. Characterize the platform by determining total power requirements, system capacity (e.g., volume of air purified per unit time), reproducibility of performance, long-term stability, and other performance metrics, as appropriate. Produce a plan for transitioning relevant designs and characterization experiments into protocols that are sufficiently robust and reproducible to be viable as commercial technologies. Deliverables include protocols, platform schematics, and valid test data as appropriate for a commercial production path.

PHASE III DUAL USE APPLICATIONS: A successful microfluidic biofiltration platform with robust and reproducible performance has significant potential to transition rapidly to the commercial sector for use in DoD and industrial applications. A large number of operating environments—including underwater vehicles, air and spacecraft, and factories—will stand to benefit from improved air quality from reductions in VOC concentrations, with measurable improvements to worker performance and health.

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19. DARPA Industry Day Presentation, September 8, 2016

KEYWORDS: Biofiltration, volatile organic compounds (VOCs), microfluidics, environmental remediation

ST16C-002 TITLE: Generating Material Properties From Flight Representative Structures

TECHNOLOGY AREA(S): Air Platform, Materials/Processes

OBJECTIVE: Develop, demonstrate and validate test methods (test articles and testing techniques) to generate thermophysical and mechanical properties for refractory composite materials for components representative of flight structures.

DESCRIPTION: There is a compelling Defense Department (DoD) need to develop improved capabilities for measuring thermophysical and mechanical properties of refractory composite materials to increase confidence in the design of high-temperature structures for flight vehicles. When executing a structural design, it is critically important that designers employ thermophysical and material properties that are representative of material to be used in fabricating that design. For vehicle designs employing high-temperature structures based on refractory composites materials, this has often been a challenge. This is due to the fact that material properties are often based on samples derived from geometrically simple components that are not manufactured at the scale and complexity representative of the flight structure. It is also due to the fact that existing material property-testing techniques are designed to use coupons derived from these geometrically simple components.

The traditional approach to measuring properties for refractory composite materials is to fabricate simple geometric shapes such as flat plates, extract test coupons, and perform the property tests over a range of temperatures. For refractory composites such as carbon/carbon (C/C) or ceramic-matrix systems, the plates are typically thin in order to enable loading the coupon to failure at elevated temperature. The properties generated from test articles derived from these small and geometrically simple material samples are not necessarily representative of those to be expected from thicker structures with complex geometric features. The reason for this is that as manufacturing procedures are modified to accommodate the large physical scales and geometric complexities associated with fabrication of flight structures, thermophysical and mechanical properties can change. The goals of this effort are (1) to develop and demonstrate a strategy and specific methods for fabrication of analogue test articles having appropriate scale and complexity to be representative of refractory-composite based flight structures, and (2) to develop and demonstrate experimental approaches and techniques for extracting coupons/test samples and then testing those samples to establish the thermophysical and mechanical properties required for use in thermostructural design.

The effort should include an assessment to identify and prioritize those refractory composite thermophysical and mechanical properties that are most sensitive to process changes introduced due to manufacturing scale-up and geometric complexity of parts, and identify and prioritize those properties for which improvements in testing techniques are most critically needed to improve the ability to employ refractory composites in the design of hot structures.

The desired end state would be approaches and techniques that could be applied across a broad family of refractory composite-material systems. However, the effort should focus first on carbon/carbon and second on ceramic-matrix material systems.

PHASE I: Identify and prioritize those refractory composite thermophysical and mechanical properties that are most sensitive to process changes introduced due to manufacturing scale-up and geometric complexity of parts. Identify and prioritize those properties for which improvements in testing techniques are most critically needed to improve the ability to employ refractory composites in the design of hot structures. The effort should focus first on carbon/carbon and second on ceramic-matrix material systems.

Identify and develop a strategy and specific methods for fabrication of analog test articles having appropriate scale and complexity to be representative of refractory flight structures, and (2) identify experimental approaches and techniques for extracting coupons/test samples and then testing those articles to establish the thermophysical and mechanical properties required for use in thermostructural design.

Assess and quantify the expected improvements to be realized through implementation of the proposed experimental techniques.

Phase 1 Deliverables: Report on all work including: recommended designs for flight-representative structures to be fabricated; new experimental approaches and techniques to be demonstrated.

PHASE II: Design and fabricate the flight-representative structures from which to extract test coupons. Design and fabricate required test-specific hardware/fixtures. Conduct material property tests. Compare the test data to analysis and traditionally derived test data.

Phase II Deliverables: Test fixture designs, structure design from which test coupons can be extracted for testing, test coupon design, and validation of test approach and properties.

PHASE III DUAL USE APPLICATIONS: Commercial: All hot structure designers could benefit from this work. Multiple test houses around the country would incorporate the improved test techniques.

Military: This work would provide improved/more realistic material properties for DoD/military applications including boost glide vehicles, air-breathing hypersonic weapons, and space access vehicles.

REFERENCES:
1. Glass, D. E., “Ceramic Matrix Composite (CMC) Thermal Protection Systems (TPS) and Hot Structures for Hypersonic Vehicles”, 15th AIAA Space Planes and Hypersonic Systems and Technologies Conference, April, 2008, Dayton, Ohio, AIAA-2008-2682.

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France, AIAA 2002-5137.

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KEYWORDS: Refractory composites, hot structures, leading edges, carbon/carbon, ceramic matrix composites, properties, testing

ST16C-003 TITLE: Optimizing Human-Automation Team Workload through a Non-Invasive Detection System

TECHNOLOGY AREA(S): Air Platform, Human Systems

OBJECTIVE: Enable more capable human-machine teaming constructs for future systems by measuring and characterizing human-system state. Determine the feasibility and reliability of using vocal tension, laryngeal electromyography (EMG), and/or other surface potentials as indicators of operator workload strain during critical task execution and emergency communication. Demonstrate the application of a concept with supporting foundational cognitive engineering approach.

DESCRIPTION: There is a critical Defense Department (DoD) need for highly capable human-machine teams to perform in a variety of operational and support constructs. Computers and automation are increasingly employed to monitor, assess, and assist human performance in many safety critical situations from aircraft operation, to command center operation and air traffic control. These modern automation systems are complex and can, counter to their engineered intention, confuse and frustrate even highly skilled operators. There are a number of ongoing DARPA programs that employ human-machine teaming constructs that could benefit from enhanced methods to detect human-system state and task status.

In many situations, rapid task execution and superior performance expectations create stress on the human operators of critical mission systems. That stress is experienced subjectively by each person depending on many things including experience, skill level, distraction, fatigue, and emotional state. The self-perceived workload, or 'strain,' is determined less by busy-time (knitters) or number of tasks (cooking) than it is by the egocentric proficiency and self-forecast of success. When the situation begins to deteriorate, this attitude of capability and confidence deteriorates and operators feel increased strain. If this strain were detectable by a teamed automation system, it could be used to adaptively enhance operator training, cue an offer of assistance, or automatically assume critical tasks.

Published studies of performance as a function of workload typically identify a continuous non-linear function upon which some threshold of performance degradation is identified as exceeding operator workload capacity [Cummings]. However, task analysis rarely takes into account the non-continuous abrupt transition that can occur in an emergency. It is well documented that human workload strain intensifies when the operator detects the commission of an error, whether they attribute the error to themselves or to the automation system [Gehring].

Several studies have examined the reliable presence of an electro-encephalogram (EEG) potential, known as Error-Related Negativity (ERN), elicited by the known commission of an error, both for operator manual errors and vocal errors. The latter may occur in such jobs as air traffic control or aircrew checklist coordination. Masaki showed its presence even for sub-vocalized verbal errors. Microphone-based measures have repeatedly shown increased pitch for stressed individuals and increased tension in the laryngeal EMG has been shown to correlate [Inbar and Eden]. There is evidence to suggest even mere mental rehearsal of an emotional response in the vocal musculature can be detected in both laryngeal EMG and facial EMG [Metzner].

This topic seeks a novel technological approach to non-intrusively detect a shift in human workload strain as a result of an abrupt reduction in operator confidence or a sudden operator-perceived reduced forecast of success.

PHASE I: Design a concept of signal processing equipment and algorithms to elicit and measure electro-potentials related to error commission and operator strain. This phase would include the exploration of recent technical literature and the execution of a feasibility analysis of the proposed concept, including a design with a supporting cognitive engineering approach. Foundational engineering data displaying functionality should be included if possible. The effort would also entail the preparation of an experimental design, including power analysis, to examine the hypothesis that a signal or combination of signals can be used to reliably detect operator strain. Finally, this phase would involve development of an experimental protocol that includes task simulations and error elicitation with varying levels of failure likelihood and consequences. A final report would incorporate the results of all Phase I activities.

PHASE II: Conduct experimental research determining the viability of, and preferred methods of, human workload anxiety metrics for eventual feedback use in automation systems. If successful, the products of a Phase II could result in future automation systems that are much more skilled at partnering with humans, because of their enhanced understanding of the state of their human partner. It is expected that Phase II would follow a proper experimental protocol. In Phase II, a performer should obtain Human Use Research approval and conduct the experimental protocol(s) designed in Phase I. The performer would collect and analyze the data and prepare a report on the statistical relevance to the hypotheses developed in Phase I. Phase II would ideally consider approaches to how to incorporate an individual's overall baseline and operator shift or flight calibration to increase levels of confidence in the analysis.

The final report should also include a description of all test equipment and algorithm approaches, provide a description of a practical implementation and estimate the acceptability of use in operational systems, and explore the potential for commercialization of the proposed implementation.

PHASE III DUAL USE APPLICATIONS: This technology could be inserted into the cockpit suite of any number of transportation systems to provide a signal to the automation system to adapt the displayed information, offer assistance, or take emergency control. The product should be simple to use and acceptable to the operator, while presenting no additional injury risk. The final implementation should provide a reliable tool with an open interface to automation and augmentation systems that would allow the juried use of the detection in machine decision making. Examples of a likely path of transition would be to the providers of cockpit human-machine crew teaming or to the Next Generation Air Traffic Control system.

The application of this technology to defense systems is very similar to that described in commercial system with the added utility in command and control applications. It could also be used during training episodes, to provide an assessment of trainee mental workload strain and coping skills. Examples of a path of transition would be to DARPA's Aircrew Labor In-Cockpit Automation System (ALIAS), Collaborative Operations in Denied Environment (CODE), and Hallmark programs.

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8. DARPA Industry Day Presentation, September 7, 2016

KEYWORDS: adaptive control, system interfaces, operator performance, operator workload, flight controls, automation