# U.S. Army Artificial Intelligence Opportunities for International Partners

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## *ABSTRACT*

*The United States (U.S.) Army Modernization Strategy identifies Artificial Intelligence (AI) as one of the key Army Priority Research Areas (PRAs) [1]. As part of the U.S. Army Combat Capabilities Development Command (DEVCOM) science and technology enterprise, the DEVCOM-Atlantic Forward Element launched two new AI initiatives this year to promote collaborative opportunities with foreign academia and industry in this PRA. The first initiative, the Artificial Intelligence Focused International Virtual Exchange Series (AI FIVES)[2], is a virtual seminar that provides international organizations a platform to present their AI research and development activities and capabilities to U.S. Department of Defense subject matter experts and stakeholders to foster discussions and collaborations. Presentations facilitated under AI FIVES have addressed topics to include adversarial machine learning; robust and resilient AI; predictive analytics from small data; explainable and trustworthy AI; cyber and security; AI for improved situational awareness and decision-making; and manned-unmanned interaction and teaming. The second initiative, xTechGlobal – AI Challenge [3], is the inaugural expansion of the Assistant Secretary of the Army (Acquisition, Logistics, and Technology) Expeditionary Technology (xTech) prize competition program [4] to international participants. The xTechGlobal – AI Challenge seeks innovative, relevant technologies from non-traditional/small business technology developers in Europe, Africa, and the Middle East to address the problem of robust, AI-enabled capabilities to manage, integrate, process, and derive information from disparate data sources for rapid decision-making under severe resource constraints such as computing power and bandwidth at the point of need. Following a successful competition, the opportunity exists to continue and expand the xTechGlobal competition to other priority challenge themes sponsored by the different geographically based DEVCOM Forward Elements in Atlantic, Americas, and Indo-Pacific. This paper will discuss the genesis, results, and contributions to the Army's broader AI research activities from each of these initiatives.*

## 1.0 INTRODUCTION

The U.S. Army Combat Capabilities Development Command (DEVCOM) is a major subordinate command of the U.S. Army Futures Command and is the Army's science and technology leader [5]. DEVCOM comprises of eight major subordinate elements, including: Armaments Center; Army Research Laboratory; Aviation and Missile Center; Chemical Biological Center; Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance and Reconnaissance Center; Data & Analysis Center; Ground Vehicle Systems

Center; and Soldier Center. In addition to the lab and seven centers, DEVCOM has three international forward elements: DEVCOM-Americas, DEVCOM-Atlantic and DEVCOM Indo-Pacific. The command provides fundamental scientific research, technology development, engineering, and analysis support to the Army's six modernization priorities focused on delivering capabilities to support multi-domain operations.

DEVCOM-Atlantic has positioned scientists, engineers, and military officers at International Technology Centers (ITCs) in the United Kingdom, France, Germany, and Israel. The role of the ITCs is to develop relationships with allies and close partners; conduct technology search with foreign governments, industry and academia; and provide robust science and technology support by identifying opportunities in basic and applied research with foreign partners through academia, industry, and government partnerships [6]. DEVCOM-Atlantic also includes Field Assistance in Science and Technology (FAST) Advisors who serve as liaisons between Army elements of the Combatant Commands and research laboratories identifying critical needs and experimentation opportunities in support of the Army's mission.

Starting in 2020, DEVCOM-Atlantic launched two new initiatives to promote collaborative opportunities with academia and industry in their geographical area centered on artificial intelligence (AI). The first initiative, the Focused International Virtual Exchange Series (FIVES) provides international organizations a platform to present their AI research and development activities and capabilities to U.S. Department of Defense subject matter experts and stakeholders to foster discussions and collaborations. The second initiative, xTechGlobal is the pilot expansion of the Assistant Secretary of the Army (Acquisition, Logistics, and Technology) Expeditionary Technology (xTech) prize competition program [4] to international participants, which included an AI problem statement.

## 2.0 FOCUSED INTERNATIONAL VIRTUAL EXCHANGE SERIES

The ongoing global pandemic of coronavirus disease 2019 (COVID-19) brought a halt to travel and in-person meetings worldwide for much of 2020 and the beginning of 2021. As discussed in the previous section, the benefit of DEVCOM Forward Elements is their physical position, which allows them to interact with international organizations at their home institutions thus fostering and maintaining long-lasting relationships. However, with the limitations imposed by COVID-19 the question became how to continue to build partnerships with international academic, governmental, and industry researchers engaged in cutting-edge research and thus create continuity between the rest of the world's technologies and capabilities with the U.S. Department of Defense (DoD). During the global pandemic, the U.S. DoD pivoted to the Commercial Virtual Remote (CVR) environment, which included a DoD-only version of Microsoft Teams, as a temporary work environment [4]. The CVR environment provided DoD employees the opportunity to chat, file share, and videoconference while working remotely. In an effort to best maximize the videoconferencing tools in the new environment, Amanda Napier, DEVCOM-Atlantic ITC Southern Europe (SE) Technical Director, created the Focused International Virtual Exchange Series (FIVES) initiative to connect leading international organizations within a defined technical focus area with an audience of DoD subject matter experts and stakeholders [2]. The FIVES initiative leveraged the Microsoft Teams virtual platform to provide international industry, academic, and research organizations an opportunity to showcase their capabilities, technologies, and research and development activities to broaden mutual awareness across the services and foster discussion and collaboration between the international organizations and DoD subject matter experts (SMEs) and stakeholders as a foundation for future bi-lateral engagements.

## 2.1 FIVES Model

The FIVES model begins with the selection of a focused, Army-relevant topic, then moves on to building a domestic and international community of interested parties. The international organizations selected to provide a presentation (up to two hours) are either from existing networks, targeted scouting at virtual conferences and trade shows, or new outreach. Each potential presenter receives an introductory overview that includes information about the DEVCOM-Atlantic organization, potential collaboration tools, and the objectives of the FIVES initiative in order to best refine their presentation. Promotion for the virtual exchange (VirtEx) takes the form of a presenter-developed flyer, which provides a sampling of the topics covered during the VirtEx. Flyer distribution includes email to the domestic community of interest (COI) and submittal to the weekly internal DEVCOM publication. After the VirtEx event, which includes time for questions and answers, the domestic COI personnel receive access to a repository with presentation material and resources for further review. The FIVES lead then facilitates follow-on discussions and collaboration opportunities as requested by DoD SMEs and stakeholders. A flow chart depicting the process provided to potential FIVES presenters is shown in Figure 1. Every FIVES concludes with a U.S.-only discussion of collaboration tools, high-level summary of presentations, feedback from SMEs and stakeholders, and identification of possible ways forward. DEVCOM Atlantic is now considering future FIVES events, as well as the possible expansion to DEVCOM's two other Forward Elements in the Americas and Indo-Pacific regions.

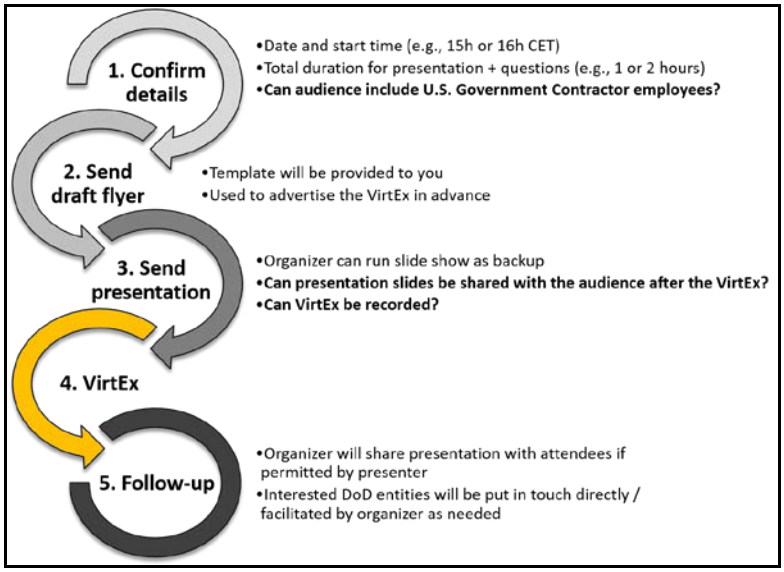


**Figure 1: FIVES Participation Flow Chart.**

## 2.2 AI FIVES

The inaugural FIVES focused on Advanced Materials & Enabling Technologies for Extreme Environments (AMETEE) and at the genesis of the second FIVES, the chosen focus was artificial intelligence (AI) given its identification in the U.S. Army Modernization Strategy as one of the key Army Priority Research Areas (PRAs) [1]. The selection of AI as the next FIVES topic was not without challenges as it required gathering various AI groups into a domestic community of interest as well as identifying state-of-the-art research, foreign technologies, and potential international presenters in a notoriously close-hold technology area.

### 2.2.1 AI FIVES Focus

In addition to the general FIVES goals of enhancing international and industry collaboration with foreign partners and allies, the AI FIVES sought to address some of the principles and objectives outlined in [8], [9], and [10]. AI FIVES organizers defined a broad scope for the series with a central focus on AI-enabled solutions that benefit our troops operating across the globe; safeguard our citizens; defend our allies; and improve the effectiveness, affordability, and the speed of our operations. The broad scope allowed the AI FIVES to emphasize basic research and fundamental techniques in the hopes of increasing potential participants' willingness to present to the U.S. DoD, many of whom would be doing so for the first time.

In order to facilitate discussions with potential presenters, AI FIVES organizers provided application areas sampled from the U.S. DoD AI strategy document [9], the DoD Joint Artificial Intelligence Center (JAIC), the U.S. Army Artificial Intelligence Integration Center (AI2C), and SMEs from across the services to include the various U.S. Army DEVCOM Centers. The sample AI and machine learning (ML) application areas presented below were a means to engage with potential presenters and not limit the technical focus of potential presentations.

- Streamlining business processes: Use of AI to augment the capabilities of our personnel by offloading tedious cognitive or physical tasks and introducing new ways of working; Use of AI to reduce the time spent on manual, repetitive, and frequent tasks.

- Predictive maintenance & Supply: Use of AI to predict the failure of critical parts, automate diagnostics, and plan maintenance based on data and equipment condition; Use of AI to establish guides for the provisioning of spare parts and optimize inventory levels.

- Explainable AI: Ethics, resilience, robustness, reliability, and security of AI to reduce the chance of misperception, miscalculation, unexpected behavior or accidents; Approaches for testing, evaluating, verifying, and validating AI.

- Operationalizing AI: Use of AI for crisis management, humanitarian assistance, and disaster relief for wildfires, hurricanes, and earthquakes.

- Improving situational awareness & decision-making: Use of AI to reduce unintentional harm and collateral damage while balancing mission outcomes.

### 2.2.2 AI FIVES Community of Interest

The scope and focus of the AI FIVES set the foundation for building the international and domestic communities of interest from which presenters and audience members, were drawn.

#### *2.2.2.1 AI FIVES INTERNATIONAL COMMUNITY*

The initial AI FIVES outreach focused on international organizations identified by SMEs at U.S. Army DEVCOM, U.S. Army Engineer Research and Development Center (ERDC), Office of Naval Research Global (ONR-G), and Air Force Office of Scientific Research (AFOSR) European Office of Aerospace Research and Development (EOARD). International partners, including Ministries of Defense (MOD), innovation agencies, and supplier newsletters also provided recommendations for presenters. Additional presenting organizations were selected from targeted participation in AI virtual conference and trade shows as well as direct outreach. The outreach was a result of cross-referencing international organizations in DEVCOM-Atlantic's area of

responsibility (AOR) with those names found from in the results of a Bibliographical Assessment Tool run on AI publications worldwide as well as the Nature Index 2020 Artificial Intelligence tables [11].

While these efforts provided initial contact with 143 international leaders within the field of AI, additional alignment was required to ensure that the research areas of the potential presenters corresponded to DoD AI priorities and that presenters were interested in presenting to the U.S. DoD. Both of these topics were discussed with the leaders of 45 international organizations when they received an initial overview brief as part of the down-select to the 22 AI FIVES presenters.

DEVCOM-Atlantic invited the U.S. Office of Defense Cooperation (ODC) and the national MOD of the presenting organization to attend and participate in each of the FIVES virtual meetings in order to build a foundation for future bilateral agreements.

#### *2.2.2.2 AI FIVES DOMESTIC COMMUNITY*

The AI FIVES domestic community of interest started from a personal network and grew to over 500 members thanks to the addition of AI and ML science and technology deep dive presenters, DoD AI Symposium and technical exchange meeting participants, and promotion of AI FIVES events in the weekly DEVCOM Focus. Community members come from across the DoD, Department of Energy (DoE), Defense Advanced Research Projects Agency (DARPA), JAIC, AI2C, and the Army acquisition community. The domestic COI has access to resources, collaboration tools, and AI FIVES presentation materials through a Microsoft Teams Hub and shared repository.

## 2.3 AI FIVES SUMMARY

The seminar portion of the AI FIVES initiative ran from February to June of 2021. During this time 22 organizations from 10 European and the Middle Eastern countries presented their technologies, research areas, and capabilities to an average audience of 60 domestic COI representatives. There were two U.S.-only sessions held under the AI FIVES. The first, in November 2020, introduced the U.S. COI to the AI FIVES initiative and provided an in-depth overview of international collaboration tools. The second, in June 2021, provided a summary of the presentations under the initiative, summarized collaboration tools, and focused on the way ahead. An overview of the topics covered during the 22 presentations includes: predictive analytics, computer vision, additive manufacturing, autonomy, explainable and trustworthy AI, decision making, cyber and security, natural language processing, voice biometrics and speech recognition.

### 2.3.1 AI FIVES SAMPLE OUTCOMES

By highlighting non-traditional organizations, the AI FIVES served to increase the participation of such organizations in collaboration opportunities such as basic and applied research grants, candidates for Foreign Technology and Science Assessment Support (FTAS), as well as possible candidates under Foreign Comparative Testing (FCT) and Coalition Warfare Program (CWP) funding opportunities. Given that the AI FIVES initiative is still young, there are unrealized outcomes from introducing the 22 international organizations to the domestic COI. Many of the example AI FIVES outcomes to date are a result of the domestic COI finding commonality amongst projects as evidence in invited presentations at DoD level working groups, expanded DoD participation in meetings for existing basic and applied research grants, and increased DoD co-funding of existing basic and applied research grants. Additionally, there are scheduled virtual and in-person meetings between interested parties to explore specific research and technologies presented during the AI FIVES in more depth.

Secondary outcomes from the creation and growth of the domestic COI include the broadcasting of DoD AI funding opportunities and initiatives to the international COI. A tangible example is the xTechGlobal – AI Challenge that not only drew upon the domestic COI for reviewers during the two-round competition but also leveraged the international COI to solicit participants.

# 3.0 XTECHGLOBAL ARTIFICIAL INTELLIGENCE CHALLENGE

The U.S. Army's Expeditionary Technology Search (xTechSearch) is a prize competition for small businesses that seeks to uncover novel dual-use science and technology solutions to tackle the Army's most critical modernization challenges [4]. In 2021, xTechSearch expanded to international participants in the inaugural, xTechGlobal prize competition.

In partnership with U.S. Air Force and U.S. Navy, the U.S. Army announced in March 2021 its first international tri-service prize competition: xTechGlobal – AI Challenge [3]. The goal of xTechGlobal – AI Challenge is to engage eligible international, small to medium enterprises across the broad spectrum of science and technology in the DEVCOM-Atlantic AOR, in order to identify capabilities that provide robust, AI-enabled capabilities to manage, integrate, and process disparate data/information sources for rapid decision making. By engaging international enterprises from across Europe, the Middle East, and Africa (EMEA) the DoD aims to increase its understanding of the spectrum of world-class technologies being developed, integrate a new sector of small business innovators into the DoD Science and Technology (S&T) ecosystem, and provide mentorship and expertise to accelerate, mature, and transition technologies of interest to the DoD.

## 3.1 xTechGlobal Challenge Problem Statement

The xTechGlobal – AI Challenge problem statement consists of a topic and a motivating description of the challenge. The topic, "AI-enabled Multi-modal Analytics in Resource Constrained Environments," sought innovative solutions that could improve and advance the U.S. Army's AI and ML infrastructure, develop novel algorithm and software tools, and enable automated systems.

### 3.1.1 Challenge Topic Motivation

The motivation for the xTechGlobal – AI Challenge was the use of intelligence, surveillance and reconnaissance (ISR) sensors and intelligent agents (software and robotics) by future U.S. and coalition forces to independently and collectively conduct a wide range of distributed operations in complex, multi-domain environments [12]. Warfighters on future battlefields may not have large compute capability and may be under bandwidth constraints, thus significantly affecting the capability, workload, and utility of ISR at the tactical edge. Additionally, when faced with an information-soaked environment, warfighters do not have the time nor cognitive ability to process and sift through the deluge of data to create actionable information. This becomes more apparent with the advent of smart cities and the internet of things (IoT), such that one cannot expect a soldier on patrol in an urban area to scan every street camera, view every sensor's data, or determine social media sentiment [13][14]. AI has the potential to improve the quality of information and reduce workload at machine speed with the optimization of AI and ML techniques for such constrained environments.

More specifically, warfighters need AI-enabled capabilities to manage, integrate, and process disparate data and information sources at the speed and tempo of the mission. This is particularly challenging due to severe computing and bandwidth constraints of ISR systems and platforms. The xTechGlobal competition is interested in addressing these challenges with the following AI/ML algorithms and software tools to enable data analytic

capabilities at the tactical edge being of particular interest (see Figure 2):

- AI-enabled algorithms and services to rapidly assess availability of data and information sources and match the most relevant sources based on mission needs and available resources.

- Multi-modal reinforcement learning algorithms and AI-enabled analytic software tools for disparate data types such as (but not limited to) video, radio frequency (RF) signals, passive sensor data, and open-source multimedia.

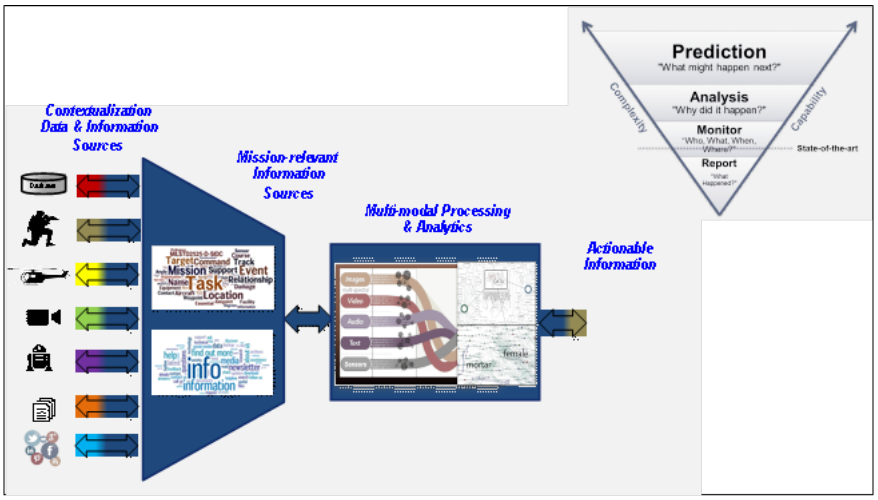


**Figure 2: Depiction of data analytic capabilities at the tactical edge.**

## 3.2 xTechGlobal Challenge Competition Structure

The xTechGlobal – AI Challenge is a two-round competition consisting of the following parts: Part 1- Request for Concept White Paper, and Part 2- Final Technology Pitches.

### 3.2.1 Part 1: Request for Concept White Paper

From 25 March 2021 to 12 May 2021, all eligible enterprises submitted a 4-page concept white paper and an accompanying single-slide summary chart outlining their technology, the potential impact on the U.S. military, the scientific viability of their approach, and the dual-use technology applications for both the commercial and defense spaces. DoD and international stakeholders (including users, program acquisition, and research and development subject matter experts) reviewed and scored each concept white paper and accompanying single-slide summary chart. The evaluation criteria included the summary chart, technology concept and viability, potential for impact or revolutionizing the Army, commercialization potential, and submission quality. An executive committee examined all of the scores and arrived at a consensus on the top-10 participants who received a prize award and an invitation to Part 2: Technology Pitches.

In addition to the prize money and an invitation to pitch their technologies, the 10 finalists also have an opportunity to participate in a mentored accelerator program. The accelerator offers innovative programming that includes training, mentoring and community building to help develop xTechGlocal participants as quickly as

possible so they can transition technologies to the warfighter. The accelerator includes guidance on product development for dual-use technologies and connections to private technology development programs.

### 3.2.2 Part 2: Final Technology Pitches

On 9 and 10 September 2021 the xTechGlobal finalists will have the opportunity to pitch their technology concepts and team capabilities either in-person or virtually to a panel of DoD and international subject matter experts at the Innovation Hub (I-HUB) Imperial College London (ICL). Each finalist will have 20 minutes to pitch, followed by 10 minutes for questions and answers from a panel of judges whose members come from across the AI ecosystem. The judges' panel will score the presentations and select the top 3 winners to receive an additional prize award.

During an orientation briefing on 15 July 2021, the finalists received detailed instructions and evaluation criteria. Finalists learned their presentations would be evaluated on their introduction, technology concept and viability, potential for revolutionary impact to the Army, military transition plan, and presentation quality. The finalists obtained the PowerPoint template and presentations guidelines that limited presentations to 15 slides, including the cover page.

After the final technology pitches, each of the finalists will receive detailed feedback from the panel. This feedback is to help accelerate transition of the technology to a U.S. military end-user by providing insight on best applications for the technology within the U.S. military, suggestions for product improvement for military use, and recommended next steps for development. However, the service representatives will not respond to questions or inquiries regarding this feedback.

## 3.3 xTechGlobal Challenge Competition Outcomes

The pilot xTechGlobal prize competition received 26 eligible proposals submitted from eight different countries across DEVCOM-Atlantic's AOR. Countries represented in Part 1 of the competition included the United Kingdom, France, Belgium, Switzerland, Italy, Sweden, Finland, and Israel as depicted in Figure 3.

The 10 finalists included industry from five different countries (UK, France, Israel, Switzerland, Finland) and cover a breadth of AI technology gaps across the DoD including AI integration, data fusion, AI training, and visualization across the TRL 5-9 spectrum. Amiral Technologies strives to maximize the uptime of all combat systems with focus areas of testing and fielding. Cognata Ltd. offers a synthetic digital twin environment for AI and ML training, testing, and verification with focus areas of testing and fielding as well as sensor and data fusion. Cyber Defense Service Ltd. provides situational awareness through deep learning signal analysis of wireless technologies with a focus area of applied research. Cynalytica International, Ltd. delivers AI-powered anomaly detection for analog industrial control systems communications with focus areas of integration and engineering as well as resilient and secure AI. Finden processes, segments, and classifies hyperspectral images using AI with focus areas of integration and engineering as well as distributed and decentralized AI. LatticeFlow offers trustworthy AI for mission-critical domains with focus areas of integration and engineering as well as resilient and secure AI. MarshallAI provides configurable deep learning pipelines for DoD computer vision with focus areas of testing and fielding as well as computer vision. Mind Foundry Ltd.'s GridFire system allows for inversion of black box models with a focus area of applied research. Rowden Technologies Ltd.'s Tactical Cortex is a context-aware system that uses ML to interpret outputs from an array of sensors with focus areas of applied research and edge computing. Spotlight Data's Nanowire surfaces pertinent information, trends, indicators, and warnings from unstructured data sources with a focus area of applied research.

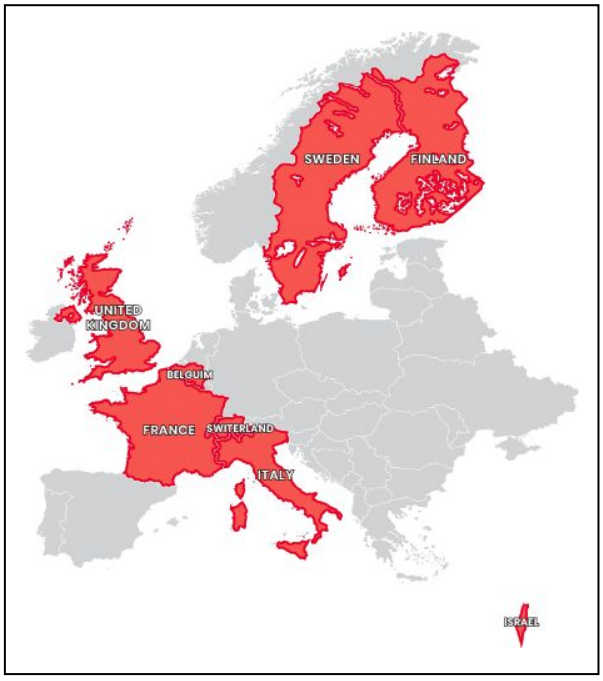


**Figure 3: Map of xTechGlobal Part 1 participants.**

As discussed in the previous section, the finalists will pitch their technologies as part of the final technology pitches with the top three winners awarded additional prizes. All 10 finalists will continue to have follow-on mentorship through the accelerator program, including periodic check-ins after the competition.

The xTechGlobal – AI Challenge demonstrates one method to engage with innovative non-traditional industry outside of the United States. After the pilot xTechGlobal, DEVCOM-Atlantic will consider expanding the model to develop further themed competitions open to international industry from around the world.

## 4.0 CONTRIBUTIONS TO U.S. ARMY ARTIFICIAL INTELLIGENCE RESEARCH ACTIVITIES

DEVCOM-Atlantic's two artificial intelligence initiatives involved scientists, engineers, and senior research scientists (STs) from across the Army modernization enterprise to include DEVCOM and AI2C. The involvement of these SMEs has laid the foundation for the efforts under AI FIVES and xTechGlobal – AI Challenge to affect current and future U.S. Army AI research activities.

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