DEPARTMENT OF THE ARMY
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
SBIR 21.4 Broad Agency Announcement (BAA)
Army Applied SBIR Opportunity (ASO) Announcement

April 1, 2021: ASO issued for pre-release
April 14, 2021: Army begins accepting proposals
May 20, 2021: Deadline for receipt of proposals no later than **12:00 p.m. ET**

IMPORTANT

Deadline for Receipt: Proposals must be **completely** submitted no later than **12:00 p.m.** ET, May 20, 2021. Proposals submitted after 12:00 p.m. will not be evaluated. The final proposal submission includes successful completion of all firm level forms, all required volumes, and electronic corporate official certification.

Classified proposals will not be accepted under the DoD SBIR Program.

This BAA and the Defense SBIR/STTR Innovation Portal (DSIP) sites are designed to reduce the time and cost required to prepare a formal proposal. The DSIP is the official portal for DoD SBIR/STTR proposal submission. Proposers are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Proposers submitting through this site for the first time will be asked to register. Effective with this announcement, firms are required to register for a login.gov account and link it to their DSIP account. See section 4.14 for more information regarding registration.

The Small Business Administration, through its SBIR/STTR Policy Directive, purposely departs from normal Government solicitation formats and requirements and authorizes agencies to simplify the SBIR/STTR award process and minimize the regulatory burden on small business. Therefore, consistent with the SBA SBIR/STTR Policy Directive, the Department of Defense is soliciting proposals as a Broad Agency Announcement.

SBIR/STTR Updates and Notices: To be notified of SBIR/STTR opportunities and to receive e-mail updates on the DoD SBIR and STTR Programs, you are invited to subscribe to our Listserv by emailing DoDSBIRSupport@reisystems.com.

Help Desk: If you have questions about the Defense Department's SBIR or STTR Programs, please call the DoD SBIR/STTR Help Desk at 1-703-214-1333, or email to DoDSBIRSupport@reisystems.com.

Topic Q&A: The Topic Q&A for this BAA opens on April 1, 2021 and closes to new questions on May 4, 2021 at 12:00 PM ET. Proposers may submit written questions through Topic Q&A at https://www.dodsbirsttr.mil/submissions/login or through the SBIR Mailbox at usarmy.pentagon.hqda-asa-alt.mbx.army-applied-sbir-program@mail.mil. In Topic Q&A, the questioner and respondent remain anonymous and all questions and answers are posted electronically for general viewing. Once the BAA closes to proposal submission, no communication of any kind with the topic author or through Topic Q&A regarding your submitted proposal is allowed.

Questions should be limited to specific information related to improving the understanding of a particular topic's requirements. Proposing firms may not ask for advice or guidance on solution approach and you may not submit additional material to the topic author. If information provided during an exchange with the topic author is deemed necessary for proposal preparation, that information will be made available to all parties through Topic Q&A. Proposing firms are advised to monitor Topic Q&A during the BAA period for questions and answers. Proposing firms should also frequently monitor DSIP for updates and amendments to the topics.

This Army Applied SBIR Opportunity (ASO) is issued under the Army Broad Agency Announcement (BAA) for SBIR/STTR 21.4. All proposals in response to the technical area(s) described herein will be submitted in accordance with the instructions provided under 21.4, found here: https://beta.sam.gov/opp/b79ded14dcf54451bcfb11bddf5cd259/view?keywords=%22army%20sbir%22&sort=-relevance&index=opp&is_active=true&page=1.

a. Eligibility
The eligibility requirements for the SBIR/STTR programs are unique and do not correspond to those of other small business programs. Please refer to Section 3.1, Eligible Applicants, of BAA 21.4 for full eligibility requirements.

b. Anticipated Structure/Award Information
Please refer to Section 1, Funding Opportunity Description, provided in BAA 21.4 for detailed information regarding SBIR/STTR phase structure and flexibility. For this BAA, Department of the Army will accept Phase I proposals for the cost of up to $259,613 for a 6-month period of performance. Proposers should refer to Section 4, Application and Submission information, of BAA 21.4 for detailed proposal preparation instructions. Proposals that do not comply with the requirements detailed in BAA 21.4 and the research objectives of this ASO are considered non-conforming and therefore are not evaluated nor considered for award.

Phase I proposals shall not exceed 5 pages. Phase I commercialization strategy shall not exceed 2 pages. This should be the last section of the Technical Volume and will not count against the 5-page limit. Please refer to Appendix A of BAA 21.4 for detailed instructions on Phase I proposal preparation.

c. Evaluation of Proposals
Section 5, Evaluation of Proposals, in BAA 21.4 provides detailed information on proposal evaluation and the selection process for this ASO.

d. Due Date/Time
Full proposal packages (Proposal Cover Sheet, Technical Volume, Price/Cost Volume, and Company Commercialization Report inclusive of supporting documentation) must be submitted via the DoD SBIR/STTR Proposal Submission website per the instructions outlined in BAA 21.4 Section 4.3 Electronic Submission no later than **12:00 p.m. ET, May 18, 2021.**

Army SBIR 21.4 Topic Index

~~A214-031~~	~~Hard Armor Ballistic Plate Boron Carbon Recovery and Reclamation~~
A214-032	Enhanced Impact Protection HGU-56P Aviator Helmet
A214-033	Advanced Thermal Management Systems
A214-034	Dismounted Device-to-Device (D2D) Communication Platform

A214-006

TITLE: Impact Resistant Baseplate

OBJECTIVE:
Develop a lightweight cost-effective design for a mortar weapon system baseplate (i.e. of a composite material or structure) that handles high impact loading while in contact with soil.

DESCRIPTION:
Many different systems, cranes, construction equipment, howitzers, etc., use some form of plate structure to couple loads to ground. These structures often consist of a flat plate with spades on the bottom to interface with the ground. The plate is normally connected to the main structure via a strut and ball-and-socket joint allowing for the plate to adjust to uneven ground. This arrangement means that the load can go through the plate at various angles. The plate also needs to interact with various soil conditions in addition to loads coming from different angles and directions. This tends to result in very heavy and robust metallic structures, which can be a severe detriment to any systems that need to be relocated by hand. For current applications the production versions of these plates are made of cast aluminum or a steel weldment.

The Army is looking for lightweight baseplate design that is resistant to the impulse load of the mortar round (which can be up to 500 kips of force) and can be made to conform to the plate with spades design. The material and associated fabrication method should also be low cost such that the final baseplates are in the same price range as current metal ones (no more than $3000.00 for an M3A2 81mm baseplate and $16,600.00 for a M9A1 120mm baseplate). The system should have a fatigue life at least as good as its metallic counterpart (which means it functions correctly for 3,000 firing cycles). The final space claim of the new ground interface plate should also be roughly the same as the old one. The system weight should be less than the current systems, ideally under 20 lbs for an 81mm baseplate and under 100 lbs for a 120mm baseplate.

PHASE I:
Develop and demonstrate a system that is resistant to impact loading. Provide the conceptual design or model of a ground interface plate that utilizes this material. Demonstrate that the material is an improvement over the standard carbon fiber and epoxy materials (e.g. IM7, Endurance 4505A resin w/ 4506B hardener). The ground interface plate design should be able to handle an impact load of 130 kips at a 45 degree angle from the top of the plate. The plate should fit within a 2 ft diameter by 6 inch tall envelope. The deliverable for this phase will be a report detailing the new design. If a new material is proposed a 1 pound sample of the proposed material will also be required.

PHASE II:
Refine the material system and produce the selected design using a process representative of plant-scale production manufacturing. Use the material to fabricate a full-size baseplate and demonstrate that it can survive the impulse load. Calculate fatigue life of the baseplate and show that it exceeds 3000 cycles. Generate a design, including fatigue life, for a second ground interface plate that can survive a 500 kip impulse and fits within a 3 ft diameter by 12 inch tall envelope. The material deliverable shall be 10 kg of the developed material and the proposed smaller ground interface plate.

PHASE III:
Finalize the development of a design solution at production level quantities that can be readily implemented on existing manufacturing equipment. Non-DoD applications include deep well components, sporting goods, fixturing, etc.

BACKGROUND:
The Army is looking for new lightweight, robust baseplate designs. In 2006 – 2007 a composite ground plate was designed mimicking the aluminum design. It was fabricated using carbon fiber epoxy cloth with unidirectional reinforcement (all carbon fibers running in a single, parallel direction) in the spades. The spades and top plate were made separately and later bonded together. During field tests the leg joints failed under the full impulse load. Recently a 3D woven version was developed without a skirt and with five legs. One design

had integral legs and the other had legs that were stitched on. Both designs failed when subjected to the full impulse load during a laboratory test.

KEYWORDS: Carbon composite; Advanced materials; Additive manufacturing; High strength material; Mortar; Mortar baseplate

REFERENCES:

1. Tomich, A., Littlefield, A., Molligan, D., Burris, R., “3D Woven Composite Mortar Baseplate,” SAMPE 2014, 3 – 5 Jun 2014, Seattle, WA.
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7. Mencattelli, L., Pinho, S., “Realising bio-inspired impact damage-tolerant thin-ply CFRP Bouligand structures via promoting diffused sub-critical helicoidal damage,” Composites Science and Technology, Volume 182, 2019, https://doi.org/10.1016/j.compscitech.2019.107684.
8. Rivera, J., Yaraghi, N., Huang, W., Gray, D., Kisailus, D., “Modulation of impact energy dissipation in biomimetic helicoidal composites,” Journal of Materials Research and Technology, Volume 9, Issue 6, 2020, Pages 14619-14629, https://doi.org/10.1016/j.jmrt.2020.10.051.
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A214-007

TITLE: Digital High-Energy Neutron Radiography (NR) Detector Panel

OBJECTIVE:
Develop an advanced digital detector panel for performing high-energy neutron radiography imaging with high spatial resolution, high sensitivity, high signal to noise ratio (SNR), high conversion efficiency and long lifetime of use in order to accurately detect defects in ammunition and armaments.

DESCRIPTION:
The U.S. Army has a need for a state-of-the-art (SOTA) digital detector panel for performing high-energy neutron radiography (NR) with energy levels up to 6-8 megaelectronvolt (MeV) average neutron energy. Such a commercial detector panel does not currently exist. Over the past decade much time and effort has been invested in an electronically produced source of high-energy neutrons for performing NR to great success. It is currently available at a commercial facility. This SOTA source requires an equally SOTA detector in order to achieve optimal results. Neutron Radiography is now performed by using a detector which is optimized for X-radiography that is then modified via the addition of a conventional conversion screen, allowing for sufficient NR to be performed. Neutron radiography is so important because whereas X-radiography highlights possible defects in the high-density components of a munition, neutron radiography highlights defects in the lower density regions, even when these lower density regions are obscured by high density steel components. Thus, energetic fill and voids, gaskets, O-rings and any low-density components will show up better using NR than using traditional X-radiography. This NR technique will serve as an important complement to the current traditional X-radiography and will allow for more thorough inspections of ammunition and armaments. Requirements for the detector panel include an overall size, weight and power draw that is compatible with the current industry standard for an 11”x 17” usable imaging area silicon-based digital detector panel and connection to a standard computer for download of images. Long lifetime use equates to at least one (1) year of half-time (20 hours beam-on time per 40 hour work week) operation without degradation. Specific requirements for high spatial resolution, high sensitivity, high signal to noise ratio (SNR), and high conversion efficiency will be determined during Phase I.

PHASE I:
Phase I will consist of a modeling and feasibility study that will result in laboratory bench top prototype conversion screens being manufactured and then demonstrating their performance requirements in a laboratory setting. This may require the contractor to have access to a silicon-based digital detector panel, which must be arranged by the contractor. It may also require access to a high-energy neutron source, which the government can facilitate. The contractor is responsible for providing the prototype detector to the neutron source facility and providing any personnel support required. The contractor can assume the facility is Picatinny Arsenal, NJ. The main focus of the testing will be to demonstrate and quantify spatial resolution, sensitivity, SNR and efficiency. The Phase I Option will finalize the requirements specification to guide development in Phase II.

PHASE II:
Phase II will further mature the technology to ascertain and weigh any compromises on the requirements so the end result is the best possible detector panel. There will be a final demonstration with a high-energy neutron source at Picatinny Arsenal, NJ followed by delivery of this final optimized detector panel and conversion screen combination to the US Army at Picatinny Arsenal.

PHASE III:
Phase III will see the incorporation of said detector panel into all US Army NR systems in both laboratory and load plant applications.

KEYWORDS: High-energy neutron radiography; Neutron radiography; Digital detector panel; Advanced manufacturing; Munitions inspection;

REFERENCES:
1. An Overview of Digital Imaging Systems for Radiography and Fluoroscopy

2. Michael Yester, Ph.D. https://www.aapm.org/meetings/04SS/documents/yester.PDF
3. Digital radiography with large-area flat-panel detectors, E. Kotter1 & M. Langer, https://link.springer.com/article/10.1007/s00330-002-1350-1
4. N. Stull, J. McCumber, L. D'Aries, M. Espy, C. Gautier, J. Hunter, "On a Method for Reconstructing Computed Tomography Datasets from an Unstable Source", *Journal of Imaging,* 1-12, 2020.

A214-008

TITLE: Development of Novel Miniature Reserve Batteries on the Chip

OBJECTIVE:
Develop a micro-scale reserve battery on-the-chip that can be directly integrated into electronic devices, sensors and other power consuming components of munitions. Integration can be a stand-alone battery on the chip, or the stored electrical energy can be integrated and reside with the electronics. Solutions must be gun-hardened and the performance of the battery on the chip must not be sensitive to spin caused by the firing of munitions.

DESCRIPTION:
The proposed reserve batteries on-the-chip should be capable of being fabricated in an array of configurations and be individually activated to achieve the required power of the various munition components on demand. The proposed micro-scale reserve battery on-the-chip technologies must provide multiple voltage outputs and multiple current outputs. These outputs must be configurable by means of programming steps as required by the host system in order to achieve minimum power loss in voltage conversion and meet multiple power requirements in military systems at optimum efficiency. The proposed reserve batteries must also be suitable for currently available low-cost mass fabrication techniques. Recent advancements in high energy density electrochemistries has provided the opportunity to develop miniaturizable power supplies to meet a wide range of power requirements. Applications for consideration are munitions and fuzing systems which undergo high set-back acceleration forces and flight vibrations. Primary sets of applications include large and medium caliber munitions (e.g. 30 mm rounds with set-back application up to 100,000G's). The power sources needed are reserve power sources which must function under spin rates from 15 Hz to 1,000 Hz. The micro-scale reserve batteries may also be activated following events during a munition's ballistic flight and minimize unexploded ordnance and other safety and security issues. It is highly desirable that the proposed micro-scale reserve batteries technologies are capable of being manufactured at the end of a Phase 2 for transition to medium and large caliber applications. The proposed technology must also demonstrate the capability to maintain at least a 20-year shelf life, as well as the capability of operating and being stored anywhere in the military temperature range of -65 degrees Fahrenheit to 165 degrees Fahrenheit.

PHASE I:
Conduct a systematic feasibility study of the proposed micro-scale reserve battery on-the-chip technologies and their suitability for use in munitions in terms of (a) possibility of being hardened to the firing and flight environment; (b) operation in the entire military temperature range of -65 deg. F to 165 deg. F; and (c) shelf-life of over 20 years. The study must also address the manufacturing-related issues and show that the batteries can be produced with currently available low-cost mass fabrication techniques. The Phase I efforts must also include a multi-disciplinary approach to the planning of the efforts needed during the Phase II of the project in preparation for the project Phase III.

PHASE II:
Develop prototypes of micro-scale reserve batteries on-the-chip and demonstrate their performance in powering the selected electronic and sensory components that are to be identified by the project Army technical POC team during the Phase I of the project. The prototypes must also be tested during the Phase II period for shock loading survivability and extreme temperature performance together with an initial study showing a 20-year shelf-life capability.

PHASE III:
This technology would apply to almost all gun-fired munitions, mortars, and rockets. The commercial use could apply to the powering of emergency remote sensors and medical devices such as defibrillators.

KEYWORDS: Power; Battery; Micro-scale battery on a chip; Munitions; Miniaturized power;

REFERENCES:

1. W. Lee, J. W. Han, Y. Chen, Z. Cai, and B.Yildiz, "Cation Size Mismatch and Charge Interactions Drive Dopant Segregation at the Surfaces of Manganite Perovskites", *Journal of the American Chemical Society,* 135, 7909!7925, 2013.
2. Y. Chen, Z. Cai, Y. Kuru, W. Ma, H. L. Tuller and B. Yildiz, "Electronic Activation of Cathode Superlattices at Elevated Temperatures – Source of Markedly Accelerated Oxygen Reduction Kinetics", *Advanced Energy Materials,* 3 (9) 1221–1229, 2013.
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4. Z. Cai, Y. Kuru, J. W. Han, Y. Chen and B. Yildiz, "Surface Electronic Structure Transitions at High Temperature on Perovskite Oxides: The Case of Strained $La_{0.8}Sr_{0.2}CoO_3$ Thin Films" *Journal of the American Chemical Society,* 133 17696-17704, 2011.
5. H. Jalili, J. Woo Han, Y. Kuru, Z. Cai and B. Yildiz, "New Insights into the Strain Coupling to Surface Chemistry, Electronic Structure and Reactivity of $La_{0.7}Sr_{0.3}MnO_3$" *Journal of Physical Chemistry Letters* 2 801-807, 2011.
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7. D. Marrocchelli, S. R. Bishop, H. L. Tuller, and B. Yildiz, "Understanding chemical expansion in non-stoichiometric oxides: ceria and zirconia case studies", *Adv. Funct. Mater.* 22 1958-1965, 2012.
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10. A. Chroneos, B. Yildiz, A. Tarancón, D. Parfitt and J. A. Kilner, "Oxygen Diffusion in Solid Oxide Fuel Cell Cathode and Electrolyte Materials: Mechanistic Insights from Atomistic Simulations" *Energy and Environmental Science* 4 2274-2789, 2011.

A214-009

TITLE: Large Format Color Low Light Level (LLL) Focal Plane Arrays (FPAs)

OBJECTIVE:
The Apache Attack Helicopter Project Management Office (PM) and the Sensors Product Director (PD) is seeking advanced state-of-the-art Low Light Level (LLL) color capable cameras with a large format (2,000 pixels by 2,000 pixels or larger) to address desired capabilities. The objective of this SBIR is the demonstration of an advanced large format LLL color camera suitable for insertion into the Apache targeting system (Target Acquisition and Designation Sights, Pilot Night Vision System, M-TADS/PNVS).

DESCRIPTION:
The Apache PM and the Sensors PM is seeking advanced state-of-the-art LLL focal plane arrays (FPAs) to address desired capabilities, specifically a color large format LLL (2K x 2K or larger) camera. The LLL system would be fused with Forward Looking Infrared (FLIR) imagery of comparable format to provide enhanced situational awareness (SA). The color LLL sensor should support targeting by providing the capability to capture imagery from lasers, tracers, cultural lights, military lights, etc., which can then be fused with the Apache targeting FLIR. With respect to the request for a color LLL sensor, what is desired is a sensor that can provide suitable, standard RGB color performance during daytime operations and good low light level performance during dusk/dark hours. The objective of this SBIR is the demonstration of the advanced large format LLL FPA system as a color camera capable of operating at low light levels.

PHASE I:
Consider, identify, and evaluate a color LLL sensor that will support targeting by providing the capability to capture imagery from lasers, tracers, cultural lights, military lights, etc. With respect to the request for a color LLL sensor, what is desired is a sensor that can provide suitable, standard RGB color performance during daytime operations and good low light level performance during dusk/dark hours.

PHASE II:
Develop a working prototype and characterize the phase I camera to be fused with the Apache targeting FLIR. A camera of suitable size, e.g. 2K x 2K, to be installed into the existing Apache targeting system is desired, but if this is not achievable in this Phase, then a path to insertion should at least be identified. The fusion with the FLIR will be accomplished outside this effort.

PHASE III:
Deliver a color LLL sensor test bed based on the recommendations from Phase II that demonstrates the capabilities of the advanced LLL FPA system. Continue to extend the technology to a full pilotage and targeting system prototype by optimizing the hardware and software developed in the previous phase. Refine the design to minimize size, weight, power and to survive the harsh conditions experienced in a military environment (using MIL-STD-810, Environmental Engineering Consideration and Laboratory Tests, as a reference for what the equipment will need to withstand across its service life). Create a partnership with industry to manufacture the technology. Commercial applications of the technology may include penetrating atmospheric haze for determining the health of vegetation, identifying plant species, estimating biomass of vegetation, assessing soil moisture, assessing water clarity, or other remote sensing applications.

KEYWORDS: Low Light Level (LLL); Focal Plane Array (FPA); Infrared (IR); Forward Looking Infrared (FLIR); Situational Awareness (SA); Fusion; Field of View (FOV); Apache; Rotorcraft; Cockpit; Workload; Aviation

BACKGROUND:
The current Apache Color TV (CTV) assembly only provides color performance during daytime operations. Good color low light level performance during dusk/dark hours is also required. The camera will be designed to replace the CTV assembly in the Modernized TV Sensor (M-TVS) without requiring modification to the optical system or control electronics.

REFERENCES:

1. MIL-STD-810E
2. MIL-STD-704F
3. MIL-STD-461E

*MIL-STD refers to a United States defense standard that is used to help achieve standardization objectives set forth by the U.S. Department of Defense. MIL-STD establishes uniform engineering and technical requirements for military-unique or substantially modified commercial processes, procedures, practices, and methods.

A214-010

TITLE: Full Color, Low Power, High Brightness Micro-Display Capabilities

OBJECTIVE:
Technologies that use micro-light emitting diodes (LEDs) offer the potential for significantly increased luminance and efficiency, unlocking new possibilities in high-dynamic-range (HDR), augmented/mixed reality, projection, and non-display applications. Organic LEDs (OLEDs) are the technology of choice for VR due to their advantages in latency, contrast ratio, and response time. A few commercial augmented-reality (AR) displays have demonstrated very compact and lightweight form factors. Seeking input from industry for innovative full color display component technology in micro-displays to be integrated into augmented reality head/helmet-mounted display systems. Work with an integrator to integrate into a vision system. Demonstrate capability to function to display imagery to user with near to eye optics.

DESCRIPTION:
Micro-display will meet full daylight readability luminescence requirements (>1,000-Foot-lambert />3,400-Candela per square meter) and night performance (<0.3-fL/<1-nit at 8 bits per color) while using sufficiently low power to be applicable to untethered mounts. Consideration of light security and personal protective equipment should be included even though this is just the image source.
Of the specifications listed below; contrast and resolution are considered to be the most important given a minimum 65 horizontal degree field of view optic. Operation with a waveguide, prism, reflective visor, and other concepts should be considered.

Potential technologies of interest include but are not limited to inorganic LED microdisplays and OLED microdisplays with advanced and readily manufacturable approaches for daylight readability luminance levels.

Key requirements include:

- Display power per channel (at max luminance with 50% pixels driven): less than 1W (T): less than .5W (O)
- Display format resolution: HD demonstrator; 1920x1080/1200 and 4K objective
- Display addressable gray/color level format: greater than 24 bit RGB (T)
- Contrast (On/Off): greater than 10,000:1; Checkerboard Contrast: greater than 1,000:1
- Display gray shades – video (Night): 32 gray shades (no ambient) (T)
- Display luminance greater than 1,000-fL white (RGB) for day; less than 0.3-fL night
- Frame rate: greater than 60Hz (Hertz) (T)
- less than $500/display in quantities in 1000s

PHASE I:
A low fidelity demonstration of a display that can meet the above requirements. A test plan is required to show how the requirements will be met. A thorough explanation/path of how the full capabilities will be met based on the demonstration. Deliverable includes demonstration and any ancillary equipment required to drive demonstration. A test report is required documenting the results.

PHASE II:
Develop prototype from Phase I that can be made commercially viable for augmented reality head/helmet mounted display systems. A fully functional display prototypes capable of meeting all performance requirements above. A Preliminary Design Review (PDR) and Critical Design Review (CDR) at the Government’s facility. Both the PDR and CDR shall present a path to full production with cost detailed. Deliverable includes five (5) pre-production displays and any ancillary equipment to drive a demonstration with commercial video interface such as HDMI.

PHASE III:
Develop full color display component technology in micro-displays for augmented reality system head/helmet mounted display systems. Work with an integrator to integrate into a vision system. Demonstrate capability to

function to display imagery to user with near to eye optics. Build twenty (20) production representative systems to supply to the Government for final operational testing.

KEYWORDS: Microdisplay; Inorganic LED display; OLED display; Augmented reality; AR; Virtual reality; VR; Vision system; High-resolution display;

REFERENCES:

1. https://onlinelibrary.wiley.com/doi/epdf/10.1002/j.2637-496X.2016.tb00949
2. https://onlinelibrary.wiley.com/doi/epdf/10.1002/j.2637-496X.2018.tb01069
3. https://onlinelibrary.wiley.com/doi/epdf/10.1002/j.2637-496X.2016.tb00918
4. https://en.wikipedia.org/wiki/MicroLED

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b(7) of the solicitation.

A214-011

TITLE: Picatinny Smart Rail (PSR) Enabler Integration

OBJECTIVE:
The Picatinny rail (Pic rail) is a military standard rail interface system that provides a mounting platform for firearm accessories, such as tactical lights, laser aiming modules, or telescopic sights. The current Family of Weapon Sights – Individual (FWS-I) (2) individual thermal weapon sight and Small Tactical Optical Rifle Mounted (STORM) (3,4,5) micro-laser rangefinder Program of Record hardware mounts onto today's Pic rail. Each system has its own battery power source and Soldier interface. This SBIR Topic is seeking innovative approaches to integrate current FWS-I and STORM hardware to the Picatinny Smart Rail (PSR) standard.

DESCRIPTION:
The current FWS-I and STORM Program of Record hardware integrates onto today's Pic rail. Each system has its own battery power source and Soldier interface. As the US Army moves toward fielding the new PSR, there is the need to develop adapters for current FWS-I and STORM systems to make these two systems compatible with the PSR interface, operating system, and electrical power source to minimize size and weight.

PHASE I:
Investigate the feasibility of developing an adapter(s) to integrate FWS-I Individual Thermal Weapon Sight and STORM Micro-Laser Rangefinder with the intelligent PSR. The adapter(s) shall provide the physical mounting and electrical power for the respective systems. The adapter(s) shall provide data, imagery, and command and control interaction with the PSR operating system for the respective systems.

Phase I will consist of a four-month trade study to determine the feasibility of an adapter(s) to integrate the FWS-I and STORM with the PSR. A conceptual design and cost estimate to fabricate one (1) set of adapters shall be included in the trade study. This early prototype adapter(s) will be used to demonstrate physical integration and static operation.

Phase I shall also include an option to fabricate six (6) sets of adapters for use in early user assessment (EUA). The EUA will include a Situational Training Exercise, weapon engagement using Multiple Integrated Laser Engagement System (MILES training system), and weapon engagement using live ammunition. The option's period of performance will be three (3) months (month 5 through 8 after contract award).

PHASE II:
Phase II will consist of the fabrication, integration, contractor test and operational test of the FWS-I and STORM adapter(s). A total of twenty (20) sets of adapters will be fabricated. Four (4) sets of adapters will be utilized for acceptance and contractor testing to verify the adapter design is mature enough for a Soldier Operational Experiment (SOE). Ten (10) sets of adapters will be used during the SOE. Two (2) Infantry Squads will be outfitted with five (5) sets of adapters each (Squad Leader, Team Leaders, and Riflemen). Three (3) sets of adapters will be reserved as spares. The final three (3) sets of adapters will be utilized for logistic support activities.

PHASE III:
Phase III will be the fielding of FWS-I and STORM adapters for integration with the PSR, and its operating system, to Infantry Units to enhance the Warfighter's situational awareness and actionable intelligence.

KEYWORDS: Picatinny rail system; Rail interface system; Adapter; Hardware integration; Advanced manufacturing;

REFERENCES:

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4. https://www.harris.com/sites/default/files/storm-slx_l3harris_2pg_r5.pdf
5. https://www.harris.com/sites/default/files/storm-slx-e_l3harris_r5.pdf

A214-012

TITLE: Environmental Conditioning of Man-Portable Weapons Systems

OBJECTIVE:
Develop and design a portable solution capable of evacuating the toxic fumes generated from firing small arms weapons inside of an environmental conditioning while maintaining constant temperature and humidity.

DESCRIPTION:
Man-portable weapon systems (i.e. small caliber weapons systems) are frequently required to demonstrate their performance under the harshest environments throughout the Test and Evaluation (T&E) process. Specifically, test items are subjected to temperature extremes of -60 to +160°F and humidity ranges of 0 to 100% Relative Humidity (RH) while being operated at maximum capacity. These weapon systems are generally manually operated and are frequently serviced in the conditioned test space by engineers, technicians, and other test personnel.

Controlling the environment to be able to conduct tests in such extremes is inherently challenging and is often exacerbated by local climate conditions. For example, maintaining an extremely cold test chamber with low humidity would be difficult in a region with naturally high temperatures and high humidity. Further complicating the environmental control is the fact that weapon systems emit toxic fumes from the burning of the ammunition's propellant. Without appropriate mitigation, the test space becomes inhospitable to weapon system operators and other test personnel. Consequently, a significant percentage of fresh makeup air is required.

To combat these challenges, robust HVACR (Heating, Ventilation, Air Conditioning, and Refrigeration) systems are required. Aside from the initial and ongoing maintenance/repair costs, these systems are not especially practical or reliable. These HVACR units and chambers are limited in number and generally fixed in their position. This has proven inadequate for current weapons testing demand as it has created scheduling conflicts and delays while also limiting the mobility of testing across ranges. The testing issues are further compounded by the fact that temperature/humidity extremes are difficult to achieve and maintain because of the large volume of fresh makeup air required to maintain safe Carbon Monoxide levels.

The focus of this effort is to develop a solution that facilitates mobile testing of man-portable weapon systems in conditioned environments. As such, the following requirements apply:

- The system shall be fully portable to allow for quick and easy movement between ranges, incorporating modular design features where applicable. For example, a complete chamber system with large HVACR unit may be fully contained and fixed on trailer or may be designed for operators to disassemble within four (4) hours using basic hand tools in the field to load components onto a trailer using a forklift
- System shall create testing environment with safe operating levels of toxic fumes present in accordance with all relevant Occupational Safety and Health Administration (OSHA) regulations for up to four (4) system operators without use of supplied air system or other lifeline while firing one (1) weapon as described below:
- Temp conditioning of weapon and all ancillary equipment from -60 to +160°F
- Humidity conditioning of weapon and all ancillary equipment from 0 to 100% RH
- System shall accommodate additional instrumentation (e.g. thermocouples, pressure sensors, etc.) fitted to the weapon system for data acquisition and allow for easy access to that instrumentation by test personnel. If applicable, instrumentation ports shall be included
- System shall be designed to accommodate man-portable weapon systems (i.e. small arms systems, 40-mm grenade launchers, etc.) at maximum rates of fire up to an hour in continuous duration, and up to eight hours per day
- A fully enclosed chamber space (if applicable) shall have interior space of no less than 15 x 15 x 10-ft (L x W x H)
- A fully enclosed chamber (if applicable) shall accommodate personnel entering/exiting the chamber up to five times per hour

- A fully enclosed chamber (if applicable) shall provide two firing ports – one for the weapon and one for instrumentation/target acquisition
- System shall not impede access by operators to service the weapon or instrumentation
- System may be retrofitted to pre-existing Government furnished equipment (e.g. chamber)

PHASE I:
Research and evaluate current technology and methods for simulating environmental conditions. Adapt findings to include the introduction of live fire testing of man-portable weapons into the test space. Hazards due to live firing in a confined, conditioned space shall be identified and addressed. Determine if there are existing technologies that can be utilized in the design of a system to accomplish the desired outcome. If such a current technology and/or method does not exist, develop concept that includes novel technology and/or method or improvements upon existing technology and/or method. Potential solutions will be further evaluated and developed in Phase II.

PHASE II:
Select concepts from Phase I shall be further developed and evaluated to determine the best candidate. Efforts shall be made to demonstrate each candidate system's performance, reliability, safety and general compliance with the requirements using scientifically backed data including computer models, historical examples/data or other appropriate means. A final candidate shall be selected based on these results. The selected candidate system shall be extensively modeled to ensure feasibility of design and compliance with requirements. If feasible, a scaled or full prototype shall be developed and tested to demonstrate compliance with requirements.

PHASE III:
A final prototype shall be developed for demonstration to the U.S Government and DoD contractors. While this effort intends to satisfy a specific DoD T&E need, this technology could be adapted to various firing range facilities across both public and private sectors, potentially saving significant start up and lifecycle costs.

KEYWORDS: HVAC; Portable HVAC; Conditioned test environments; Thermal management; Heating and ventilation; Toxic fumes;

REFERENCES:

1. MIL-STD-810H
2. OSHA - Toxic Fumes
3. Toxic Fume Requirements
4. Propellant Burning Characteristics

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A214-013

TITLE: Behavioristic Electromagnetic Spectrum Assessment General Learning Engine (BEAGLE)

OBJECTIVE:
Develop an automated AI-based spectrum interface capability across the White Sands Missile Range (WSMR) range that monitors RF signals in order to identify, classify, track and predict detected signals over frequency bands for signal interference detection and signals analysis. Currently, when WSMR sends test data across the range, there is RF interference that disrupts the data flow.

DESCRIPTION:
Develop, design, and incorporate AI deep learning tools to enable WSTC to identify and classify RF signals within an area of interest. This effort will provide automatic modulation classification in addition to emitter position, navigation, and timing (PNT) information. BEAGLE is required to track the history of all encountered RF devices at WSTC and visualize the history of these previously identified devices. AI deep learning will enable BEAGLE to be self-trained in order to provide automated RF signal trending, prescribe solutions to any RF interference, predict expected RF environment behavior, and validate RF test events.

PHASE I:
In BEAGLE Phase I, a six-month study is proposed for determining the scientific and technical merit and feasibility.

PHASE II:
This phase will further develop the first phase, in which awards shall be made on the scientific, technical, and commercial merit of the Phase II proposal. Phase II is the principal research and development effort and is expected to produce a well-defined deliverable prototype. This Phase is expected to be a 1-year Phase.

PHASE III:
This phase intends to provide product/commercialization of the Phase II prototype in which Department of Defense (DoD) and/or commercial Applications of SBIR/STTR-funded R&D are developed. This Phase is expected to be a one-year phase.

KEYWORDS: RF signal; Signal classification; Machine learning; Artificial intelligence; Modulation classification; RF signal trending; RF interference;

REFERENCES:

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2. http://mil-embedded.com/news/dod-signs-agreements-for-spectrum-monitoring-systems/
3. https://dodcio.defense.gov/Portals/0/Documents/Spectrum/DoD%20CIO%20Memo%20DoD%20Principles%20on%20MESE%20w-attach.pdf
4. https://www.electronics-notes.com/articles/radio/rf-mixer/rf-mixing-basics.php

A214-014

TITLE: Advanced GPS-Based Minefield Detection/Clearance System

OBJECTIVE:
Investigate and develop a smart digitized map populated with threat data collected by a network of target geo-location devices that can work in a GPS or GPS-denied/degraded environment for legacy and next generation handheld detectors, and for explosive breacher mine detection for targeted neutralization of the explosive hazard threat.

DESCRIPTION:
The U.S. Army has a need for a smart, networked threat map that can be integrated with the handheld mine detector as the sensor, and the designated explosive breaching system as the "shooter." Currently, fielded handheld mine and Improvised Explosive Device (IED) detectors do not have GPS or positioning sensors to record the location of detected threats. Additionally, current mine detection capabilities are limited, which do not allow engagement with specific mine threats. In this effort, data from the handheld detectors will be analyzed using artificial intelligence (AI) or advanced algorithms to accurately identify surface laid and buried mines. The data will then also be used to populate a threat map that can be utilized by the advanced explosive breaching system for selective neutralization of targets. This will greatly reduce the amount of ammunition needed to clear a mine field versus creating an area effect across the entire minefield. The digitized threat map will also provide Soldiers with situational awareness of existing or neutralized explosive hazard threats on the battlefield.

PHASE I:
Phase I will consist of investigation and evaluation of the combination of artificial intelligence (AI) with advanced mine detection algorithm software—the combination of which will undergo laboratory testing. Further hardware-in-the-loop testing and laboratory tests will be conducted to integrate the "smart" mine detection algorithm software with the explosive breaching system requirements. The results of Phase I will demonstrate the integration of the sensor with the explosive breacher. Successful laboratory tests and demonstration will conclude Phase I and specific requirements for Phase II will be identified.

PHASE II:
Phase II will further develop the advanced AI/mine detection software demonstrated in Phase I in a relevant environment and demonstrate that the detectors can detect the threat. Phase II will also generate the digital threat map of an instigated minefield with accurate locations of the threats, mines, and IEDs. The digitized map will interface with the explosive breacher, which will receive and process the inputs from the threat map to eradicate all identified threats.

PHASE III:
Success of Phase II will allow transition of the technology to fielded AN/PSS-14C Mine Detection Systems, NXGNHH, Integrated Visual Augmentation System (IVAS), and the Tactical Assault Kit (TAK).

KEYWORDS: Digitized threat map; Mine detection; Data fusion; Object detection; Terrain mapping; Machine learning; Artificial intelligence; Classification;

REFERENCES:

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3. Gaskell, S. "IEDs increasingly a U.S. threat" Politico.com. 2012.
4. Kidwell, T., Jaffke, A. "Naval R&D and Marine Corps Innovation: Advancing assault breaching" Marine Corps Gazette. 2014.
5. Soldiers Test New IVAS Technology Capabilities with Hands On Exercises, Bridgett Siter, https://www.army.mil/article/230034/soldiers_test_new_ivas_technology_capabilities_with_hand_on_exercises
6. Army Tactical Assault Kit Always Adapting for New Era, George Seffers, https://www.afcea.org/content/army-tactical-assault-kit-always-adapting-new-era

A214-015

TITLE: Stationary Target Indicator Waveforms for Theoretical Active Electronically Scanned Array Antenna

OBJECTIVE:
The Apache Attack Helicopter Project Management Office (PMO) and the Sensors Product Director (PD) is seeking to develop an optimized Stationary Target Indicator (STI) waveforms with a supporting modeling and simulation tool set. The tool set will demonstrate capabilities of a theoretical Active Electronically Scanned Array (AESA) antenna to detect stationary ground targets while using the STI waveforms.

DESCRIPTION:
The Apache Attack Helicopter PMO would like to explore the potential benefits of a type of phased array antenna, specifically an Active Electronically Scanned Array (AESA) for the detection of stationary ground targets. An AESA within the Mast Mounted Assembly (located above the rotor) would allow transmission of Stationary Target Indicator (STI) waveforms and beam articulation over a target area. STI waveforms and tools are needed to establish capabilities and limiting factors of a Fire Control Radar (FCR) with a theoretical AESA.

Waveforms must address both Pulse Width (PW) and Pulse Repetition Frequencies (PRF) optimizations to accommodate interference caused by the rotary wing when engagement profiles force the beam to pass through the blades. Waveforms employing multiple-input multiple-output (MIMO) should be considered for generation of high resolution, low sidelobes and enhanced orthogonality. The tools will be employed to optimize the STI waveforms in the detection of targets within an area of 300 m cross-range (azimuth angular) by 150 m down-range in the following modes: 1. Real-Beam Imaging (RBI) and 2. Synthetic-Aperture Radar (SAR). The Apache will be positioned at theoretical altitudes, flight profiles and slant ranges detailed in the table below.

Innovative techniques to distinguish unique target signatures such as variable dwell times (the time an antenna beam spends on a target) to improve detection in low signal-to-noise ratio (SNR), wide bandwidths for fine range resolution, multiple transmit and/or receive channels, Doppler beam sharpening, radar cross section (RCS) pattern matching and others can be used. The STI waveforms and tools will be used at a minimum to define target area coverage, detectable target size, AESA specifications, Flight Profiles (Altitude, Slant Range, Velocity, Attitude, Look Angle to Target), and Beam Time on Target requirements. The optimized STI waveforms and tools will support development of combat techniques to be used in stationary target engagements in both: 1. RBI and 2. SAR.

Fire Control Radar with Theoretical AESA	
Aperture	8 in H x 22 in W
Peak TX Power	400 W
Duty Factor Pulse Compressing Allowed	20 %
Frequency	Ka and Ku
Polarization	Fully Polarmetric
Gain	45 dBi
Minimum Detectable Signal	-110 dBm
Range Resolution	0.3 m
Doppler Resolution	0.1 m/sec
Azimuth Beamwidth	0.75 deg.
Elevation Beamwidth	2 deg.
Theoretical Altitude, Slant Range and Detections	
Altitude	100-5,000 ft. AGL
Dismount Detection of 0.75 m^2 Target Location Error of 6 m	0.5-15km Slant Range
Vehicle Detection at 10 m^2 Target Location Error of 0.5 m	0.5-25km Slant Range
Theoretical Flight Profiles Heading to Target	
Hover at 0 deg. at Altitude and Slant Range	

Pedal Turns are allowed to enhance cross-range returns
Head-On at 0 deg. at Altitude and Slant Range S Turns Allowed to enhance cross-range returns
Broadside 90 deg. at Altitude and Slant Range Profile Arcs as required

PHASE I:
Develop an initial concept design for prototype STI waveforms for both RBI and SAR modes and manually demonstrate the expected results from each waveform. After the STI waveforms have been completed, development of supporting modeling and simulation (M&S) tools may be accomplished. The modeling tools can be existing in-house tools or based on commercially available products and will focus at a minimum on the system, battlefield environment and scenario parameters. The simulation tools can be existing in-house tools or based on commercially available products and will at a minimum apply parameters to the waveform under test at the following increments: Altitude 100 ft., Slant Range (Dismount 100 m, and Vehicle 100 m) with a focus on transmit frequency, polarization and bandwidth, number of antenna subarrays and platform movements. FCR radar data may or may not be supplied depending on availability, therefore data sources may be generated, or historical data may be used. The required Phase I deliverables will include a formal report documenting the analysis and designs accomplished, STI waveforms, and the proposed M&S tools.

PHASE II:
The adapted M&S tools used in Phase I will be optimized into a standalone software tool set to support the enhancement of the prototype STI waveforms with emphasis on the STI in RBI and SAR modes. The tool set will exercise the STI waveforms with input signatures of stationary ground target within clutter using signal simulation, signature databases, or collected data depending on availability. Results will be documented, and adjustments made to the prototype waveforms as signal extractions are accomplished. This process will result in enhanced STI waveforms for the detection of stationary ground target in clutter while in RBI and SAR modes. The desired Phase II result is a demonstration to substantiate the operation and capabilities of the waveforms and tool set. The required Phase II deliverables will include a formal report, enhanced STI waveforms, and the optimized tool set.

Classified proposals are not accepted under the DoD SBIR Program. In the event DoD Components identify topics that will involve classified work in Phase II, companies invited to submit a proposal must have or be able to obtain the proper facility and personnel clearances to perform Phase II work.

PHASE III:
In Phase III the vendor will work with PM Apache and the prime contractors to integrate the STI waveforms into a prototype FCR employing an AESA. The goal is to mature the STI waveforms and tool set to develop real world combat flight profiles and system configurations, which will be used to perform in-flight demonstrations. It is envisioned that an approach of increasing complexity will be used. The initial step is to develop RBI and SAR flight profiles and radar configurations for simplistic target engagements to test the optimized STI waveforms. The next step will be to develop progressively more complex RBI and SAR flight profile and system configurations for more difficult target engagements to completely test the optimized STI waveforms. During each iteration compare flight test results to the results produced by to M&S tool set and evaluate the differences to determine if the waveforms or tool set require modification. Any changes to the STI waveforms or tool set would be documented and presented to the government.

In the longer-term, the desire is to potentially integrate this technology onto current and/or future Army rotorcraft radars, such as Future Vertical Lift radars or the AH-64 Apache Fire Control Radar. The waveforms and accompanying tool set can be used in the digital evolution of target extraction techniques from high noise environments in military and civilian for applications (i.e. perimeter security, terrain mapping, advanced nonvisual point to point navigation in denied GPS environments and terrain avoidance). Also, the modeling and simulation tool set is not limited to RF-derived signal strings. Other commercial applications may include detection and processing of any sub-clutter signals as seen medical scanning, atmospheric anomaly, and industrial object detection.

KEYWORDS: Active Electronically Scanned Array; Stationary Ground Targets; Radar; Multiple-Input Multiple-Output; Low Signal-To-Noise; Clutter; Target Signatures; Real-Beam Imaging; Synthetic-Aperture Radar; Doppler Beam Sharpening;

REFERENCES:

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A214-016

TITLE: Unmanned Aircraft System (UAS) Full Motion Video (FMV) Enhancement

OBJECTIVE:
Develop a capability to help the MQ-1C Gray Eagle (a medium-altitude, long-endurance unmanned aircraft system) Payload Operators improve situational awareness (SA) and increase intelligence gathering efficiency to ultimately reduce workload. The desired capability would provide additional geography features, map overlays, known targets identifications, and user generated markings on the Full Motion Video (FMV) received at the unmanned aircraft system's Ground Control Station. This capability will be used to facilitate intelligence capture, Pattern-of-Life notifications, or to become part of a user-generated Database that provides information to operators that are surveilling an area.

DESCRIPTION:
MQ-1C Gray Eagle is an important Intelligence, Surveillance, and Reconnaissance (ISR) platform for the United States Army. The capture of intelligence products is labor intensive for the MQ-1C Gray Eagle Payload Operator. During the typical ISR mission, the Gray Eagle Payload Operator is often task saturated while also conducting radio communication with ground units. A seamless capability that would allow for quick tagging of Points of Interest, overlay of key geographical features (roads, buildings of interest), and integration of targeting / Field of View algorithms would reduce the amount of workload required of the operator. Other desired capabilities are quick intelligence capture by automatic creation of a quad chart that would detail graphical details, technical details (how many, how much, Pattern-of-Life), and other relevant details.

Useful information quickly accessible on the FMV would be an overlay road names, past events of military interest, high granularity coordinates, enemy or friendly locations, and past observation reports. This capability when complete will support added resiliency for Army and Multi-Domain Battle (MDB) mission threads in a contested environment. Once complete, this capability could be scaled for use in other Army systems.

PHASE I:
Determine the feasibility of adding real-time or near real-time information overlays to the FMV stream that is displayed to the Gray Eagle Payload Operators inside the Ground Control Station. The feasibility study should address the key components and technologies required to implement this capability. The proposed system should be modeled to benchmark the processing performance required to support the application and include an analysis of the latency.

PHASE II:
In Phase II, a prototype of the system will be developed and demonstrated in a laboratory environment. MQ-1C Gray Eagle has a Golden Full Motion Video set from a flight test from a CONUS test facility. The software application would process this mission representative Full Motion Video feed to demonstrate the capability to add information to the FMV to enhance the Operator's SA and reduce workload. The demonstration will provide an understanding of relevant data and help develop soldier requirements to provide a relevant capability once integrated into the MQ-1C Gray Eagle. As a potential follow-on, Product Manager Endurance Unmanned Aircraft Systems (MQ-1C Gray Eagle) has a lab environment that would allow for quick integration and assessment of the software application.

PHASE III:
In Phase III, the Army desires to pursue a fully-qualified capability for integration and testing in the MQ-1C Gray Eagle System. Training Materiel will be required to attach this application to the MQ-1C Gray Eagle software product line. In addition, the Army requires Defense Information System Agency (DISA) Certification to install the software application on military computing systems.

It is also envisioned that the FMV enhancement could be paired with the pre-existing Vision Based Navigation (VBN) onboard the UAV to provide a synergistic effect. Product Manager Endurance Unmanned Aircraft Systems (MQ-1C Gray Eagle) has a Vision Based Navigation (VBN) flight test program underway that could potentially facilitate this assessment.

In the commercial sector, the FMV enhancement could be useful for the law enforcement and homeland security domains, or in any application where there is a need for increased situational awareness.

KEYWORDS: Augmented Reality; Unmanned Aircraft Systems (UAS), Motion Imagery; Full Motion Video; Vision Based Navigation; Geographic Information System Mapping; Ground Control Station; Intelligence; Surveillance; and Reconnaissance (ISR);

REFERENCES:

- DISA (https://www.disa.mil/)
- STANAG-4586
- STANAG-4609
- Motion Imagery Standards Board https://gwg.nga.mil/misb/
- NATO STANAGs: https://nso.nato.int/nso/nsdd/listpromulg.html

A214-017

TITLE: Pandemic Entry and Automated Control Environment (PEACE)

OBJECTIVE:
Current Department of Defense force protection capabilities require the physical handling of Common Access Cards (CAC) and other DoD-issued identification cards. This process results in the physical handling of cards which are known vectors of diseases and which can result in large percentages of personnel being exposed. This is issue is specifically pertinent to bases and installations such as the Pentagon, military bases, and highly secured special facilities. Pandemic Entry & Automated Control Environment (PEACE) utilizes the metadata already collected and stored on CAC cards and related databases to facilitate rapid and seamless entry capability with the additional utility of providing both entry as well as internal control of personnel distribution and activities. In time, this capability could further be leveraged to promote network security as well as control of weapons and their platforms under respective programs of record.

DESCRIPTION:
Current identity management requires having a physical card (something you have) which is subject to compromise and in a pandemic environment results in a significant risk to the population that is to be protected. PEACE leverages biometric (something you are) and other metadata (something you know, i.e. password) already collected, so that entry operations to bases and installations can be conducted safely and the military's mission successfully accomplished.

Use of PEACE provides real-time validation of persons at the entry point location as well as within the installation and various facilities.

PHASE I:
Provide a white paper outlining a strategy towards gaining this capability that leverages current CAC card metadata (including biometrics) and other respective metadata. To the extent possible, the approach should comply with open standards and leverage existing infrastructure to include sensors currently employed for entry operations. The goal should be to increase throughput of personnel at entry points by order of magnitude over existing procedures while increasing safety and security. It is permissible to leverage other electronic systems commonly carried by military and governmental personnel. However, such leverage should not affect standard entry during degraded operations (i.e. failure of electrical system, cellular network, etc.).

PHASE II:
Successfully demonstrate the system's capabilities at an entry point as well as within the base/facility on a military installation.

PHASE III:
The objective is a flexible system of identification that is not reliant on something one is carrying and that provides a comparable or superior level of protection while providing scalable, reliable and smarter DoD force protection capabilities. This capability will be used across DoD and governmental agencies and would apply for commercial and general public use without compromising any aspect of the privacy or security of the process or participating individuals. Objective capabilities would be used to secure access to sensitive/classified areas, access and operations of critical weapons/respective platforms, and homeland protection in urban areas. Commercial applications include venues such as Disney World where annual passes are sold as well as major sporting events whose tickets are subject to counterfeiting.

KEYWORDS: Biometrics; meta data; force protection; entry control sensors;

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A214-018

TITLE: Recognition Biometric Camera System

OBJECTIVE:
Design and build a biometric recognition camera system to be integrated with the pre-existing Automated Installation Entry (AIE) system for deployment at Army installation Access Control Points (ACPs). The camera system can see through the windshield of approaching vehicles in various weather conditions during the day and nighttime and will also be used to report security alerts.

DESCRIPTION:
A growing demand for biometric recognition software is driving development of the technology as agencies like TSA employ this capability to automate the identity and boarding pass verification process at their airport checkpoints. The National Institute of Standards and Technology (NIST) studied the biometric recognition performance of 189 algorithms from 99 different manufacturers and reported varying degrees of performance. Advances in high resolution image cameras and identity analytics software are closing the performance gap with respect to errors encountered in the visual spectrum and illumination changes.

The current effort would use existing technology to develop a facial recognition system that has the capacity to detect passengers in a moving vehicle and compare the captured image of the driver to a photo gallery of pre-approved users. The results would be displayed to the guard with a photo of the driver indicating an access granted or access denied response in time to allow uninterrupted vehicle traffic flow for approved users. The system would be used 24/7, day and night, and in a variety of weather conditions.

PHASE I:
Develop an overall system design that includes specifications of the high-resolution cameras and recognition technology. System metrics include:

- Agnostic: Platform agnostic capability supports 3rd party systems or access control systems
- Scalable: Scalable architecture to support hundreds of thousands of photo records
- Data: Ability to leverage existing biometric data and user profile information
- Mobile: Ability to leverage guard force’s handheld wireless devices to collect, search, match, and display results
- Field of view: Programmable
- Resolution: >= 1600 x 1200 pixels
- Stand-off Distance: 5 – 15m
- Size: <= 143mm x 36mm (Mounted/positioned at vehicle lane allowing unobstructed view of oncoming traffic by the guard).
- Authentication: Authenticate the identity of multiple people grouped together.

PHASE II:
Develop and demonstrate a prototype system in a realistic environment. Conduct testing of an autonomous system to prove feasibility over extended operating conditions. The Government will provide access to a designated vehicle lane for setup, testing, and demonstration. Power source of 110V will be made available at the vehicle lanes. System metrics include:

- Image capture: Capture a facial image through the windshield of the approaching vehicle at a speed of no less than 5 mph up to 10 mph
- Accurate: 100% accuracy
- Processing Speed: <= 500 millisecond search and retrieval time
- Authentication: Authenticate the identity of vehicle occupants
- Data Metrics:
    - Number of facial captures: daily and cumulative totals
    - Number of facial matches and percentage: daily and cumulative totals
    - Match Accuracy: 100%
    - Throughput rate per minute: 10 or greater

- Average system response time

PHASE III:
This system could be used in a broad range of military and civilian security applications where automatic entry are necessary – for example, in installation protection operations or in enhancing security in industrial facilities.

KEYWORDS: Cameras; Identity analytical software; Digital image; Video frame;

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A214-019

TITLE: Biometric Data Cleansing

OBJECTIVE:
Resolve biometric data issues in the current authoritative biometrics database, the Department of Defense's Automated Biometric Identification System (DoD ABIS), through the development of a machine learning software application to identify errors and improve data quality, increasing speed and accuracy of responses to match requests.

DESCRIPTION:
For the purposes of this SBIR topic, biometrics refers to face, finger, iris, palm, latent images resident in the authoritative biometric data base systems. Cleansing refers to the deduplication of identity records, image (image = all/each modality) identification, image to field type association, image rotation analysis, image quality analysis, image spoofing, missing image analysis, and highest quality identification (per biometric).

DoD ABIS, the authoritative data base, is required to accept all encounter submissions from across the DoD for inclusion within the biometric data set. Much of this input is from old and nearing obsolescence, legacy collection systems that do not limit inputs that are incorrect or limit in any meaningful way based on image capture quality. For this reason, the authoritative data base includes a large number of biometric records with errors, missing data, or low-quality images. This poor quality data uses valuable computing resources as well as results in a higher number of "yellow" matches which require a human examiner to review the request as well as to manually determine if there is or is not a match in the biometric data within the data base and the request.

This issue will remain unresolved until all the legacy collection systems are displaced from the force. For that reason, a long term (3-5 year time horizon) solution is required to first, cleanse the data, and second, to continue to assess all incoming data, in order to rank and associate a data quality score for all images in the data base. As the old systems are removed from use in the field, data quality through the enforcement of collection quality thresholds which can be set on current COTS/GOTS (commercial/government off-the-shelf) collection systems.

This will greatly improve system matching results and reduce the number and type of requests that require manual examination by the operations division examination team. This will in return also reduce the examination team's backlog and greatly increase their ability to respond to the smaller number of inquiries that will require manual adjudication by the human examiner.

PHASE I:
The objective of this Phase is to design a concept for a set of machine learning tools to rate, rank and associate a data quality score for all images in the data base. Required Phase I deliverables include a determination of the feasibility for development of a prototype in Phase II, along with a preliminary design of the prototype which can rate and rank at least one of the several modalities of biometric image. Phase I deliverables include a plan for practical deployment of the proposed software applications including phases for the design, development and testing of a full suite of machine learning software for the initial data cleansing. Define the proposed concept and develop key component technological milestones in the design, development and testing of a continuous "triage" capability that will can rate, rank and categorize biometric data against all biometric modalities.

PHASE II:
The Phase II objective is to realign systems performance based on the output and the metrics associated to the data reclassification conducted in Phase I. Required Phase II deliverables include a functional prototype which can rate and rank at least one of the several modalities of biometric image. Demonstrate the prototype in accordance with the demo success criteria developed in Phase I for a single modality prototype. Required Phase II deliverables will also include expansion of the Phase I prototype design to cover all biometric modalities found within encounter-based records of the DoD ABIS authoritative data base. Phase II deliverables will include a detailed plan for the testing of additional modality cleansing as well as milestone proposal for the complete cleansing of the existing data set, as well as the milestone plan elements of the software applications

that will continuously “triage” all new biometric data submitted to the authoritative data base.

PHASE III:
The desired end state is the successful development of a machine learning algorithm that can rate, rank and categorize biometric data against all biometric modalities, which will directly impact the success of two Army Programs of Record (POR). Until collection devices are fielded across the Army and the DoD that can check biometric quality at the point of capture, the biometric data base will continue to be contaminated with poor quality biometric images and other data quality issues that hinder optimal performance of search algorithms for matching of biometrics.

A resident set of machine learning tools, that assess biometric quality of records as they enter the authoritative repository will provide a higher level of overall data quality and increase the timeliness and accuracy of biometric match requests from all DoD users that access the authoritative biometrics repository (ABIS 1.2/3 Army POR).

Until the authoritative data base is cleansed of incomplete, incorrect and poor-quality data, human examiners will be required to adjudicate match requests that would otherwise be addressed through the transaction manager and current matching algorithms. System performance, regardless of investments in new hardware, and software are limited in their ability to improve systems metrics without data cleansing as described herein.

The proposed solution should incorporate COTS/GOTS to the maximum extend to aid in the speed of development and deployment of a complete software solution that addresses current data in the authoritative data base as well as the ongoing “triage” of data from old Army legacy devices still in use for biometrics capture.

KEYWORDS: Biometrics; Modality; Face; Finger; Iris; Palm; Latent images; Authoritative biometric data base;

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A214-020

TITLE: Correlation of Detected Objects from Multiple Sensor Platforms

OBJECTIVE:
Research methodologies, frameworks, and processes to ingest, process, and correlate object detections and tracks from multiple imaging sensors including but not limited to ground, aerial, and overhead imagery and video. Outputs from the proposed study and eventual system will enable improved accuracy and confidence of detections as well as location across the ever-increasing number of sensors employed by Army Force Protection Systems (FPS).

DESCRIPTION:
Army Force Protection Systems (FPS) currently employs ground-based video sensors for situational awareness around bases; however, there exist multiple other forms of video and imagery-based systems that can provide additional situational awareness and intelligence to operators and commanders. With these additional data sources comes the possibility for improved accuracy of detections, tracks, and geolocation of objects of interest. This SBIR is intended to study (Phase I) how current detections are used, how to add additional data sources, and analytic products and produce a software prototype (Phase II) to improve correlation across the data sources identified in Phase I.

PHASE I:
Conduct a study on current use of analytics and type of sensors used in current systems deployed by FPS to determine additional sensor types that can be incorporated in Phase II along with architecture diagrams of data flow, possible outputs, and how to increase accuracy of analytics with the option to develop an initial software prototype design.

PHASE II:
This phase will produce a software prototype based on the Phase I study and outcomes. It is expected that the system will define an architecture and/or framework in order to ingest analytic products (i.e., metadata) and correlate the products from multiple sensor types and sensor modalities (e.g., aerial, ground, tower, etc.). It may be necessary to develop additional computer vision and machine learning algorithms in order to be able to determine that an object is the same object from multiple sensor platform perspectives (e.g., between a ground sensor and an overhead system). The prototype developed under Phase II can be run on already collected data to prove out the concept but is desired to be run in real time during Phase III.

PHASE III:
The end-state of the proposed research is a system that can improve upon the current baseline of sensor systems and analytic products used by FPS to improve upon the understanding of operators using deployed systems. During Phase III, the software prototype is desired to be matured to run in real time on multiple data sources (greater than two) and integrated with FPS programs.

KEYWORDS: Computer Vision; Machine Learning; Force Protection; Multi-INT Correlation; Analytics;

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The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b(7) of the solicitation.

A214-021

TITLE: Multi-spectrum Combat Identification Target Silhouette (MCITS)

OBJECTIVE:
Design and develop a technology approach/solution to create and provide realistic multi-spectral (i.e. infrared (IR), radar, Identification of Friend/Foe (IFF), electro-magnetic (EM), etc.) and other visual Combat Identification signatures in support of the live fire training domain. The capability must support armor and aviation gunnery training doctrine. The capability must be modular, low cost to procure and maintain and most importantly, not damaged by live fire engagements against the silhouettes.

DESCRIPTION:
During combat vehicle and aviation live fire gunnery training events, there hasn't been technology to provide accurate hostile/neutral/friendly multi-spectral representations to the training unit. Current training dogma does not allow the training unit to utilize all of the resources and capabilities of the combat systems to maximize training opportunities. This technology will:

- Align to the train as you fight philosophy
- Provide radar reflectivity signatures
- Provide electro-magnetic signatures/responses
- Provide real-time infrared/thermal signatures
- Incorporate Identification of Friend/Foe (IFF) responses to interrogations

The technology will allow the target silhouettes to provide realistic representation of actual vehicles across multi-spectral tactical equipment. The target silhouette should 'look' like the real vehicle relative to radar reflectivity, infrared signatures, electro-magnetic signatures, and IFF responses.

Since the training ranges, and target systems support many training events, the technology must allow for the programming of effects/responses. The same silhouette must be able to replicate a T-72, a battel tank, in one training event and a Stryker, a helicopter, in the next with nothing more than software parameter modifications. The dynamic configuration of the target silhouettes will enable active links between Live Fire Training and the Synthetic Training Environment (STE). This will allow STE enabled training systems to 'drive' the threat representations without need for live fire training range reconfiguration.

The technology solution will be utilized worldwide within the open air live fire training environments throughout a year (exposed to rain, snow, solar effects, wind, dust, etc.). The technology solution will be permanently installed in a target emplacement. Currently, Armor Live Fire Target Silhouettes are utilized on approximately 200 ranges; with 30 systems each with the silhouettes replaced every 20 days (10 times a year).

The technology and research elements should utilize a Modular Open System Approach (MOSA) toward fulfillment of the performance objectives; could be one box or many as long as interoperability is achieved.

The S&T of the effort is the mechanism, processes, and approaches to achieve the effects. The solution(s) must support an eventual safety certification. Space limitations will apply, and will be driven to the space available within a live fire target emplacement (refer to TC 25-8 and CEHNC 1110-1-23). No hazardous materials will be used within the approach or solution.

The design must support normal training operations of three to five days between maintenance actions (number of actuations will vary by training event and signature replication).

PHASE I:
Determine the feasibility and approach of developing a modular multi-spectrum Combat Identification Target Silhouette (MCITS) solution. The study shall explore and determine the solutions for creating the realistic signatures for the multi-spectrum elements. The study shall determine the design capacity based on the various training use cases, and develop the design approach to ensure training requirements can be supported. The study shall consider the environmental impacts and ballistic protection schemas as required.

PHASE II:
Continuation and realization of the research and development constructs investigated during Phase I. The Phase II efforts will focus on the lab development of proof of principle concepts supporting the generation of realistic multi-spectral signatures. The individual modular elements will be integrated together to ensure compatibility of the technologies into a singular prototype solution.

Develop a prototype Modular Combat Identification Target Silhouette (MCITS) technology solution for integration with existing FASIT Stationary Armor Target (SAT) and Moving Armor Target (MAT) Presentation Devices (i.e., target lifters). At a minimum, the prototypes will consist of one each frontal and flank target silhouette. The prototype will demonstrate the technology's ability to create accurate multi-spectral responses back to the training unit/vehicle/airframe in support of threat and combat identification based on scenario parameters. The prototype will demonstrate the technology's ability to align with the Live Training Transformation (LT2) product line in terms of common command and control (via Service Oriented Architecture (SOA) interfaces/contracts).

The prototype demonstration of the technology will be performed at an existing Army live fire training range prior to the completion of the Phase II activities. The expectation is to achieve a Technology Readiness Level (TRL) 6 upon Phase II completion.

PHASE III:
Transition technology to the Army Program of Record (POR) called Future Army System of Integrated Targets (FASIT). The technology would be viable for both digital and non-digital ranges, and other live fire training ranges where accurate multi-spectral target representations are required to support combat identification. The developed technology would have applicability to both the force-on-force training domain, and live fire test and evaluation environments.

To the maximum extent practicable, models should leverage Synthetic Training Environment (STE) representations, or be driven by them in a training event.

Commercial applications include gaming and law enforcement applications.

KEYWORDS: Multi-spectrum; Infrared signature; Radar signature; Electro-magnetic signature; Thermal signature; Target silhouette; Combat Identification

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A214-022

TITLE: Immersive Gaming of C5ISR Training and Testing

OBJECTIVE:
Develop and demonstrate a material solution to provide adaptive, scalable, cost effective training and testing to improve the Command, Control, Communication, Computers, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR) system operations for the Army's Signal Soldiers.

DESCRIPTION:
The desired solution at completion will significantly improve (or revolutionize) the network systems training and testing (TT) for the Warfighters, and enable the adaptive, scalable and cost-effective TT to keep pace with the rapid advance of the technology. The solution will address planning, installing, operating, and maintaining techniques, tactics, and procedures (TTPs) in the area of NetOps as well as the test and evaluation (T&E) on the hardware (HW) and software (SW) and other human machine interface (HMI) functions. The solution will provide immersive 3D simulated tactical network systems, address both individual and collective tasks as well as a variety of common challenging scenarios faced by the Warfighters to enable warfighters to be trained and use the latest HW/SW in the simulated operational environment. The solution will use a Modular Open Systems Architecture (MOSA) to enable integration of 3rd party vendors and Original Equipment Manufacturers (OEMs) to produce software modules for their respective network systems. The desired solution will enable users to set battle space scenarios, training collaboration between multiple-users, training with the latest HW/SW packages just clicks away, assess the HW and SW capabilities and provide the near-real time operational feedbacks to improve the products, shorten the product development-testing-training-fielding cycles, and ultimately reduce the field support costs for training and fielding through reduction of field support engineers.

PHASE I:
The Phase One deliverable will be:

- A comprehensive white paper describing:
    - Key C5ISR systems and the key operational parameters
    - Critical scenarios and variables of the scenarios encountered by signal soldiers
    - How learning objectives will be measured
    - The software requirements and software architecture that will meet the requirements
    - The hardware to be used and how it addresses size, weight, and power (SWAP) constraints
- A limited prototype demonstration

PHASE II:
Develop and demonstrate a prototype solution that can be executed by users at Soldier Touch Points for feedback back into the system. Phase Two deliverables will include:

- Prototypes that have:
    - Key C5ISR systems with configurable parameters that can be tested for accuracy
    - Configurable scenarios representing common challenges for signal soldiers
    - Both training mode and testing mode
    - Achieve a Technology Readiness Assessment of TRL 5
- Product documentation detailing the design of the prototype and Monthly Progress reports. The reports will include all technical challenges, technical risks, and progress against the schedule.
- Test reports detailing solution effectiveness
- Proposed Phase III Schedule

PHASE III:
Develop and demonstrate a multiplayer C5ISR solution, demonstrate a solution that simulatesscalable training and testing. Phase Three deliverables will include:

- Prototype that includes:
  - Key C5ISR systems with configurable parameters that can be tested for accuracy
  - Has configurable scenarios representing common challenges for signal soldiers
  - Has both training mode and testing mode
  - Has the ability to measure trainee progress as well as recommend practice scenarios
  - Uses a MOSA architecture
- Demonstration of the prototype of the C5ISR systems
- Test report detailing solution performance
- Product documentation detailing the functions and operations of the prototype
- Productization readiness report which presents any remaining design or implementation issues with respect to suitability to deploy
- Monthly Progress reports. The reports will include all technical challenges, technical risks, andprogress against the schedule

KEYWORDS: Training; Planning; C5ISR; Network; Signal; Cyber; Netops; Radios

BACKGROUND:
Current NetOps training and testing activities are cumbersome, costly, long cycles and not adaptive to the hardware (HW) and software (SW) releases on the Army Command, Control, Communication, Computers, Cyber, Intelligence,Surveillance and Reconnaissance (C5ISR) network systems or the fast pace of the technology improvement. Signal Soldiers do not have the capability to master their cyberspace operations skills by practicing operational planning, IOM, and Battle Drills on a tactical network. Nor do they have the ability to train on the network with realistic operational scenarios. In addition, the operationaltest feedback on Human Machine Interfaces of the network systems (both HW/SW) are not only limited but behind the technology advancement and release cycles. The solution, if successful, could potentially revolutionize the current training and testing process by providing an operational interface to simultaneously develop the user as a key component of the system of system.

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A214-023

TITLE: CTA Track/Discrim improvements for advanced threats

OBJECTIVE:
Develop and demonstrate Machine Learning based radar algorithms/techniques to improve Point of Origin (POO) Target Location Accuracy (TLA) in Counter-fire Target Acquisition (CTA) applications for semi-ballistic trajectories.

DESCRIPTION:
With the emergence of advanced threats, such as semi-ballistic RAM, the Army is interested in enhancing its ground-based CTA radar systems with the ability to better track/discriminate the advanced threats in order to improve POO TLA. The existing approaches, focused on ballistic trajectories, result in significant Target Location Errors against semi or non-ballistic targets. Significantly improving the Target Location Accuracy (TLA) against these advanced threats is a high Army priority. The main purpose of this effort is to investigate, develop, and demonstrate Machine Learning Based Radar algorithms/techniques to improve POO TLA in CTA applications for semi-ballistic RAM.

Effective deployment of these advanced algorithms may serve to enhance the performance of current and future Army CTA radar systems such as the AN/TPQ-50 and AN/TPQ-53. Both Programs of Record are funded annually for modernization efforts, commonly referred to as Modernization Development Efforts (MDE), which provide a conduit for the integration of improved hardware and emerging software algorithms. This includes initial design and development efforts, laboratory design, productization into the software baseline, and field-testing.

PHASE I:
Identify candidate Machine Learning (ML) based algorithms that address the challenge described in the objective section of this document. Investigate current tracker/discrimination functionality, investigate emerging applicable threats as delineated in the Validated Online Lifecycle Threat (VOLT), develop suitable ML based track/discriminate algorithms, conduct studies on candidate algorithms (size, power consumption, speed, and complexity), and perform laboratory testing on viability of candidate models and algorithms. At end of Phase I, prepare and present a study report to: (1) identify algorithms that improve POO TLA for semi and non-ballistic trajectories, (2) provide process and schedule for productization into the software baseline, and (3) demonstration plan for Phase II.

PHASE II:
Develop and demonstrate improvements to POO TLA for semi-ballistic trajectories during Live Test Events at Yuma Proving Ground, Arizona utilizing current ground-based Army radar systems.

PHASE III:
Productization of improvements into the software baseline: provide analysis, design updates, implementation support, and systems engineering testing for proposed algorithmic updates developed under Phase I and demonstrated in Phase II. Additionally, update the software and firmware to accommodate the final design and provide the following: software source code and executable files, system/subsystem specification updates, and performance specification document updates. Lastly, prepare lab tests, engineering test plans, and procedures to demonstrate the performance of the algorithms during a test event.

KEYWORDS: CTA Radar Systems; Tracking Algorithms; Discrimination Algorithms; Machine Learning; Semi and Non-Ballistic Trajectories

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A214-024

TITLE: Q-53 Long Range Artillery Guidance

OBJECTIVE:
Develop and demonstrate alternative extended range cannon artillery (ERCA) precision guidance mechanism utilizing the AN/TPQ-53 radar system resulting in increased firing accuracies and improved hit-to-kill performance. The AN/TPQ-53 was created by Lockheed Martin and detects, classifies, tracks and determines the location of enemy indirect fire in either 360- or 90-degree modes.

DESCRIPTION:
With the emergence of extended range cannon artillery (ERCA), the Army is interested in enhancing its ground-based CTA radar systems with the ability to better support the Long-Range Precision Fires (LRPF) mission. The main purpose of this effort is to investigate, develop, and demonstrate concepts/algorithms to improve accuracies for the AN/TPQ-53 system in order to provide precision guidance. Significantly improving the Target Location Accuracy for command guidance is a high Army priority.

Effective deployment of these advanced concepts/algorithms may serve to enhance the performance of current and future Army CTA radar systems, such as the AN/TPQ-53 to support the LRPF mission. This Programs of Record is funded annually for modernization efforts, commonly referred to as Modernization Development Efforts (MDE), which provide a conduit for the integration of improved hardware and emerging software algorithms. This includes initial design and development efforts, laboratory design, productization into the software baseline, and field-testing.

PHASE I:
Identify concepts that could be utilized to improve accuracies for the AN/TPQ-53 DDREX in order to provide precision guidance. Candidate concepts could consist of multi-sensor, software or hardware concepts to improve accuracies in support of precision guidance. Special consideration should be given to size, power consumption, cost, complexity of the proposed concept; accuracy improvements associated with proposed concept; and modeling/simulation on viability of proposed concepts. At end of Phase I, prepare and present a study report to: (1) identify concepts that improve accuracies to support precision guidance, (2) identify size, power consumption, speed, and complexity of selected modes/algorithms, (3) provide modeling/simulation results, and (4) demonstration plan for Phase II.

PHASE II:
Develop and demonstrate accuracy improvements to support precision guidance utilizing high fidelity modeling and simulation, collected AN/TPQ-53 data and/or a surrogate prototype radar system.

PHASE III:
Productization of improvements into the software baseline: provide analysis, design updates, implementation support, and systems engineering testing for proposed algorithmic updates developed under Phase I and demonstrated in Phase II. Additionally, update the software and firmware to accommodate the final design and provide the following: software source code and executable files, system/subsystem specification updates, and performance specification document updates. Lastly, prepare lab tests, engineering test plans, and procedures to demonstrate the performance of the algorithms during a test event.

KEYWORDS: CTA Radar Systems; Long Range Precision Fires; Radar Guidance

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A214-025

TITLE: TPQ-53 Managed Comms/ Radar Functionality

OBJECTIVE:
Develop and demonstrate a Comms capability and Multi-Function resource manager for the AN/TPQ-53 radar system. The AN/TPQ-53 radar system detects, classifies, tracks, and determines the location of enemy indirect fire in either 360- or 90-degree modes.

DESCRIPTION:
With the emergence of digital array technologies capable of supporting Multi-Function capabilities, the Army is interested in developing and integrating a Comms capability into the AN/TPQ-53 radar system, as well as a Multi-Function resource manager to efficiently manage the Comms and Radar functionality. The main purpose of this effort is to investigate, develop, and demonstrate concepts/algorithms to enable timely data sharing between multiple radar systems for improved Target Location Accuracies and Probability of Detection.

Effective deployment of these advanced concepts/algorithms may serve to enhance the performance of current and future Army CTA radar systems, such as the AN/TPQ-53 for improved TLE and Pd, as well as enabling future ‘cooperative’ radar concepts. This Program of Record is funded annually for modernization efforts, commonly referred to as Modernization Development Efforts (MDE), which provide a conduit for the integration of improved hardware and emerging software algorithms. This includes initial design and development efforts, laboratory design, productization into the software baseline, and field-testing.

PHASE I:
Identify and develop an initial comms capability for the TPQ-53 DDREX radar and investigate candidate Machine Learning (ML) based techniques to manage Radar/Comms functionality with minimal impact to Radar performance. Specific considerations: Investigate comms mode implementation (including encryption); benefit of comms to the Counter-fire Target Acquisition (CTA) mission; conduct studies on size, power consumption, speed, and complexity of candidate comms modes and radar/comms management algorithms; and perform modeling & simulation on viability of candidate modes and algorithms. At end of phase I, prepare and present a study report to: (1) identify comms mode and radar/comms management algorithms, (2) present use cases for combined radar/comms capability for CTA mission, (3) identify size, power consumption, speed, and complexity of selected modes/algorithms, and (4) demonstration plan for Phase II.

PHASE II:
Develop and demonstrate a prototype comms mode and radar/comms management algorithms utilizing surrogate radar systems.

PHASE III:
Productization of improvements into the software baseline: provide analysis, design updates, implementation support, and systems engineering testing for proposed algorithmic updates developed under Phase I and demonstrated in Phase II. Additionally, update the software and firmware to accommodate the final design and provide the following: software source code and executable files, system/subsystem specification updates, and performance specification document updates. Lastly, prepare lab tests, engineering test plans, and procedures to demonstrate the performance of the algorithms during a test event.

KEYWORDS: CTA Radar Systems; Multi-Function; Cooperative Radar

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A214-026

TITLE: Threat/Target Sensor Stimulation Technology

OBJECTIVE:
Develop and demonstrate the capability to synthetically simulate infrared and radar signatures to trigger a threat or target response from the system under test for use in assessing automatic target detection, recognition, and identification in a fully immersive hardware-in-the-loop test environment.

DESCRIPTION:
Aberdeen Test Center's (ATC) Moving Target Simulator (MTS) is a hardware-in-the-loop simulator used to assess the target acquisition and target tracking performance of combat vehicles and fire control systems. The MTS is a 100-foot radius dome structure whereby the interior of the dome doubles as a projection screen. Items being tested in the MTS are presented with visual and infrared targets on the projection screen which follow various predetermined target paths. System operators then attempt to acquire the target as quickly as possible and track it accurately throughout the target path. Legacy systems have primarily relied on the operator to identify and track targets. However, future systems will employ infrared and radar-based sensor technology to assist with or automatically detect, identify, track, and engage targets. The MTS requires the ability to simulate the infrared and radar signatures of these targets and thus trigger these sensors so that the system under test believes that a threat or target exists so the resultant response can be measured. The goal being that the threat stimulation capability remains independent of the system under test and built into the fully immersive visual test environment at ATC.

PHASE I:
Determine the technical feasibility of synthetically generating realistic targets that can be used to trigger infrared and radar-based automatic target/threat detection systems in a hardware-in-the-loop test environment.

PHASE II:
Produce a prototype and demonstrate the capability of generating synthetic targets in ATC's Moving Target Simulator facility.

PHASE III:
Implement the capability into ATC's Moving Target Simulator and continue to adapt and evolve the technology to keep pace with advances in automatic target detection systems. The ability to synthetically generate targets will provide ATC and the DoD with the technology leap necessary to assess automatic target/threat detection, recognition, and identification of manned and unmanned weapon systems in controlled hardware-in-the-loop test environments. This technology can be leveraged by private industry to test such things as self-driving cars, delivery robots, and any autonomous system that uses infrared and radar sensor technology for navigation and decision making.

KEYWORDS: Target detection; Sensors; Infrared signatures; Radar signatures; Automated target recognition; Synthetic data

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3. Ahmed, Sherif, et al. "Radar target stimulation device and method." U.S. Patent No. 10,527,715. 7 Jan. 2020.
4. Hager, Benjamin, and Jace Allen. Raw Data Injection and Failure Testing of Camera, Radar, and Lidar for Highly Automated Systems. No. 2019-01-1378. SAE Technical Paper, 2019.

A214-027

TITLE: Dynamic Hartmann Turbulence Sensor Processing

OBJECTIVE:
Army SMDC aims to reconstruct the vertical profile of turbulence (C_n^2) as a function of height above ground using a Hartmann Turbulence Sensor (HTS) mounted on a tracking gimbal and platform that lifts 1000 meters off the ground. The goal of this SBIR grant is to develop a system including a beacon, turbulence sensor and data collection methodology to collect and process dynamic optical turbulence data from the sensor to measure the turbulence with consideration to the rate of movement of the beacon platform.

DESCRIPTION:
As modern laser weapon systems are becoming more prevalent, measuring atmospheric turbulence for predicting the laser system effectiveness will be of great concern. Of particular interest is the variation in atmospheric turbulence as a function of height above ground. Among the most proliferated and trusted atmospheric turbulence measurements, is the Hartmann Turbulence Sensor (HTS). This sensor requires an optical source (beacon) to be placed at some distance from the sensor head and for an integrated turbulence measurement to be performed along the path. Consequentially, turbulence measurements with HTS have been restricted to static, near ground paths only.

There are numerous challenges to overcome to obtain turbulence measurements as a function of height, which can be achieved by elevating the beacon on a platform (e.g. Unmanned Aircraft System). Some challenges include existing hardware constraints in both the turbulence sensors and beacons. Turbulence sensors typically have very narrow fields of view which requires very accurate pointing. Similarly, beacons are typically limited in beam width to less than 10 degrees and must be accurately and actively pointed at the sensor on the ground to prevent loss of signal. This SBIR grant shall include research on how to implement the entire data collection system and data processing required to accurately reconstruct the vertical C_n^2 profile.

The proposal for this effort shall include details on how to construct the data collection hardware including mounting a beacon a platform (e.g. UAS) with pointing ability, identifying a turbulence sensor to be used (e.g. Shack Hartmann Wavefront Sensor), and tracking capability for the turbulence sensor. The proposal shall address the necessary data collection rates of the turbulence sensor to measure the turbulence with consideration to the rate of movement of the beacon platform. There are two different data processing functions that should be researched and developed in order to provide the complete solution that is required of this program. The first is the conversion of raw Shack-Hartmann wavefront sensor (SHWFS) data to atmospheric turbulence parameters such as the Fried coherence length (r0) and the refractive index structure function, C_n^2. The second function is the reconstruction of the vertical turbulence profile using the full data set captured over a complete beacon ascent. The SHWFS data processing should consider the following established methods as a minimum; differential image motion (DIMM), difference of differential tilt variance (DDTV), and differential scintillation. Other methods as well as new innovations in this area are encouraged but their performance in comparison to the above listed methods should be well documented. The vertical profile reconstruction problem should consider iterative stepwise solutions as well as more optimized simultaneously solved system solutions in order to overcome the noise amplification problems that are expected with the iterative solutions.

PHASE I:
The Phase 1 effort will use wave optics generated (simulated) HTS data to establish the minimum requirements for the HTS and to develop the processing algorithms. The outcome of this work will be to develop, demonstrate, and deliver the processing algorithms that can optimally process the HTS data and reconstruct the vertical turbulence profile. The accuracy limitations and its dependence on HTS design parameters such as frame rate, SHWFS resolution, noise, beacon ascent rate, as well as any other pertinent

parameters will be fully defined and described.

PHASE II:
The results of the Phase I designs will be utilized to establish the design requirements for an optimized HTS prototype system. This HTS system will be built and then used to collect dynamic HTS data which will be used to further develop and demonstrate the processing methods developed in Phase I.

PHASE III:
High energy DoD laser weapons offer benefits of graduated lethality, rapid deployment to counter time-sensitive targets, and the ability to deliver significant force either at great distance or to nearby threats with high accuracy for minimal collateral damage. Knowledge of the atmospheric turbulence along the shot path is a key limiting factor for lethality and as such it is a critical input for the fire control system.

The Phase III effort shall be to design and build a system that could be integrated into an Army's High Energy Laser Weapon System for real time use as part of the fire control system. Military funding for this Phase III effort would be executed by the U.S. Army Space and Missile Defense Technical Center as part of its Directed Energy research.

KEYWORDS:
Optical tracking sensor; High energy lasers; Atmospheric turbulence measurement; Atmospheric turbulence profiling

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4. Terry J. Brennan, David C. Mann, "Estimation of optical turbulence characteristics from Shack Hartmann wavefront sensor measurements", Proc. SPIE 7816, Advanced Wavefront Control: Methods, Devices, and Applications VIII, 781602 (12 August 2010); doi: 10.1117/12.862808

A214-028

TITLE: Risk Assessment Modeling Tool (RAMoT)

OBJECTIVE:
Develop a high-fidelity real-time risk assessment tool for hypersonic testing to analyze test mission missile flight debris paths in different configurations (direction, velocity, altitudes) so as to predict the impact zone and ensure the safety of infrastructure and people surrounding the White Sands Missile Range.

DESCRIPTION:
White Sands Missile Range needs to enhance public safety with a high-fidelity real-time flight safety risk assessment modeling tool (RAMoT) that will be used to analyze the risk of proposed airborne missile test missions. The model will quantify in a variety of different missile debris path configurations the vulnerability models used to reduce risk in WSMR-adjacent populations. This tool is required to handle the modern next generation calculations that are required for airborne hypersonic weapons in order to maintain proper Flight Safety Analysis processes.

RAMoT should be a single, comprehensive, government-owned Flight Safety Analysis computing tool that relies heavily on software development and can take full advantage of modern computing power to determine risk levels with high fidelity. Risk analysis for the purposes of Flight Safety management is a time-intensive process which requires the capability to generate, interpret, and analyze large quantities of data.

RAMoT requires advanced computational models that can give accurate estimates of vulnerabilities based on physical models rather than engineering estimates. As part of their flight safety analyst duties, operators are required to analyze risk for the missions being conducted on the range for a wide variety of programs involving many different configurations for missile flight debris path. The wide variety of missile types, trajectories, and flight termination systems requires detailed analysis for each mission, where the operator must accurately quantify the risk to both adjacent populations and property. In order to quantify the risk, the operator must be able to determine the vulnerability of things such as building, houses, aircraft, and unsheltered persons. Historically the vulnerability models have been based on empirical data or engineering estimates that can overstate or understate the associated risk. The intent of RAMoT is to provide accurate vulnerability models, more precisely quantify risk, and reduce the uncertainty associated with WSMR's current empirical processes, giving operators more confidence in the analysis.

RAMoT is a Flight Safety requirement that should act as a next-generation one-stop-shop tool that supports the entire Flight Safety Analysis process. This process broadly consists of four steps: loading and extracting data, simulating vehicle behavior, trapping of state vectors, and risk analysis. Each step requires the generation or the processing of many (up to tens or hundreds of thousands) of trajectories.

PHASE I:
In RAMoT Phase I, a six-month study is proposed for determining the scientific and technical merit and Feasibility.

PHASE II:
This phase will further develop the first phase, in which awards shall be made on the scientific, technical, and commercial merit of the Phase II proposal. Phase II is the principal research and development effort and is expected to produce a well-defined deliverable prototype. This Phase is expected to be a 1-year Phase.

PHASE III:
This phase intends to provide product/commercialization of Phase II prototype in which Department of Defense (DoD) and/or commercial Applications of SBIR/STTR-funded R&D are developed. This Phase is expected to be a one-year phase.

KEYWORDS: Risk Analysis; Risk assessment; Flight safety analysis; Hypersonic testing; Debris risk; Debris propagation; Trajectory propagation; Vulnerability model

REFERENCES:

1. https://www.wsmr.army.mil/fn/Pages/White-Sands-Flight-Safety-Officials-Play-Role-in-Space-Milestone.aspx
2. https://www.nasa.gov/pdf/483000main_ModelingFlight.pdf
3. https://ntrs.nasa.gov/search.jsp?R=19870012908
4. https://www.japcc.org/how-can-modelling-and-simulation-support-integrated-air-and-missile-defence/

A214-029

TITLE: Metamaterial Based Antenna

OBJECTIVE:
The SBIR objective is to create an antenna design for satellite communication bands, including Ku, K, and Ka bands, based on metamaterials to decrease size, weight, performance and cost (SWaP-C) and increase antenna bandwidth, improve signal reception, and provide a higher gain. The antenna design would be developed for Army Aviation platforms with a focus on a low profile and a conformal fit, while maintaining optimal performance to allow installation on non-ideal surfaces encountered in the adverse aviation environment. The SBIR would also characterize the potential gains and tradeoffs of such a metamaterial-based topology.

DESCRIPTION:
Army aviation has the need of a broadband antenna with reduced size and weight while obtaining enhanced power efficiency and ultra wide bandwidth (UWB) frequency capability. Such a capability would contribute to the Army's superiority in multiple abilities, to include conducting joint air-ground operations, maintaining manned-unmanned teams, and operating in contested airspace. In addition, a physically low profile is needed for airborne applications to maintain aircraft aerodynamics and minimize surface clutter and interaction with other pre-existing equipment. Airborne platforms have limited surface area for antenna mounting, and it is often non-electrically conductive. These constraints require the antenna(s) to be "electrically small," with a total height less than one quarter of a wavelength at its center frequency. It is envisioned that emerging developments and technology using metamaterials could provide a solution for such an antenna.

The focus of this SBIR is to conduct research culminating in the development of a metamaterial-based antenna that will provide the desired performance for aircraft applications. Metamaterials are artificial engineered materials that possess a negative index of refraction for an isotropic medium. Their properties can be tailored to provide anomalous interactions with the electromagnetic field. These electromagnetic interactions include the effect of causing the electromagnetic waves phase and group velocity to have a reversed direction of propagation with the respect to the direction of energy flow, as well as, preventing reflected and scattered radiation return on active antenna surfaces. Utilization of left-handed materials (LHM), such as double negative materials (DNG) and epsilon near-zero permittivity (ENZ) materials enable the antenna size to be reduced while increasing the antenna efficiency and bandwidth. Legacy techniques, such as, utilization of split ring resonators (SRR) and complimentary SRRs (CSRR) in the substrate and superstrate of the PCB based antennas are known to increase the radio frequency (RF) bandwidth and directivity by manipulation of permittivity and permeability in specific frequency bands.

Much metamaterial research and work has been competed during the last fifteen years. The challenge presented in this SBIR will be to combine multiple efforts and create a product that can perform in the aviation adverse environment and endure that grueling environment without failure in high operational situations. This also implies that the antenna must survive in extreme environmental conditions, to include heavy rainfall, high heat desert type temperatures, very cold environments covered with ice and snow, and continual abrading due to small particles such as sand.

The antenna is expected to interface with a 50 Ohm coaxial cable with a suitable high frequency capable connector. If power is required, it will be derived from 28 VDC aircraft power.

PHASE I:
The purpose of Phase I is to determine the engineering feasibility of designing and antenna with tri-band performance in portions of Ku, K, and Ka band. An engineering study will be conducted to explore the options and the design space of what is possible from a SWaP and antenna performance perspective. The

trade space will include frequency bandwidth, antenna gain, and antenna efficiency versus the antenna height, length, width, and weight. Projected radiation patterns and polarization predictions are also required. The Army needs adequate antenna parameters and characteristics to predict how well the antenna would perform at various aircraft installation points. The antenna should also be capable of transmitting at least 40 Watts in the same bands. The primary objectives of Phase I are:

a. Determine the feasibility of designing and airborne capable antenna Ku, K, and Ka tri-band operation.
b. Develop a preliminary antenna design that would be compatible for the AH-64E (attack helicopter), CH-47F (heavy lift helicopter), UH-60M (medium lift helicopter), and Future Vertical Lift (FVL).
c. Develop a concept of operation showing how the antenna could be utilized in Ku, K, and Ka band radio frequency (RF) scenarios (i.e., link distances and incident angles with respect to the aircraft).
d. Perform an analysis of how the antenna would perform on top, side and bottom installations for AH-64E, CH-47F, UH-60M, and FVL aircraft. The analysis should also include rotor blade masking effects at various pitch angles and expected RPMs.

Phase I deliverables will include a feasibility report outlining the gaps and path forward needed for implementation and cover all four areas lists above at a minimum.

PHASE II:
Develop a proof of concept/prototype capable of demonstrating RF link performance in Ku, K, and Ka bands.

Phase II deliverables will include functional antenna hardware, completed antenna design, and antenna test results including radiation patterns, gain, and input reflection coefficient (S11) versus frequency.
Phase II will reach at least TRL 5 and commercial viability will be quantified.

PHASE III:
The expectation is to broadly field the metamaterial-based antenna across Army Aviation. Phase III will consist of all the required acquisition activities required to transition the capability to full-rate production. The small business is expected to obtain the funding from non-SBIR government and private sector sources to transition the technology into viable commercial products. Specific military applications may include AH-64E, CH-47F, UH-60M, and FVL capability.

KEYWORDS: Aviation; Helicopter; Aircraft; Antenna; Rotary; Prototype; Metamaterials

REFERENCES:
1. M. Palandoken, A. Grede, and H. Henke, “Broadband Microstrip Antenna with Left-Handed Metamaterials,” *IEEE Transactions on Antennas and Propagation*, vol. 57, no. 2, Feb., pp. 331-338, 2009.
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3. J. Soric, N. Engheta, S. Maci, and A. Alu, “Omnidirectional Metamaterial Antennas Based on Epsilon-Near-Zero Channel Matching,” *IEEE Transactions on Antennas and Propagation*, vol. 61, no. 1, Jan., pp. 33-43, 2013.

A214-030

TITLE: Wide Bandgap Bi-Directional Converter

OBJECTIVE:
Design a wide bandgap bi-directional converter (BDC) capable of operating across all military ground vehicles. The use of different wide bandgap semiconductors, such as Gallium Nitride (GaN) and Silicon Carbide (SiC), are expected to significantly increase the BDC's end-to-end efficiency which will reduce size, weight and cooling demands.

DESCRIPTION:
With the growing vehicle electrical power requirements in military vehicle systems the use of wide bandgap semiconductor technology is necessary for the future. Topic proposals should focus on a BDC capable of bi-directionally converting from 600VDC to 28VDC and from 28VDC to 600VDC and delivering 20kW. The converter must account for safety, efficiency, scalability, configurability, CAN control, and integration. The BDC should be 8-bit microcontroller (MCU) or smaller. The solution will have the processing power necessary for fault detection and handling capabilities, built-in diagnostics, and stand alone and remote control in a compact device suitable for use in military ground vehicle applications. The proposed unit must use wide bandgap technology, such as GaN or SiC, that is capable of operating at high voltages. The use of wide bandgap power electronics that can operate in a 71 degrees Celsius ambient environment is required. The unit should be able to communicate using J1939 CAN interface, and should demonstrate High Voltage Interlock capabilities, and Ground Fault Detection and Protection. The proposal should address thermal management plan for the BDC, while also meeting military standards.

PHASE I:
Develop a proof-of-concept circuit for a wide bandgap bi-directional converter that addresses the features and functionality described above. This preliminary design will include a packaging plan with a size, weight power, and cost analysis (SWaP), thermal analysis, and considerations for meeting MIL-STD-1275, MIL-STD-810G, and MIL-STD-461 by modeling, analysis, and/or brass board proofs of concept, all to be provided. For further elaboration, MIL-STD-1275 standardizes characteristics of 28-volt DC input power to utilize equipment in military vehicles, MIL-STD-810G reviews the potential impacts that environmental stresses can have on materials, and MIL-STD-461 standardizes the requirements and test limits for the measurement and determination of the electromagnetic interference characteristics of electronic equipment.

PHASE II:
Electrical, thermal, mechanical, and functional aspects of a wide bandgap bi-directional converter solution will be designed, developed, and built. Demonstration and technology evaluation will take place in a relevant laboratory environment, on a military ground vehicle system, or in a stand-alone configuration.

Phase II will reach at least TRL 5 and commercial viability will be quantified.

PHASE III:
Mechanical packaging and integration of the solution into a vehicle will be achieved (TRL6) and a technology transition will occur so the device can be used in military ground vehicle applications, and/or in a stand-alone configuration. Conformance to key military standards will be emphasized in the Phase III effort.

KEYWORDS: Power Conversion; Power Electronics; Gallium Nitride; GaN, Silicon Carbide; SiC, Wide Bandgap; Bi-Directional

BACKGROUND:
This new Bi-Directional Converter will utilize wide-band gap technology to improve performance for the vehicles. The Bi-Directional Converter is also critical component being used in the Extended Range Canon

Artillery (ERCA) mission, which aim to field systems capable of accurately firing at targets more than 70 kilometers away. This effort will serve as an example of that potential as well as provide a path to transitioning the technology into power conversion that can be used in existing vehicles, such as MRAP CS13 vehicles, the Stryker family of armored fighting vehicles, Bradley infantry fighting vehicle, Abrams, armored multi-purpose vehicles (AMPV), and the THAAD Missile Defense System.

REFERENCES:

1. MIL-STD-1275
2. MIL-PRF-GCS600A
3. MIL-STD-810G
4. MIL-STD-461

*MIL-STD refers to a United States defense standard that is used to help achieve standardization objectives set forth by the U.S. Department of Defense. MIL-STD establishes uniform engineering and technical requirements for military-unique or substantially modified commercial processes, procedures, practices, and methods.

A214-031 - TOPIC REMOVED

A214-032

TITLE: Enhanced Impact Protection HGU-56P Aviator Helmet

OBJECTIVE:
The objective of this SBIR grant is to enhance impact protection of the HGU-56P aviator helmet, which is already known as the most protective helicopter helmet ever made. Currently, the HGU-56P helmet retrofit of lining material is capable of delivering threshold impact performance improvement of 20% over current Extended Polystyrene (EPS) foam.

DESCRIPTION:
At present, aviation helmets provide minimal impact protection due to weight limitations associated with crash load requirements. For example, if the helmet is too heavy under an otherwise survivable crash landing, the weight of the helmet cannot allow breaking the neck of the aviator. Optimal helmet design requires a balance between the need for protection from trauma and the comfort and practicality of the helmet for the user to ensure the best outcomes. New foam technology used in commercial industry promises superior crash protection with no impact on helmet weight. Improved impact protection to the user in a hard landing or crash scenario is a fundamental component of soldier lethality, one of the six army modernization priorities of the Army which includes the core requirement of communication.

Intent of this proposal is to perform retrofit using a new material/design which spreads out impact load and cuts the energy absorbed by the user to reduce instances of brain injury/Post-traumatic stress disorder (PTSD) and concussion. *A redesign of the helmet will not be an option consideration due to cost reasons.*

This solicitation intends to identify an existing commercial technology to provide the best overall reduction in impact energy to the user. Key considerations for evaluation shall at minimum (but not be limited to) include reduction in impact energy by comparison to EPS (threshold is 20%, objective is 40%), weight, cost of material, ability to absorb more than one impact without requiring replacement, and ability to retrofit a standard HGU-56P helmet without tools. Additional considerations shall be data showing user comfort is desired for proposed solution (ability of material to conform to user’s head to eliminate hot spots, material does not absorb sweat, heat (can the material vent heat from the user), etc.). Other factors may include material properties such as ability to perform under temperature ranges common to Army users and resistance to exposure to petroleum/oil/lubricants (POL) commonly encountered on Army helicopters.

PHASE I:
This effort shall identify and test the most promising material solution to reduce impact to the user, which can be retrofit into the HGU-56P aviator helmet with no weight gain to the helmet and at the least cost. The initial proposal shall identify a solution which provides impact energy reduction by comparison to EPS foam. Data showing attenuation of the technology proposed by comparison to EPS foam shall be included in the proposal. The contractor shall perform a laboratory demonstration in Phase I demonstrating and quantifying impact reduction in tests using two Government furnished HGU-56P helmets in the same size. The contractor shall modify one of the helmets with the proposed improvements and perform identical tests using one modified and one unmodified HGU-56P helmet so that comparison data clearly shows performance improvements achieved. Crash testing shall be done per the item specification for the HGU-56P helmet, in System 2 Helmet Configuration (AIHS-FS-0002), Section 4.2.5.2-4.2.5.3, titled Aircrew Integrated Helmet System Fabrication Specification. For cost reasons, testing shall only be done on the crown of the helmet. The final report shall estimate costs and weight impact of the technology solution proposed and document the actual impact energy absorption measured in the laboratory demonstration test.

Key meetings shall be a kickoff meeting within 3 weeks of contract award, bi-weekly telecons not to generally exceed 30 minutes in length with a single point of contact who can brief status of project and a test readiness review, which can be combined with a bi-weekly telecom. The contractor shall host Government witness of the laboratory demonstration, with particular focus on test setup.

PHASE II:
The solution identified in Phase I will be applied and tested to meet all requirements of the specifications proposed for update or replacement in all helmet sizes. The contractor shall propose changes for all lining material in the helmet being replaced. The contractor shall purchase helmets in all user sizes to support testing. Crash testing shall be done per the item specification for the HGU-56P helmet, AIHS-FS-0002, Section 4.2.5.2-4.2.5.3, titled Aircrew Integrated Helmet System Fabrication Specification for all helmet sizes retrofitted with new material solution. A summary report at the end of the test shall document performance improvement of the new solution. The contractor shall update the Aircrew Integrated Helmet System Fabrication Specification to reflect new performance capability of the new material. This may include the addition of testing for rotational energy reduction. The contractor shall perform analysis or test demonstrating performance does not change at high and low operating temperatures.

Deliverables will include a test plan, test report, an updated performance specification reflecting measured improvement in impact absorption energy performance, minutes for all meetings conducted with the vendor, presentation slides for test readiness review, a white paper detailing the installation cost of the retrofit solution, and a cost report detailing manufacturing cost as a function of helmet quantity from a minimum of 50 and up to 1000 at a time. The test report shall document all test results done under the contract. A retrofit procedure for replacing the existing helmet liners with the new solution shall be required and demonstrated at the end of the contract.

Key meetings shall be a kickoff meeting within 3 weeks of contract award, bi-weekly telecons not to generally exceed 30 minutes in length with a single point of contact who can brief status of project and a test readiness review, which can be combined with a bi-weekly telecom. The contractor shall host Government witness of any testing, with particular focus on test setup.

PHASE III:
Develop production processes for all materials necessary for retrofit into HGU-56P helmet in all user sizes. Update any specifications needed to reflect final production configuration weight and performance. Repeat bench qualification testing if production configuration deviates too far from prototype configuration tested in Phase II. Support operational testing on multiple Army rotary wing aircraft to evaluate user comfort. Aviation helmets used throughout DoD may find retrofit application for this same solution, not to mention the potential for helmets common to Army ground soldiers.

KEYWORDS: Impact Reduction; Impact Attenuation; Impact Protection; Elastic Microlattice Polymer; Helmet

BACKGROUND:
Army aviation has relied on Enhanced Polystyrene (EPS) foam as a standard and cost-effective impact solution for over 20 years. During this time, new designs and materials have been marketed in sports helmets which have been certified to have superior impact protection. This includes liquid nanofoam and elastic microlattice polymers.

In 2010 Kali began making motorcycle helmets with a layer of softer, less dense, foam next to the head, with cones or pyramids of the softer foam sticking up into the layer of harder, denser foam in the outer layer. The softer foam next to the head crushes first, and if the impact is a lesser one that may be the extent of the crush. In harder impacts the denser foam begins to be involved. The conical shape of the cones means that more of the dense foam is involved as the crush continues down the cone. It is easy to crush the tip of the cone, but as the crush zone moves downward the volume of dense foam involved increases rapidly, in effect stiffening the liner with a smooth increase in resistance. This tunes the foam to give a softer landing in the first stages of crush, while stiffening up as the crush continues to prevent bottoming out in the hardest impacts. Results of testing done by the Australian Government can be found here.

Molding techniques for EPS have evolved over the half century that it has been used for helmets, enabling manufacturers to push the envelope by producing a helmet liner with harder and softer foam in layers (variable density foam). That lets the softer inner layer of foam crush in a lesser impact, where harder foam would just resist and pass the energy on to the head. The harder outer layer is still there when the soft foam bottoms out to keep managing the energy in a hard impact. Details on these and other technologies can be found here.

This project will fund the build of foam inserts identical to those used in the HGU-56P Army Aviation helmet and testing to verify claims of improved impact performance. Testing will be performed by the manufacturer and repeated at the Government laboratory to ensure independent confirmation of results. If testing shows demonstrable reduction in energy being transmitted to the users' brain, implementation will be by retrofit.

REFERENCES:

1. https://newatlas.com/materials/liquid-nanofoam-football-helmet-head-protection/
2. https://newatlas.com/materials/elastic-microlattice-helmet-padding/
3. https://www.infrastructure.gov.au/roads/safety/publications/2001/helmet_liner.aspx
4. https://kaliprotectives.com/pages/the-future-of-protectives
5. https://helmets.org/liners.htm

A214-033

TITLE: Advanced Thermal Management Systems

OBJECTIVE:
The U.S. Army is interested in improving the thermal management system(s) for enhanced cooling and control of aviation systems. The Army would like to explore the utilization of novel thermal management systems for light to medium/heavy duty applications on current enduring rotorcraft and Future Vertical Lift (FVL) platforms.

DESCRIPTION:
The U.S. Army is interested in identifying novel approaches for improving the thermal management and efficiency for aviation systems. Current thermal management systems are insufficient for future aviation applications due to high weight, lower heat rejection capabilities, and forced air systems predominately implemented on Army rotorcraft based on 1970’s technology, which has had incremental improvements since. As advancements in power electronics, energy dense batteries, high-power dense electric machinery, small turbine machinery, and power generation units evolve, the thermal management requirements to operate these technologies efficiently, effectively, and safely is increasingly important for aviation implementation. By taking advantage of newer technologies, techniques, and approaches, the U.S. Army is seeking opportunities to explore advanced thermal management solutions for aviation applications that meet size, weight, performance and cost (SWaP-C) requirements.

The following would be accomplished by but not limited to: advanced manufacturing techniques, additive manufacturing, passive/active cooling, fuel cooling applications, innovative heat exchangers and cooling plates, novel rejection techniques and the application of novel materials.

Classified proposals are not accepted under the DoD SBIR Program. In the event DoD Components identify topics that will involve classified work in Phase II, companies invited to submit a proposal must have or be able to obtain the proper facility and personnel clearances in order to perform Phase II work.

PHASE I:
During Phase I, innovative approaches and enabling technologies, which support the development of thermal management solutions shall be modeled and analyzed. Designs may include simulation models of the key enabling technology benefits and risks over current state of the art cooling technologies. Designs shall seek to improve thermal efficiency and thermal cooling capacity while improving or not compromising SWaP-C requirements. Designs may also consider opportunities to modify existing systems, especially those utilized on Army Aviation platforms today, to achieve effective solutions.

The Army would like to have an understanding of the areas of improvement of current systems in addition to the trade spaces and technology innovations required for an enhanced thermal management system.

A report should be delivered to the Army that documents the design decisions the Army could make when utilizing an innovative thermal management system. If possible, a demo would be desired.

PHASE II:
During Phase II, the Army would desire working prototypes with simulated aircraft loads and heat dissipating component. Phase II will leverage component and system level knowledge gained from Phase I and build a prototype that integrates with the aircraft.

A laboratory environment would be required to simulate the aircraft architecture. Initial qualification testing and analyses will occur during this phase to reduce risks for meeting Army certification requirements. The Army desires testing performed that would demonstrate the most optimal setup for their thermal management system required for Army rotorcraft.

The final deliverable would be a report with testing and design data that would give the Army a path forward.

PHASE III:
During Phase III, the Army desires to pursue full qualification of the components and aircraft integration/testing on UH-60 (a medium utility helicopter), AH-64 (an attack helicopter), CH-47 (a heavy-lift helicopter), and/or FVL. Also, it is envisioned that this technology will have applicability to commercial aircraft market.

The final deliverable for this effort would be a qualified thermal management system and solution for Army rotorcraft or the commercial market.

KEYWORDS: Thermal Management, Cooling, Efficiency, SWaP-C, FVL, Rotorcraft

REFERENCES:

1. MIL-STD-704
2. RTCA/DO160
3. MIL-STD-461

A214-034

TITLE: Dismounted Device-to-Device (D2D) Communication Platform

OBJECTIVE:

Develop a Device-to-Device (D2D) squad-level communication platform that uses direct communications without network assistance of a radio access network (RAN). The D2D platform shall implement a cognitive agent controlling jamming mitigation strategies in contested electronic contested environments to provide increased resiliency and lethality for dismounted soldiers.

DESCRIPTION:

The current state of the art for dismounted soldier communications is the adoption of commercial wireless waveforms (e.g., IEEE 802.11x, LTE) or existing tactical radios. In the case of commercial wireless waveforms, the waveform provides high bandwidth throughput and scalability. However, commercial wireless waveforms are not developed to operate in electronic contested environments (i.e., Electronic Warfare). In the case of tactical radio waveforms, bandwidth throughput is minimal in comparison to commercial bandwidth speed. It does not support high bandwidth services or electronic warfare resiliency at the dismounted soldier level. In both cases, commercial and tactical radios, neither supports an evolving threat matrix or information-driven decision-making. Therefore,a solution is required that combines high-speed bandwidth throughput (i.e., commercial waveform) and resiliency in electronically contested environments.

The Offeror is required to provide an innovative solution that encompasses commercial high bandwidth and scalability. Some of these innovative solutions could be LTE-A, an intelligent cognitive agent, power-efficiency, and jamming mitigation electronics in a lightweight form-factor for dismounted operations. The following Key Performance Indicators (KPIs) for the said solution is below:

- The Dismounted D2D Node shall provide voice and data communications. Data communicationsare defined as Situational Awareness (SA), Command & Control (C2), and Video.
- The Dismounted D2D Node shall support Push-to-Talk (PTT) voice communications
- The Dismounted D2D Node shall use direct communications without RAN coordination
- The Dismounted D2D Node shall use discovery without RAN coordination
- The Dismounted D2D Node shall use a UMTS Subscriber Identify Module (USIM) for provisioning
- The Dismounted D2D Node shall use Cryptographic Algorithms for Bearer Channel Security
- The Dismounted D2D Node shall use Secure Real-Time Transport Protocol (SRTP) for Media Channel Security
- The Dismounted D2D Node shall use licensed or unlicensed frequency bands
- The Dismounted D2D Node shall support multicast for one-to-many (Group) communications
- The Dismounted D2D Node shall support broadcast for one-to-many (Group) communications
- The Dismounted D2D Node shall automatically establish direct communications up to 1000D2D Nodes within range
- The Dismounted D2D Node communication range shall be no less than 500 meters
- The Dismounted D2D Node communication throughput shall be no less than 300 Mbps
- The Dismounted D2D Node communications shall operate in degraded mode in contested environments
- The Dismounted D2D Node shall be Low Probability of Intercept & Low Probability of Detection (LPI/LPD)
- The Dismounted D2D Node shall be Jam Resistant
- The Dismounted D2D Node shall implement Frequency Agility
- The Dismounted D2D Node shall implement Machine Learning for Signal Feature Extraction

- The Dismounted D2D Node shall implement Machine Learning to direct and control Jammer

Mitigation Strategies

- The Dismounted D2D Node shall implement Decoy Signal(s) outside of the frequency band of operation(s)
- The Dismounted D2D Node shall implement Adaptive Antenna Technology
- The Dismounted D2D Node shall not exceed 6" x 2" x 3" in volume
- The Dismounted D2D Node shall not exceed 0.5 lbs
- The Dismounted D2D Node shall not exceed 2W budget
- The Dismounted D2D shall not exceed $500
- The Dismounted D2D Node shall use USB for external communications

PHASE I:
The Offeror shall prepare and deliver a feasibility study at the end of phase 1. The feasibility study shall contain a proposed design concept, and implementation of a dismounted D2D communication platform based on system description and KPIs discussed and outlined in the description section.The proposed design concept and implementation shall be substantiated through modeling/simulation or other analytic means. When presenting modeling/simulation or analytic outcomes in the feasibility study, the offer shall include assumptions, caveats, and test data used substantiate conclusion(s) in the feasibility study.

PHASE II:
The Offeror shall provide 8-10 operational prototypes and demonstrate functionality at the end ofphase 2. The network communication test scenarios shall consist of the following:

- 8-10 node network where voice quality and data throughput rates will be scrutinized.
- Verification and Validation of the 1-26 KPIs outlined in the description section above.

PHASE III:
The Offeror shall demonstrate the Dismounted D2D Communication Platform with a limited number of nodes that autonomously forms a network, processes Voice, C2, SA, and Video data traffic in support of dismounted soldiers. In terms of commercialization, the communications technology developed through this SBIR can be readily used in the IoT (Internet of Things) commercial market space. Several areas of the IoT include sensor networking and management, dataoff-loading for LTE (Long-Term Evolution) networks, and Smart Grid Communications.

KEYWORDS: D2D; Jam Resistance; Frequency Agility; LTE

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