Defense Threat Reduction Agency (DTRA)
DoD 2024.B Small Business Technology Transfer (STTR) Program
Proposal Submission Instructions

INTRODUCTION

The Defense Threat Reduction Agency (DTRA) mission is to enable the DoD, the U.S. Government, and International Partners to counter and deter Weapons of Mass Destruction (WMD) Chemical Biological, Radiological, Nuclear) and Improvised Threat Networks. The DTRA STTR program is consistent with the purpose of the Federal SBIR/STTR Program, i.e., to stimulate a partnership of ideas and technologies between innovative small business concerns and through Federal-funded research or research and development (R/R&D).

The approved FY24.B topic(s) solicited for the Defense Threat Reduction Agency (DTRA) Small Business Technology Transfer (STTR) Program are included in these instructions followed by the full topic description. Offerors responding to this Broad Agency Announcement (BAA) must follow all general instructions provided in the related Department of Defense Annual Program BAA and submit proposals by the date and time listed in this release. Specific DTRA requirements that add to or deviate from the DoD Annual Program BAA instructions are provided below with references to the appropriate section of the DoD document.

Proposers are encouraged to thoroughly review the Annual Program BAA and register for the DSIP Listserv to remain apprised DoD of important programmatic and contractual changes.
• The DoD Annual Program BAA is located at: https://www.defensesbirsttr.mil/SBIRSTTR/**Opportunities/#announcements**. Be sure to select the tab for the appropriate BAA cycle.
• Register for the DSIP Listserv at: https://www.dodsbirsttr.mil/submissions/login.

The DTRA Small Business Technology Transfer (STTR) Program is implemented, administered, and managed by the DTRA SBIR/STTR Program Office. Specific questions pertaining to the administration of the DTRA STTR program and these proposal preparation instructions should be directed to:

Mr. Mark D. Flohr
DTRA SBIR/STTR Program Manager
Mark.D.Flohr.civ@mail.mil
Tel: (571) 616-6066

Defense Threat Reduction Agency
8725 John J. Kingman Road
Stop 6201
Ft. Belvoir, VA 22060-6201

For technical questions about specific topic requirements during the pre-release period, contact the DTRA Technical Point of Contact (TPOC) for that specific topic. To obtain answers to technical questions during the formal BAA open period, visit: https://www.dodsbirsttr.mil/submissions/login. For questions regarding the Defense SBIR/STTR Innovation Portal, contact DSIP Support at: dodsbirsupport@reisystems.com.

Proposals not conforming to the terms of this announcement will not be considered. DTRA reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality as determined by DTRA will be funded.

DTRA reserves the right to withdraw from negotiations at any time prior to contract award. The Government may withdraw from negotiations at any time for any reason to include matters of national security (foreign persons, foreign influence or ownership, inability to clear the firm or personnel for security clearances, or other related issues).

Please read the entire DoD announcement and DTRA instructions carefully prior to submitting your

proposal as there have been significant updates to the requirements.

Proposers responding to a topic in this BAA must follow all general instructions provided in the Department of Defense (DoD) STTR Program BAA. DTRA requirements in addition to or deviating from the DoD Program BAA are provided in the instructions below.

Proposers are encouraged to thoroughly review the DoD Program BAA and register for the DSIP Listserv to remain apprised of important programmatic and contractual changes.

- The DoD Program BAA is located at: https://www.defensesbirsttr.mil/SBIR-STTR/Opportunities/#announcements. Be sure to select the tab for the appropriate BAA cycle.
- Register for the DSIP Listserv at: https://www.dodsbirsttr.mil/submissions/login.

Specific questions pertaining to the administration of the DTR STTR Program and these proposal preparation instructions should be directed to: Mr. Mark Flohr, DTRA SBIR/STTR Program Manager; (mark.d.flohr.civ@mail.mil).

PHASE I PROPOSAL GUIDELINES

The Defense SBIR/STTR Innovation Portal (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. Detailed instructions regarding registration and proposal submission via DSIP are provided in the DoD STTR Program BAA.

Technical Volume (Volume 2)

The technical volume is not to exceed a 20-page limit and must follow the formatting requirements provided in the DoD STTR Program BAA. Any pages in the technical volume over 20 pages will not be considered in proposal evaluations.

Content of the Technical Volume

A Phase I Proposal Template is available to provide helpful guidelines for completing each section of your Phase I technical proposal. This can be found at https://www.dodsbirsttr.mil/submissions/learningsupport/firm-templates.

Offerors should follow the DoD STTR Program BAA guidelines regarding Technical Volume content.

Cost Volume (Volume 3)

The Phase I Base amount, notwithstanding the amount allocated for TABA, must not exceed $200,000.00. All costs must be clearly identified on the Proposal Cover Sheet (Volume 1) and in Volume 3. DTRA requires the use of an excel spreadsheet for the Cost Volume The cost template becomes visible to the offeror when the Cost Volume is initiated.

Important: when completing the cost volume, enough information should be provided to allow the agency to understand how you plan to use the requested funds if a contract is awarded.
Itemized costs of any subcontract or consultant should be provided to the same level as for the prime small business. If an unsanitized version of costs cannot be provided with the proposal, the Government may request it during negotiations if selected. Refer to the instruction provided in the DoD Annual STTR program BAA for additional details on the content of the Cost Volume.
Note: Cost for travel funds must be justified and related to the needs of the project.

Please review the updated Percentage of Work (POW) calculation details included in the DoD Program BAA. DTRA normally will not accept any deviation to the POW requirements however if discovered

during review in Contracting the offeror may be allowed to revise the cost proposal to be in line with the POW requirements.

Page Limit, Cost and Duration:

Project Phase	Technical Vol Page Limit	Cost	Duration
Phase I	20 pages	$200,000.00	7 Months
Phase II	40 pages	$1,300,000.00	24 Months

Company Commercialization Report (CCR) (Volume 4)
Completion of the CCR as Volume 4 of the proposal submission in DSIP is required. Please refer to the DoD STTR Program BAA for full details on this requirement. Information contained in the CCR will not be considered by DTRA during proposal evaluations.

Supporting Documents (Volume 5)
Volume 5 is provided for proposing small business concerns to submit additional documentation to support the Coversheet (Volume 1), Technical Volume (Volume 2), and the Cost Volume (Volume 3). Please refer to the DoD Program BAA for more information as to additional supporting documents or information that may be included in Volume 5.

All proposing small business concerns are REQUIRED to submit the following documents to Volume 5:

1. Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment
2. Disclosures of Foreign Affiliations or Relationships to Foreign Countries

   Note 1: Offerors having any concerns pertaining to mandatory requirements number 2 as stated above should provide a mitigation plan addressing the concerns.

   Note 2: A completed proposal submission in DSIP does NOT indicate that the mandatory supporting documents have been uploaded. It is the responsibility of the proposing small business concern to ensure that the mandatory documents listed above have been included with the proposal submission.

DIRECT TO PHASE II PROPOSAL GUIDELINES
The Defense Threat Reduction Agency does not participate in the Direct to Phase II (DP2) proposal submission program.

PHASE II PROPOSAL GUIDELINES
Phase II proposals may only be submitted by Phase I awardees.
Those small business concerns submitting a Phase II proposal should plan to submit a fully developed proposal into the DSIP proposal system within thirty (30) days after the end of the Phase I period of performance. The small business concern may or may not be automatically notified of the recommended proposal due date.

The Phase II proposal Technical Volume should generally follow the outline and structure of the Phase I to include benefits or lessons learned from the Phase I effort.

DTRA plans on a Phase II project not to exceed $1,300,000.00 notwithstanding TABA, and two (2) years duration.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA) In accordance with the Small Business Act (15 U.S.C. 632), DTRA will authorize the recipient of a Phase I or Phase II STTR award to purchase Discretionary Technical & Business Assistance services, such as access to a network of scientists and engineers engaged in a wide range of technologies, or access to technical and business literature available through on-line data bases, for the purpose of assisting in areas such as:

- making better technical decisions concerning such projects;
- solving technical problems which arise during the conduct of such projects;
- minimizing technical risks associated with such projects;
- developing/ commercializing new commercial products/processes resulting from such projects; and,
- meeting cyber security requirements.

If you are proposing use of Discretionary Technical and Business Assistance (TABA), you must provide a cost breakdown in the Cost Volume under "Other Direct Costs (ODCs)" and provide a one-page description of the vendor you will use and the Technical and Business Assistance you will receive. For the Phase I project, the amount for TABA may not exceed $6,500 per award. For the Phase II project, the TABA amount may be less than, equal to, but not more than $50,000 per project. The description should be included in Volume 5 of the proposal.

Approval of Discretionary Technical and Business Assistance is not guaranteed and is subject to review of the contracting officer.

For Discretionary Technical and Business Assistance, small business concerns may propose one or more vendors. Additionally, business-related services aimed at improving the commercialization success of a small business concern may be obtained from an entity, such as a public or private organization or an agency or other entity established or funded by a State that facilitates or accelerates the commercialization of technologies or assists in the creation and growth of private enterprises that are commercializing technology.

EVALUATION AND SELECTION

All proposals will be evaluated in accordance with the evaluation criteria listed in the DoD STTR Program BAA.

Proposing firms will be notified of selection or non-selection status for a Phase I award within 90 days of the closing date of the BAA. DTRA has a single Evaluation Authority (EA) for all proposals received under this solicitation. The EA either selects or rejects Phase I and Phase II proposals based upon the results of the review and evaluation process plus other considerations including limitation of funds, and investment balance across all the DTRA topics in the solicitation. To provide this balance, a lower rated proposal in one topic could be selected over a higher rated proposal in a different topic. DTRA reserves the right to select all, some, or none of the proposals in a particular topic.

Notifications.

Following the EA decision, the DTRA SBIR/STTR office will release notification e-mails of selection or non-selection status for a Phase I award within 90 days of the closing date of the BAA. The E-mails will be sent to the addresses provided for the Principal Investigator and Corporate Official.

Offerors may request a debriefing of the evaluation of their not selected proposal and should submit this request via email to: dtra.belvoir.RD.mbx.sbir@mail.mil and include "STTR 24.D / Topic XX Debriefing Request" in the subject line. Debriefings are provided to help improve the offeror's potential response to future solicitations. Debriefings do not represent an opportunity to revise or rebut the EA decision.

For selected offers, DTRA will initiate contracting actions which, if successfully completed, will result in contract award. DTRA Phase I awards are issued as fixed-price purchase orders with a maximum period of performance of seven-months. DTRA may complete Phase I awards without additional negotiations by the contracting officer or without opportunity for revision for proposals that are reasonable and

complete.

DTRA Support Contractors
Select DTRA-employed support contractors may have access to contractor information, technical data or computer software that may be marked as proprietary or otherwise marked with restrictive legends. Each DTRA support contractor performs under a contract that contains organizational conflict of interest provisions and/or includes contractual requirements for nondisclosure of proprietary contractor information or data/software marked with restrictive legends. These contractors require access while providing DTRA such support as advisory and assistance services, contract specialist support, and support of the Defense Threat Reduction Information Analysis Center (DTRIAC). The contractor, by submitting a proposal or entering into this contract, is deemed to have consented to the disclosure of its information to DTRA's support contractors.

The following are, at present, the prime contractors anticipated to access such documentation: Broadleaf Inc. (contract specialist support); Kent, Campa and Kate, Inc. (contract closeout support), ARServices (Program Management Advisory and Assistance Services--A&AS), Systems Planning and Analysis, Inc. (Subject Matter Expertise A&AS), Amentum (A&AS), Polaris Consulting (Small Business Program Support), Seventh Sense Consulting, LLC (Acquisition Support), Savantage Solutions (Accounting and Financial Systems Support); TekSynap Corporation and Kapili Services, LLC (DTRIAC).. This list is not all inclusive (e.g., subcontractors) and is subject to change.

Protests.
Refer to the DoD STTR Program BAA for procedures to protest the Announcement.
As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to:
(a) Protests, as defined in section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the Government Accountability Office (GAO), shall be served on the Contracting Officer (addressed to Mr. Herbert Thompson, Contracting Officer, as follows) by obtaining written and dated acknowledgment of receipt from (if mailed letter) Defense Threat Reduction Agency, ATTN: AL-ACQ (Mr. Herbert Thompson), 1680 Texas Street, Kirtland AFB, NM 87117. If Federal Express is used for the transmittal, the appropriate address is: Defense Threat Reduction Agency, ATTN: AL-ACQ (Mr. Herbert Thompson), 8151 Griffin Avenue SE, Building 20414, Kirtland AFB, NM 87117-5669.

AWARD AND CONTRACT INFORMATION
DTRA plans on Phase I projects for a seven (7) month period of performance with six months devoted to the research and the final month for the final report. The award size of the Phase I contract is no more than $200,000.00 notwithstanding a maximum of $6,500.00 for Discretionary Technical and Business Allowance (TABA). For a Phase II project, DTRA plans on a 24-month period of performance. The award size of a Phase II contract is no more than $1,300,000.00 notwithstanding a maximum of $50,000.00 for Discretionary Technical and Business Allowance (TABA) for the entire project.

ADDITIONAL INFORMATION
The International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, will apply to all projects with military or dual-use applications that develop beyond fundamental research, which is basic and applied research ordinarily published and shared broadly within the scientific community. More information is available at https://www.pmddtc.state.gov/ddtc_public.
The technology within some DTRA topics is restricted under export control regulations including the International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR). ITAR controls the export and import of listed defense-related material, technical data and services that provide the United States with a critical military advantage. EAR controls military, dual-use and

commercial items not listed on the United States Munitions List or any other export control lists. EAR regulates export-controlled items based on user, country, and purpose. **The offeror must ensure that their firm complies with all applicable export control regulations.**

NOTE: Export control compliance statements found in these proposal instructions are not meant to be all inclusive. They do not remove any liability from the submitter to comply with applicable ITAR or EAR export control restrictions or from informing the Government of any potential export restriction as fundamental research and development efforts proceed.

Cyber Security
Any Small Business Concern receiving an SBIR award is required to provide adequate security on all covered contractor information systems. Specific security requirements are listed in DFARS 252.204.7012, and compliance is mandatory.

Feedback
In an effort to encourage participation in, and improve the overall SBIR award process, offerors may submit feedback on the SBIR solicitation and award process to: dtra.belvoir.RD.mbx.sbir@mail.mil for consideration for future SBIR BAAs.

END

DTRA STTR 24.B Topic Index

DTRA24B-001 TITLE: Mobile Objective Vehicle Emulator (MOVE)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber

OBJECTIVE: DTRA seeks innovative approaches to develop an agile, scalable, all-electric vehicle emulator to enable Counter-WMD sensing techniques using non-line-of-sight Seismic, Acoustic, and Magnetic phenomenologies. The emulator shall be all-electric, scalable, and capable of replicating the Seismic, Acoustic, and Magnetic signatures of various sized vehicle classes for both near-field and far-field MASINT sensor testing. The selected proposal winners will be provided with recorded Seismic, Acoustic, and Magnetic data from three different source-vehicle types to help with the Phase I design and engineering phase. The vehicle data will be of a standard passenger vehicle, a medium-sized truck, and a very large, over 40-ton class wheeled vehicle. The Phase II objective demonstration is of an all-electric test vehicle that is able to traverse a straight tunnel at speeds up to 15 mph while transmitting a simultaneous combination of the source-vehicle Acoustic, Magnetic, and Seismic signatures for a sustained period of at least 10 minutes while moving back and forth underground.

Additionally, a variation of this capability would enable a novel magnetic transmitter/receiver pair where the transmitter can be located inside a tunnel and a receiver can be located outside and above the tunnel at ranges of 100 meters or more. The magnetic vehicle emulator, acting as a signal transmitter, shall be able to modulate a unique bit sequence that can be demodulated at a magnetic receiver to uniquely identify or "fingerprint" the signal. Both the transmitter and receiver are to be all-electric, capable of using new/novel renewable energy generation and storage techniques. Performers may choose to create Phase II/III prototypes that use the magnetic simulator signals to create and demonstrate this transmitter/receiver concept. Phase III commercialization opportunities include future applications of modular/scalable all-electric testbeds for self-driving vehicles, city/county traffic management, and logistics delivery tracking services.

DESCRIPTION: The Department of Defense (DOD) and Intelligence Communities require a multitude of target vehicles for Counter-WMD tests and operational exercises. Acquiring real vehicles can be difficult, cost prohibitive, and slow. Contractors can design and build realistic vehicle simulators but that will be expensive and a lengthy process. The cost for logistics, operation, maintenance, and sustainment of large vehicles is also steep. A mobile, all-electric vehicle emulator that can simulate many of the required target vehicle signatures will be cheaper and safer to operate in various environments. An all-electric vehicle emulator will facilitate its use in indoor and underground facilities and produce zero emissions. A scalable, all-electric, multi-phenomenology vehicle emulator will enable an innovative underground sensor testing capability against advanced threats.

A novel method is sought to create multi-pole near-field and far-field magnetic signatures that closely replicate actual vehicles that will likely be bounded by the following assumptions. The system may require a gimbaled solenoid to orient the DC magnetic field, and a method to control current strength. 100-200 A/m2 per ton of steel is assumed as a general guide depending on the amount of steel in the vehicle. Smaller vehicles are defined to be 6 tons/axle (single wheeled) or 12 tons/axle (dual wheeled) Department of Transportation (DOT) ratings for roads. For an example design approach, a 500 ft spool of 4-gauge wire (0.25 Ω/1000 ft) with about 42 turns plus some extra wire and about 0.125 Ω, 65 lbs. Eight 42-turn coils (336 total turns) wired in series is 1 Ω to the DC power supply. A 50 V DC power supply could potentially deliver a maximum of 50 A to the coils, producing 16,800 A/m2 using 2.5 kW (30 A, 120 VAC or 20 A, 240 VAC power source). This indicates the challenge is at least feasible for an all-electric replication of signals as follows:
1. Baseline of a small vehicle, 2-ton pickup/SUV (300 A/m2) requires only 893 mA and 893 mV, or 797 mW.
2. Simulating a 10-ton truck (1500 A/m2) requires approximately 4.5 A and 4.5 V, or about 20 W.

3. Simulating a mid-sized 20-ton vehicle (3000 A/m2) requires approximately 8.93 A and 8.93 V, or 80 W.
4. Simulating a large 40-ton vehicle (6000 A/m2) requires approximately 17.86 A and 17.86 V, or about 320 W.
5. Simulating a very large 80-ton vehicle (12,000 A/m2) requires approximately 35.7 A and 35.7 V, or about 1276 W.

Lighter wire gauges allow more turns, but give higher resistance, heat, and require higher supply voltages. Additionally, a method of modulating a signal on top of the magnetic simulator to demonstrate communications of a detectable bit sequence over short (tens of meters) distances is desired.

PHASE I: Create a proposed design, develop and test an all-electric prototype vehicle emulator which mimics small, medium, and large vehicles with shaped magnetic, acoustic, and seismic phenomenologies using playback of recordings fed into one or more Helmholtz coil or similar magnetic, acoustic, and seismic sources and/or other techniques to replicate within 10% the acoustic and magnetic profile of threat vehicles. A trailer may be used that can be towed by an electric powered vehicle into tree covered tunnels. It is recognized that there can be significant coupling between acoustic and seismic signatures and therefore seismic emulation can be achieved with acoustic sources. Nevertheless, reference material indicates possible approaches to create more accurate vehicle seismic signatures beyond acoustic-only coupling. The all-electric vehicle emulator will allow testing in tunnels too small and too unsafe to house actual full-sized internal combustion engine vehicles of interest. Phase I shall also include applicable electrical and other applicable safety and hazard assessments and proposed risk mitigation as appropriate.

PHASE II: Develop and test a scaled down working prototype that emulates the smaller class vehicle type. After test and evaluation and data analysis, demonstrate a scaled-up version of the prototype to address mid and/or large vehicle emulation objectives. Additionally, a variation of this capability could enable a novel magnetic transmitter/receiver pair where the transmitter can be located inside a tunnel and a receiver can be located outside and above the tunnel. Phase II shall include a design variation proposal that would add modulation to the magnetic vehicle simulator, to modulate a bit sequence that can be demodulated at the receiver to uniquely identify or "fingerprint" the signal. Both the transmitter and receiver are to be all-electric, capable of using new/novel renewable energy generation and storage techniques. Deliver all design and test results in a final Phase II report. The final Phase II report should also include an updated design plan, if needed, to scale the prototype to meet full Phase III requirements.

PHASE III DUAL USE APPLICATIONS: Phase III will demonstrate a fully capable all-electric vehicle simulator system within an underground facility. Performers may choose to create Phase III prototypes that use the magnetic simulator signals to create and demonstrate this transmitter/receiver concept. Phase III commercialization opportunities include future applications of modular/scalable all-electric testbeds for self-driving vehicles and city/county traffic management and logistics delivery tracking services. All data collected during the demonstration and analysis of the final system will be included in the final report along with a user's manual and a data package on all critical system components.

REFERENCES:

1. "FDTD Seismic Simulation of Moving Tracked Vehicle" Stephen A. Ketcham*, Mark L. Moran*, Roy J. Greenfield, USACE Engineer Research and Development Center, Cold Regions Research and Engineering, Laboratory (ERDC-CRREL), 72 Lyme Rd, Hanover, NH 03755, Stephen.A.Ketcham@erdc.usace.army.mil, Department of Geosciences, Penn State University, University Park, PA 16802, roy@geosc.psu.edu
2. Moran, M., and Greenfield, R., 1997, "Seismic Detection of Military Operations," 97-CEP-511-1, U.S. Army Maneuver Support Battle Laboratory, Ft. Leonard Wood, MO.

3. IEEE Proceedings of the Users Group Conference (DOD_UGC'04) "Seismic Waves from Light Trucks Moving Over Terrain,"Stephen A. Ketcham Mark L. Moran, and James Lacombe USACE Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory (ERDC-CRREL), Hanover, NH {Stephen.A.Ketcham, Mark.L.Moran, James.Lacombe}@erdc.usace.army.mil
4. "Novel System for Underground Tunnels Detection" S. Tapuchi and D. Baimel, Shamoon College of Engineering, Beer Sheva, Israel
5. "Research of Distorted Vehicle Magnetic Signatures- Recognitions, for Length Estimation in Real Traffic Conditions" Donatas Miklusis, Vytautas Markevicius, Dangirutis Navikas, et. al.
6. Won, M. "Intelligent Traffic Monitoring Systems for Vehicle Classification: A Survey." IEEE Access 2020, 8, 73340–73358. [CrossRef]
7. Gheorghiu, R.A.; Iordache, V.; Stan, V.A. "Urban traffic detectors—Comparison between inductive loop and magnetic sensors." Proceedings of the 2021 13th International Conference on Electronics, Computers and Artificial Intelligence (ECAI), Pitesti, Romania, 1–3 July 2021; pp. 1–4.
8. M. Roberson, D. Hull, S.Vinci "Advanced Anomaly Detection," Proceedings of the Military Sensing Symposium (MSS) on Battlespace Acoustic, Seismic, Magnetic, and Electric-Field Sensing (BAMS), October 2022
9. S. Vinci, Z. Drummond, et. al., "Low-SWaP-C sensing for Battlefield Anomaly Detection," Proceedings of the MSS-BAMS, 2022.
10. M. Roberson, J. White, D. Hull, S. Vinci, "Extensions to Advanced Anomaly Detection", Proceedings of the MSS BAMS, November 2023.
11. "Magnetometer Modeling and Validation for Tracking Metallic Targets," Niklas Wahlstrom, F. Gustafsson, Published 1 February 2014, IEEE Transactions on Signal Processing, vol 62, pp 545-556
12. Q. Zhang , et al, "Detection of vehicle tracks by a three-axis magnetometer," Sensors and Actuators A: Physical, Volume 276, 15 June 2018, Pages 83-90
13. "Classification of Vehicles Using Magnetic Dipole Model," Prateek G V, Rajkumar V, Nijil K and K.V.S. Hari, IEEE TENCON 2012, Cebu, Philippines, 21st November 2012

KEYWORDS: Seismic, Acoustic, Magnetic Phenomenology; Helmholtz Coil;
Counter WMD (C-WMD); Vehicle Emulator

DTRA24B-002 TITLE: Tools and Methodologies to Transition DTRA High Fidelity Codes to Leverage Heterogeneous Accelerated Processing Units

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software

OBJECTIVE: The objective of this project is to develop a performance analysis toolkit that developers can use to transition their codes to leverage Accelerated Processing Units (APUs). The toolkit must be part of a mature performance tools framework, providing other related performance analysis methodologies. A significant portion of the theoretical peak performance of several Exascale systems is attributed to APUs. Preparing DTRA's High-Fidelity (HF) computer codes to leverage APUs is of high importance. While advancements in technology, such as NVIDIA's Heterogeneous Memory Management (HMM), and Advanced Micro Devices (AMD)'s CDNA2 Coherent Memory Architecture demonstrate the industry's efforts to simplify the offloading of codes to APUs by enabling shared or unified memory access between CPUs and GPUs, there remains a substantial amount of work. Significant code refactoring and optimization efforts will still be required to performantly "map" DTRA's HF codes to DoD High Performance Computing Modernization Program (HPCMP) systems equipped with APUs. Such efforts can be intelligently guided by workload performance characterization and analysis tools, which inspect the behavior of large-scale HF codes and suggest refactoring and optimization strategies, such as which computational loops could benefit from offloading to the APUs.

DESCRIPTION: DTRA uses HF codes on DoD HPCMP systems to investigate weapon effects phenomenology and techniques for countering WMD. End-to-end HF simulations in support of the DTRA projects require calculations including multiple phenomena that occur in vastly different time scales (μs to hours). With DTRA's growing reliance on HF codes tasks, the efficient use of current computational resources and the strategic planning for upcoming architectures are essential. The existing best practices for offloading large codes to leverage APUs might not be directly applicable to HF codes. Many of these are legacy codes, developed over decades, and may require initial evaluation for modernizing their programming model, such as transitioning from an MPI-Only to a hybrid MPI+OpenMP and MPI+OpenMP+APU-Offload model, or adopting a more portable cross-platform programming framework. As such, collaborating with a DTRA HF code team to understand the requirements for developing the envisioned toolkit is highly encouraged. In addition, approaches that are portable to different APU offerings from different vendors are desired. Offerors must meet all DoD HPCMP user requirements for access to these systems which includes, but is not limited to, possessing a Security Clearance, or having a National Agency Check with Inquiries (NACI). DTRA will provide an allocation of HPC system resources and assistance in obtaining successful offeror's user accounts on DoD HPCMP system(s).

PHASE I: Investigate the existing open-source solutions in terms of the applicable programming frameworks (such as RAJA and KOKKOS) for HF codes. Document potential gaps in existing performance analysis tools that limit their abilities to provide metrics of interest for HF codes on heterogenous systems (including those that provide shared/unified memory accesses across CPUs and APUs.) Understand the benefits and limitations of shared/unified memory access feature and the accompanying programming model. Generate a feature-list for the envisioned toolkit tailored for HF codes and how it fits into an overall mature performance tools framework. Identify key concepts and methods that, when implemented, will provide non-intrusive cross-platform tools that can effectively operate on complex HF codes by collaborating with DTRA code developers. The proposers may use an open-source proxy code in Phase I to demonstrate the feasibility.

PHASE II: Develop a production ready cross-platform toolkit based on the Phase I approach and integrate within the overall tool framework. Demonstrate the use of the tools on DOD HPCMP systems on a broad range of HF codes that include compressible flow (blast, high-explosives, chemistry), incompressible

flow (dispersion), multiphase flow (melting and evaporating particles), fluid-structure interaction, and large-deformation, explicit structural dynamics (cracking, spallation, contact).

PHASE III DUAL USE APPLICATIONS: The performance tools developed for use on very demanding application codes will be well suited, once refined, for use on more general HPC workloads on Exascale architectures. Improvements in this phase are expected to involve ease of use enhancements and hardening of the profiling tools for use on a wide range of application software used in Government research and industry.

REFERENCES:

1. https://developer.nvidia.com/blog/simplifying-gpu-application-development-with-heterogeneous-memory-management/;
2. https://computing.llnl.gov/projects/raja-managing-application-portability-next-generation-platforms;
3. https://kokkos.org/;
4. https://nowlab.cse.ohio-state.edu/static/media/workshops/presentations/espm2_23/PublicSC23ESPM2ProgrammingAMDInstinctMI300A.pdf;
5. https://centers.hpc.mil/users/index.html#accounts;

KEYWORDS: High Performance Computing; HPC; Accelerated Processing Units; APU; Message Passing Interface; MPI; Open Multi-Processing; OpenMP; High-Fidelity; graphics processing unit; GPU;