JSTO in the News

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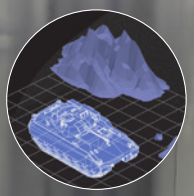
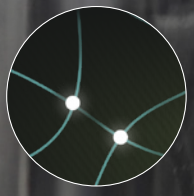


Here Be Dragons

Travel Sized



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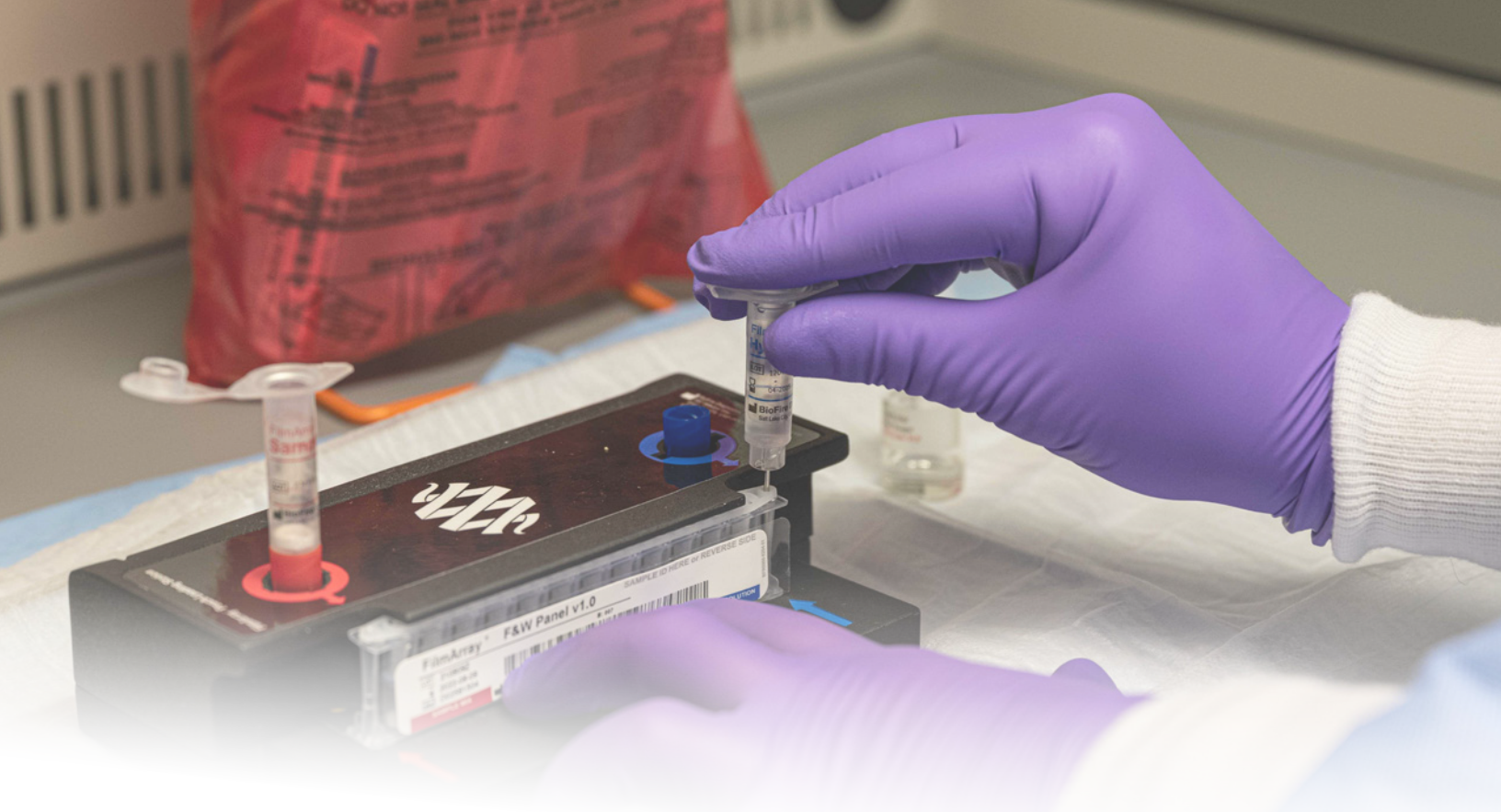

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DTRA provides cross-cutting solutions to enable the Department of Defense, the United States Government, and international partners to Deter strategic attack against the United States and its allies; Prevent, reduce, and counter Weapons of Mass Destruction (WMD) and emerging threats; and Prevail against WMD-armed adversaries in crisis and conflict.

CHEMICAL AND BIOLOGICAL TECHNOLOGIES DEPARTMENT MISSION

Lead DoD science and technology to enable the Joint Force, nation, and our allies to anticipate, safeguard, and defend against chemical and biological threats.

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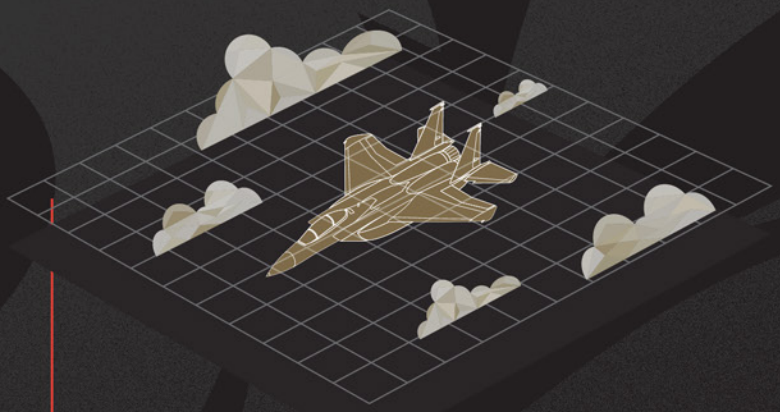
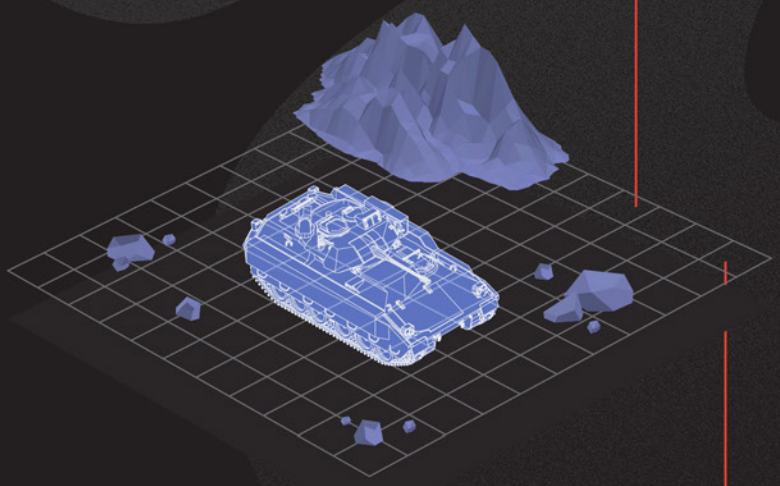
Front cover: CBRN soldiers search for biological warfare agents during a portion of the 1st Special Forces Command Validation Exercise at Dugway Proving Grounds, Utah. (U.S. Army photo by Staff Sgt. Iman Broady-Chin, 5th SFG(A) Public Affairs)

Inside cover: A U.S. Air Force medical lab technician hydrates a BioFire FilmArray pouch during a test run on Whiteman Air Force Base, Missouri. Air Force medical lab technicians provide analysis that helps prevent and treat disease while also detecting agents that could indicate biological warfare. (U.S. Air Force photo by Airman 1st Class Bryson Britt)

Back cover: Senior Airman Jamie N. Cline dons Mission-Oriented Protective Posture gear during a readiness exercise, at Aviano Air Base, Italy. All airmen across the wing, from finance to flightline, participated in a week-long readiness exercise with a variety of real-world scenarios to educate them to become familiar with how and when to use the appropriate protective gear. (U.S. Air Force photo by Senior Airman Cory W. Bush)



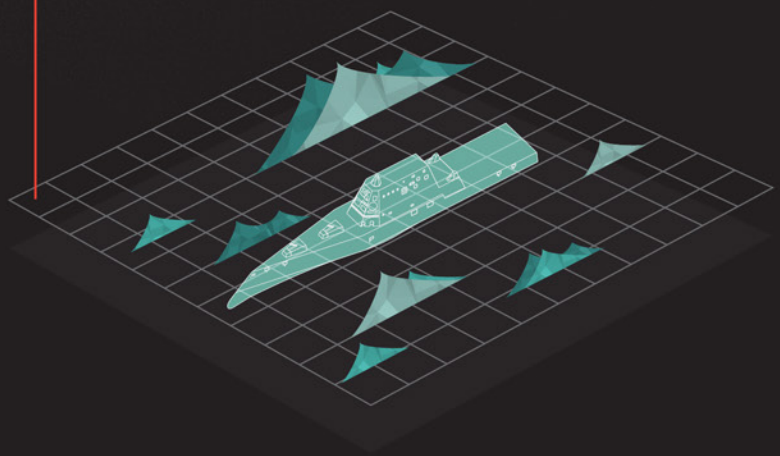


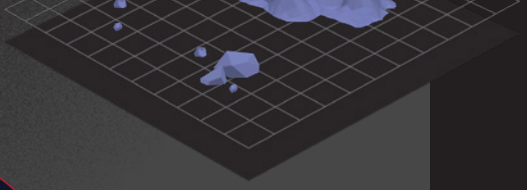
Here Be Dragons

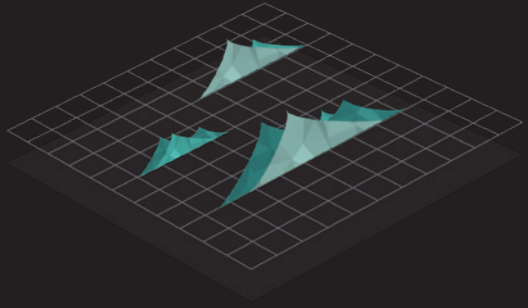
At Resolute Dragon 2, the Joint Force prepares for the uncertainties of future battlefields.

The recent Resolute Dragon 2 (RD2) advanced technology demonstration (ATD) at Aberdeen Proving Grounds, Md., featured several U.S. Marines, airmen, and sailors participating in integrated chemical, biological, and radiological (CBR) science and technology (S&T) experiments in Joint Force real-world scenarios to give feedback on the utility of new systems integrating sensors, battlespace-awareness tools, and decision-support tools. The S&T managers use this information to optimize and accelerate capability development and facilitate the transition to development and fielding.

To better prepare the Joint Force against current and future threats on the battlefield, the Defense Threat Reduction Agency's (DTRA) Chemical and Biological Technologies Department in its role as the Joint Science and Technology Office (JSTO) for Chemical and Biological Defense conducted RD2 to illustrate how combined technologies can







The ATD provided a dynamic representation of conflict where warfighters make CBR-informed decisions and respond to their consequences.

provide integrated early warning and integrated layered defense to inform CBR decision-making in Joint All-Domain Command and Control (JADC2) operations. JADC2 is a concept to integrate Joint Force technologies into a unified interoperable network that provided effective decisions at a relevant speed in an increasingly complex battlespace.

During this ATD, warfighters interacted with new integrated defense technologies aligned to prioritized future operational needs, such as tracking and responding to threats on the battlefield in near-real time, administering medical countermeasures (MCMs), using diagnostic tools to develop and simulate courses of action to respond to the scenarios, and to using new Android Tactical Assault Kit (ATAK) plugins to execute the selected courses of action and missions.

RD2 showed how CBR sensor data collected at the tactical edge can fit into and inform overarching JADC2 constructs by demonstrating three main points:

1. How CBR data collected at the tactical edge can generate a common operating picture that can inform higher-echelon decision-making environments and Joint Force-built JADC2 solutions
2. The role S&T plays in creating this CBR common operating picture through an interoperable data format and set of messaging protocols based on the Integrated Sensor Architecture standard
3. How S&T CBR technologies are not just enablers of mission execution but can also play a key role in mission planning by significantly reducing risk in allowing for CBR-based course of action identification and prioritization

RD2 comprised two segments: Mission Planning and Mission Execution.

The Mission Planning Phase included demonstrating how CBR-based decision-support tools and MCMs influence mission planning and course-of-action development, prioritization, and selection. The ATD provided a dynamic representation of conflict where warfighters make CBR-informed decisions and respond to their consequences. Highlights included demonstrating how MCM capabilities and CBR modeling and simulation tools work through a decision support framework to inform mission planners.

The Mission Execution Phase took the course-of-action planning outputs from the Mission Planning Phase and used them to conduct a Joint Service scenario-based mission. Using a real-world, multi-echelon C2 construct, RD2 generated a CBR-based common operating picture using exemplar S&T technologies and injected it into envisioned, Joint Service-developed, JADC2-compatible solutions. Highlights in this phase included Marine Expeditionary Unit/Amphibious Ready Group operations and simultaneous U.S. Air Force adaptive-basing operations. Technologies in this phase demonstrated how CBR data flows and integrates with service common operating picture systems.

The RD2 technology demonstrations, candid feedback from the participating service members, and interactive question-and-answer sessions between the attending guests and service members is another example of DTRA JSTO's goal to have the Joint Force ready to fight and win in a CB-contested environment through a coordinated effort designed to neutralize adversarial CB threats. ●

MCMs used in the mission planning phase of RD2 included Agent Catalytic Enzyme Systems, Reactivators of Acetylcholinesterase as Therapeutics, and Rapid Opioid Countermeasure System. Warfighters worked through scenarios as a group to develop a plan on how these MCMs would be used in the ATD. (DTRA photo)

In the mission planning phase, warfighters used the Marine Expeditionary Unit Risk Informed Assisted Decision Support tool, the Diminish Exposures via Multi-Agent Simulation and Quantification tool, and the Modeling and Simulation Toolbox to develop and simulate a course of action to respond to the scenario. (DTRA photo)

Participating warfighters used ATAK plugins including the CB Personal Protection, Hazard Estimation, & Assessment Tool, the Urban Downwind Hazard Prediction Tool (Integrated Urban), and the Unmanned Aerial Vehicle Flight Control Plugin (shown above) in the mission execution phase to carry out the selected course of action and CBR mission. (DTRA photo)

travel sized

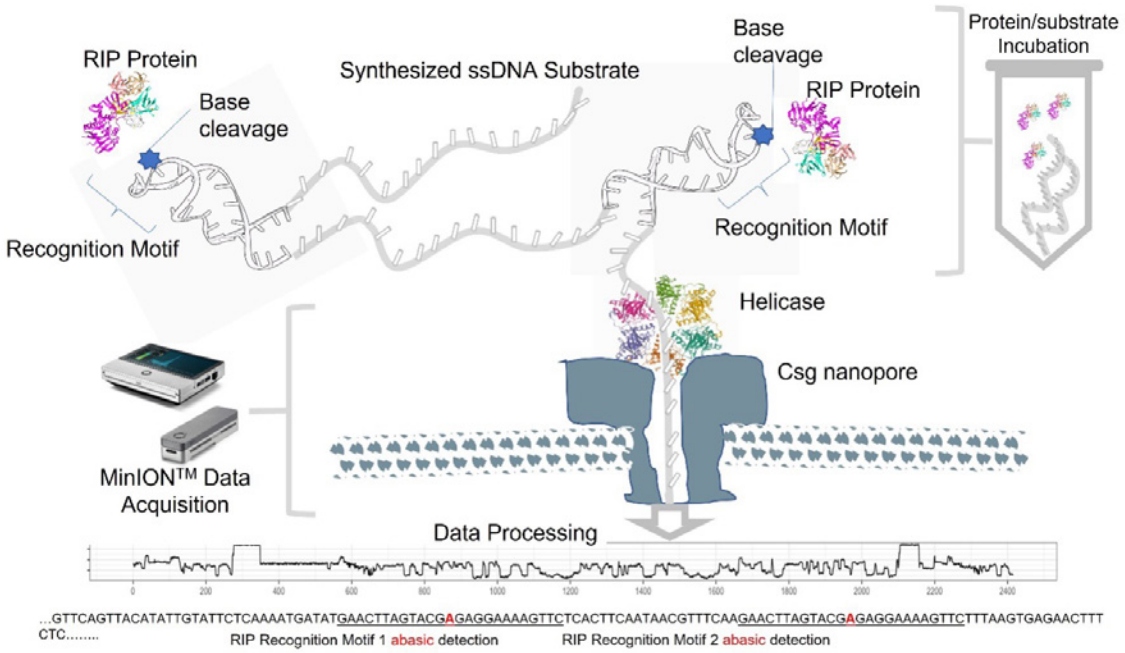
DNA sequencers were once roomy. Fitting one into the palm of a hand changes everything for diagnosis in the field.

Advances in DNA sequencing technology have enabled unprecedented access to study the genetic profile of organisms, revolutionized modern medicine, and enhanced diagnostics capabilities.

Rapid and timely threat detection is essential to prescribe appropriate medical countermeasures along with broader Joint Force health protections.

When warfighters deploy to austere environments under potential threats from biological warfare agents (BWAs), rapid and timely threat detection is essential to prescribe appropriate medical countermeasures along with broader Joint Force health protections.

The Defense Threat Reduction Agency's (DTRA) Chemical and Biological Technologies Department in its role as the Joint Science and Technology Office (JSTO) for Chemical and Biological Defense is investing in a project with the Pacific Northwest National Laboratory (PNNL) to adapt a portable, commercial-off-the-shelf nanopore sequencing technology for rapid detection and diagnostics of proteins at the point of care.



Depiction of nucleic acid construct and resulting reads. The ssDNA portion of the molecule passes through the nanopore and membrane (blue section) to the trans side with sample current reading fluctuations with sequence (bottom). Features include an RNA immunoprecipitation (RIP) protein sequence recognition motif, RIP proteins, and Helicase from the National Center for Biotechnology Information and Molecular Modeling Database. (Oxford Nanopore Technologies image)

Point-of-care diagnostics is essential for immediate medical response time, reducing mortality, and preserving mission effectiveness. Unfortunately, presently available diagnostic tools in this area rely primarily on traditional immunology and polymerase chain reaction technologies, often compounding the detection of BWA-specific targets and being dependent on sample concentration. Current research and development efforts are focused on using new technologies, including biosensors, nanotechnologies, and high-sensitivity molecular assays, to improve on the limitations of traditional diagnostics assays.

The same way technological advancements have led to smaller, cheaper, and more powerful computers, DNA sequencers have come a long way over the past 20 years—from large room-sized instruments to small hand-held sequencers. One such miniature technology is nanopore-based sequencing, which introduces compact, lightweight, and highly specific sequencing platforms. These features provide a unique opportunity to develop portable sequencing capabilities for biological detection and diagnostics in the field.

A hand-held platform that can detect proteins and sequence DNA would be suitable for field-forward environments where traditional medical laboratory equipment cannot go. This expanded capability to detect and diagnose a broad range of biological threat agents in the field would be invaluable to the Joint Force, especially involving new or emerging threats.

The nanopore DNA sequencer is a laboratory device used to determine the exact sequence of nucleotides, or bases, in a DNA molecule. This effort conducted by DTRA JSTO and PNNL uses the Oxford Nanopore Technologies MinION system to also monitor protein activity in clinical and environmental samples. The researchers are adapting validated benchtop assays to the MinION platform and using MinION sequencing probes to serve as molecular substrates for BWAs that target host nucleic acids and proteins. Researchers successfully adapted probes against four targets with high sensitivity in laboratory samples and are ready to begin testing clinical and environmental samples such as blood, saliva, soil, and water. While there are several more studies to complete, this data supports nanopore technologies as a viable option for portable point-of-care diagnostics in field-forward settings.

DTRA JSTO continues to leverage cutting-edge technologies to provide warfighters with new diagnostics capabilities and to enhance troop preparedness. This hand-held platform will also provide a multiplexed solution for several biological threat agents that can readily adapt to emerging biological threats. ●

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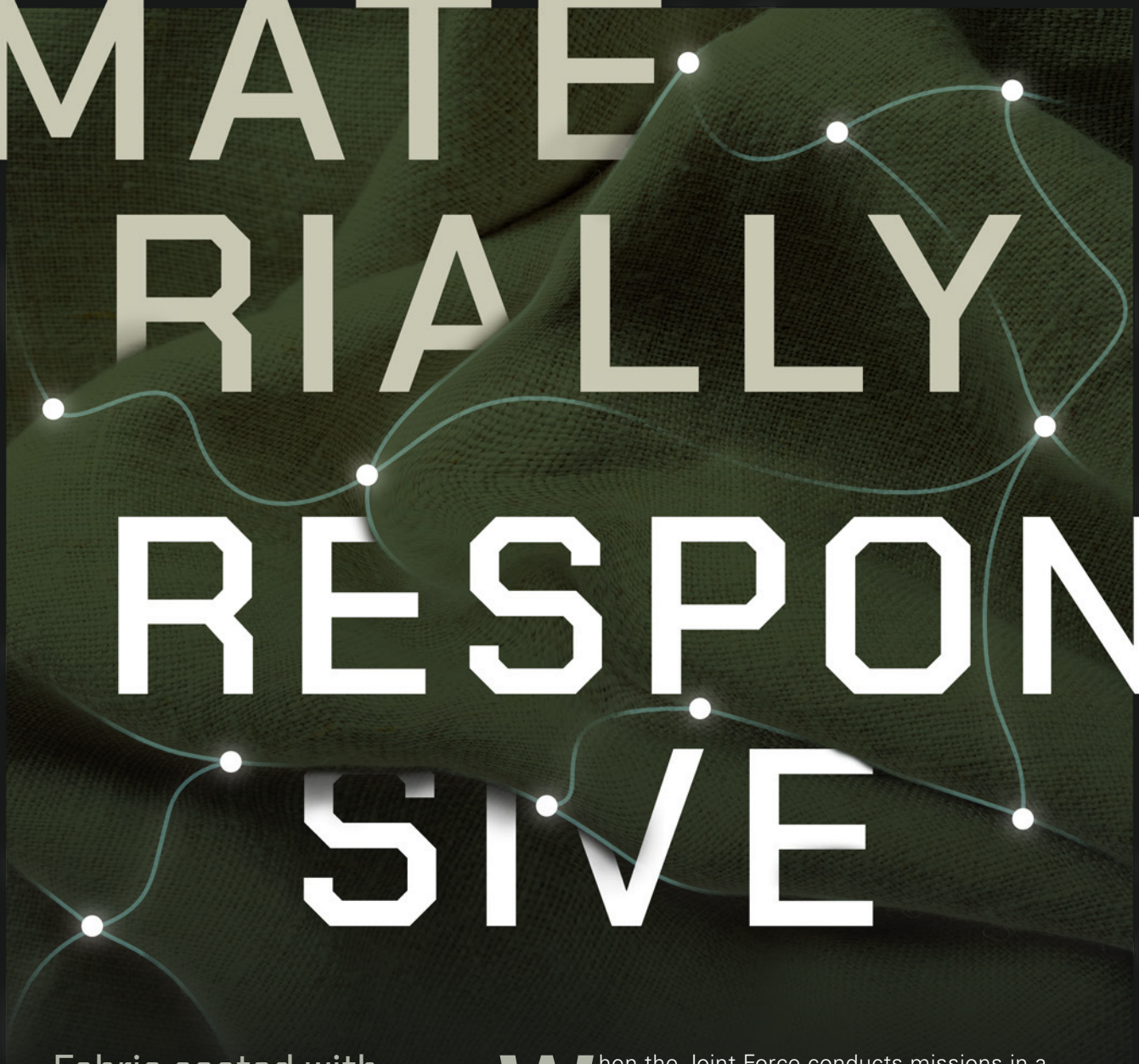
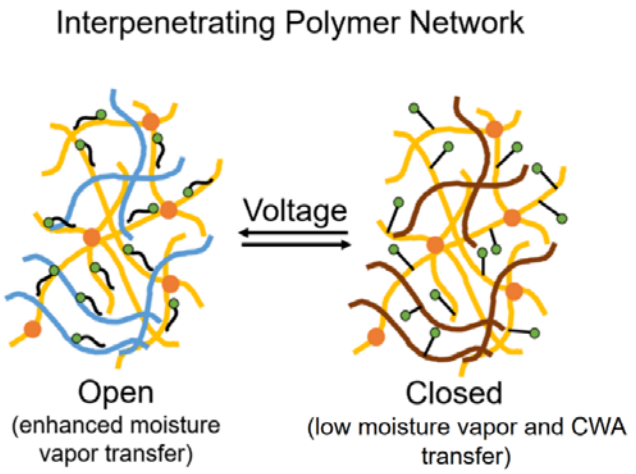
MATERIALLY RESPONSIVE



Fabric coated with switchable polymers may lead to the development of lighter and less restrictive protective garments for the Joint Force.

When the Joint Force conducts missions in a chemically or biologically contaminated operational environment, they wear protective garments, but these garments burden warfighters by increasing heat retention and restricting movement, which reduces their mission effectiveness. To reduce burden while maintaining or improving protection, the Defense Threat Reduction Agency's (DTRA) Chemical and Biological Technologies Department in its role as the Joint Science and Technology Office (JSTO) for Chemical and Biological Defense is investing with the Powerhouse Consulting Group (PCG), an industry leader in textile fabrication, to produce a prototype fabric for lightweight protective garments that would replace the current hot, heavy, and cumbersome Joint Force chemical and biological (CB) overgarment.

The current CB overgarment is the Joint Service Lightweight Integrated Suit Technology (JSLIST), which is a carbon-based protective system that provides full-spectrum protection against chemical warfare agents (CWAs), but its heat retention and movement restriction impede mission performance. To address these burdens, DTRA JSTO is developing a lighter-weight fabric coated with switchable polymers called an Interpenetrating Polymer Network (IPN) as a component of a next-generation, responsive, triggerable, chemical-threat overgarment that is lightweight, more flexible, allows high moisture and heat transfer in uncontaminated environments, and only protects and restricts moisture and heat transfer in the presence of CWAs.



The Interpenetrating Polymer Network (IPN) consists of electroactive conducting polymer (blue/red), carbon fibers, crosslinked plastic support (orange and yellow), and tethers (black and green). The IPN can switch between open (left) and closed (right) configurations by applying voltage to the system. When closed, the tethers are released and the conducting polymers are exposed, which causes a localized increase in IPN density, resulting in the protective closed state. (Powerhouse Consulting Group image)

Polymer configurations can be switched using a triggering electrical signal that has the potential to be linked to a chemical agent detector so that protection increases immediately upon detection.

The IPN has two configurations: an open configuration that allows air and moisture vapor transfer through the fabric making it more breathable, and a protective closed configuration that prevents moisture vapor and CWAs from passing through. Polymer configurations can be switched using a triggering electrical signal that has the potential to be linked to a chemical agent detector so that protection increases immediately upon detection.

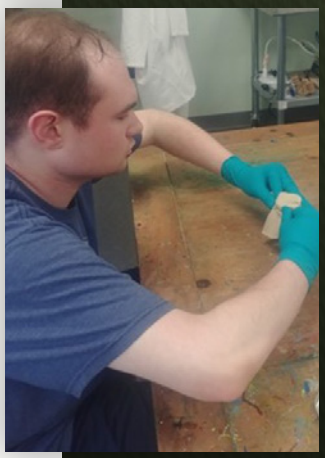
There are several advantages to an environmentally responsive protective garment:

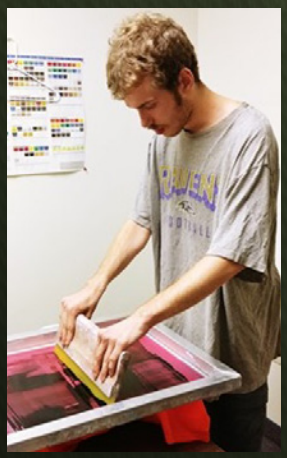
1. First, the garment can be worn in uncontaminated environments with reduced physical burden compared to current protective garments.
2. Second, protection increases as soon as the threat is detected, reducing the risk of exposure to the wearer.
3. Third, the versatility of a responsive protective garment means that it can possibly serve as both a service uniform and CB protective garment, which may reduce the overall cost of protective garments.

To enrich the CB workforce, part of the PCG staff developing these next-generation protective garments are adults within the autism spectrum. PCG's Science and Arts for Lifetime Employment Skills (SCALES) program employs an underserved but vastly talented pool of autistic adults who are developing high-tech lab skills in areas aligned with the DTRA JSTO mission. These protective garment-specific skills include dip coating, spray coating, screen printing, and sample preparation steps for measurements, all which require attention to detail and pattern recognition. The SCALES program trains autistic students and promotes job placement with prospective employers that include small businesses, large businesses, and national laboratories. Though autistic adults may be challenged with social and communication skills, they are very capable of working in environments requiring complex and multistep processes with minimal guidance.

PCG's Science and Arts for Lifetime Employment Skills (SCALES) program employs an underserved but vastly talented pool of autistic adults who are developing high-tech lab skills in areas aligned with the DTRA JSTO mission.

Together, DTRA JSTO and PCG are developing textile fabric components for future responsive garments while also training autistic-spectrum adults in skills valued by the Department of Defense. The optimal base fabric will be selected for stretchability, washability, availability, and cost. PCG will test swatches of IPN fabric with CWAs and those that perform well will guide the development of prototype, next-generation, responsive protective garments that minimize physical burden in uncontaminated environments and respond rapidly in the presence of contamination to increase protection. This reduces the risk of exposure for the Joint Force, improves garment versatility, reduces mission impact, and may lead to reduced costs. ●





DTRA JSTO employs many autistic adults who may be challenged with social and communication skills but can work with minimal guidance in environments that require complex, multistep processes. (Powerhouse Consulting Group photos)

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Within the Defense Threat Reduction Agency's Research and Development Directorate resides the Chemical and Biological Technologies Department performing the role of Joint Science and Technology Office for Chemical and Biological Defense. This publication highlights the department's advancements in protecting the Joint Force, our nation, and allies from chemical and biological threats through the innovative application of science and technology.

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