# Value Proposition of the Department of Defense Technology Transfer Program

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# Value Proposition of the Department of Defense Technology Transfer Program

## ***Introduction and Motivation***

The Stevenson-Wydler Technology Innovation Act of 1980 created the statutory responsibility for Federal agencies to participate in and support technology transfer programs, having found that "technology and industrial innovation are central to the economic, environmental, and social well-being of citizens of the United States." Subsequent amendments to this statute and additional statutes, in conjunction with executive orders, establish a mandate for Federal laboratories to disseminate the results of their research and development (R&D) enterprises through scientific publications, presentations, patents, trademarks, and active collaborations with the private sector. In terms of enabling collaborations and active exchange with private partners, the most utilized technology transfer mechanisms authorized by these statutes, executive orders, and policies are:

Cooperative research and development agreements (CRADAs): Agreements wherein a Federal laboratory provides personnel, services, facilities, equipment, intellectual property, or other resources with or without reimbursement (but not funds to non-Federal parties) and the non-Federal parties provide funds, personnel, services, facilities, equipment, intellectual property, or other resources toward the conduct of specified research or development efforts that are consistent with the missions of the laboratory.

Patent license agreements (PLAs): Agreements wherein a Federal laboratory authorizes a use of a patented invention to a licensee, protecting the licensee from a claim of infringement brought by the licensor; the government may grant non-exclusive, partially exclusive, or exclusive licenses.

Small Business Innovation Research (SBIR): While not inherently a technology transfer mechanism, this competitive, awards-based program encourages domestic small businesses to explore their technological potential by engaging in Federal R&D, while providing the incentive to profit from technology commercialization. They may be used as an additional mechanism to support small businesses developing DoD technology via a license.

Software licenses: Agreements wherein a Federal laboratory authorizes the use of DoD-developed computer software to a licensee, protecting the licensee from a claim of infringement brought by the licensor; the government may grant non-exclusive, partially exclusive, or exclusive licenses. Prior to this authority, DoD-developed computer software could only be licensed if it was patented.[1]

[1] This authority was granted in the National Defense Authorization Act for Fiscal Year 2014 (Public Law 113-66) in section 801. Please see section 801 for full description of authority and necessary conditions for its use.



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The statutory mandate to perform technology transfer activities makes it clear that Congress intends for Federal spending in R&D to offer a return on this national investment. Congress provided guidance on measuring this return by specifying that technology transfer metrics be collected and reported annually (Title 15, United States Code, section 3710). These metrics include the number of licenses executed, number of patents filed and received, amount and disposition of royalty income, and additional data. In addition to these measures, the DoD has the latitude to use tools beyond the mandated programmatic activity metrics. For example, the Defense-wide partnership intermediary TechLink has undertaken economic impact studies focused on PLAs and, more recently, CRADAs. TechLink's rigorous methodology[2] reveals substantial economic impacts from laboratory technology transfer programs: from 2000 to 2017, DoD PLAs generated an estimated $58 billion in total contribution (inclusive of sales, job creation, and other downstream effects) to the U.S. economy. While important to determine, such quantitative, economic impacts represent only one aspect of the value of DoD's technology transfer programs.

Indeed, understanding the value of technology transfer in its full breadth requires an in-depth examination of project successes, encompassing transition, project longevity, and Warfighter impact. To capture these broader, qualitative impacts for DoD's R&D enterprise, the Office of Technology Transition chartered a study in late 2008 that collected technology transfer–related case studies from across DoD. Released in 2010, the original Value Proposition report presented 23 specific stories of new technologies and tools enabled by technology transfer. These success stories have provided DoD leadership and technology transfer practitioners with concrete examples of how technology transfer delivered value and impact to the Warfighter and the Department's mission as well as economic impact to nation.

Rapid advances in science and technology and renewed interest in technology transfer at the Federal level necessitate the continued study of DoD's technology transfer programs. For instance, the Lab-to-Market Cross-Agency Priority goal in the President's Management Agenda explicitly seeks to improve technology transfer processes across the Federal government. In parallel with such initiatives, the Laboratories and Personnel Office prepared a new study based on the 2010 Value Proposition report. This report identifies recent case studies wherein technology transfer mechanisms have brought sustained success to programs developed by DoD's R&D enterprise. Laboratories across the Services provided success stories; we then investigated how the product or collaboration added a capability, saved time or lives, enhanced maintainability, or provided other benefits or impacts. Instead of collecting metrics data across all of DoD's laboratory activities, this study provides a representative set of vivid, topical, and concrete examples of the value of technology transfer for DoD from 2008 to 2019.

[2] Full description of methodology and results available at: https://techlinkcenter.org/impacts



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## ***Methodology***

To acquire, refine, and develop the case studies, we used a combination of questionnaire responses, in-person and phone interviews, and internet searching. Personnel from the three Services, several Defense Agencies, TechLink, and commercial partners provided information. The process was:

- To understand CRADAs, the Director, Laboratories & Personnel, sent a memo to the program managers of the Services' technology transfer programs as well as the Uniformed Services University of the Health Sciences (USUHS). This memo requested the program managers to identify at least five "value candidates" involving a CRADA and, for each candidate, to fill out a questionnaire identifying the DoD laboratory, the private party, and how the case study had brought value to the DoD or the private sector. The questionnaire is attached at the end of this report (Appendix 1).

- To understand PLAs and software licenses, TechLink was asked to provide information on successful PLAs. The Air Force Technology Transfer Program Office approved TechLink's participation in this study. The economic impact study team at TechLink had a ready list of successful PLA case studies based on its recent licensing study (released in 2019).

- Two additional case studies, each spanning DoD, were derived through personal contact with members of the defense community.

- Once the questionnaires were delivered, we analyzed the value candidates for stage of development, commercial sales, and general degree of usefulness to DoD or the private sector. A minority were cancelled and not pursued further or we deemed their usefulness to be inconclusive.

- We continued investigating the successful or ongoing projects by interviewing the DoD and/or private-sector partners to learn the backstories, technological details, and impact of the technologies or outcomes. The majority of the case studies required one or more interviews to obtain sufficient information. In particular, we sought to understand how the technology transfer mechanism(s) factored into each narrative and the qualitative impact of the resulting research or product.

- As a study output, we developed a standard quad chart format to highlight the successful/ongoing projects. DoD laboratories personnel and private-sector partners were critical in obtaining figures and graphics for the quad charts. Completed quad charts were sent to DoD and private-sector stakeholders for comment and approval for public release.



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## ***Results***

A summary of the submissions is presented in **Table 1**:

***Table 1. Summary of Submissions***

| **Component**: | **Army** | **Navy** | **Air Force** | **USUHS** | **Fourth Estate** |
|---|---|---|---|---|---|
| **CRADA** (submitted by Component) | 16 | 11 | 4 | 6 | 0 |
| **PLA** (submitted by TechLink) | 5 | 5 | 5 | 1* | 0 |
| **Total** | **21** | **16** | **9** | **6** | **2**‡ |

*Duplicate with submission directly from USUHS ‡Derived from personal contacts during the investigation

Overall, we collected and reviewed **54 total case studies, of which 44 are successful or ongoing**. Ten are inconclusive, on hold, or cancelled (see definitions below).

The "successful or ongoing" projects have already generated commercial products with sales, have imminent pathways to commercialization, or provide clear, realized benefits to either DoD or the private sector. Details about the ongoing or clearly successful submissions are presented in **Table 2** (p. 8), divided by DoD component. The table also includes laboratory, private-sector partner, and type(s) of technology transfer mechanism(s) involved for each project.

We also classified the successful case studies by *how* the technology transfer mechanisms brought value to the projects, to clearly identify the qualitative benefits of technology transfer for DoD. Tech transfer professionals can refer to these case studies to demonstrate how innovative partnerships can advance and assist their missions. These categories, presented in **Table 3** (pp. 12-13), include technology transfer cases wherein:

a. The collaboration between DoD and private sector enabled technology maturation
b. The private sector gained access to DoD tools or capabilities
c. DoD gained access to private-sector tools or capabilities
d. A license enabled a product sold to DoD
e. A license enabled a product sold outside DoD
f. Technology transfer supported acquisition or policy
g. A license facilitated the creation or growth of a startup

Finally, a minority of case studies were categorized as inconclusive, on-hold, or cancelled (**Table 4**, p. 14). Projects deemed "inconclusive" are generally still in the development phase and may generate a useful product or output in the future. Projects labelled "on-hold" or "cancelled" have no clear pathway to commercialization or have been dropped by one or both partners.


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## ***Conclusions***

The case studies collected here present excellent examples of how technology transfer mechanisms generate value by enabling interactions between DoD and the private sector. On the intramural side, the stories span the Defense Laboratories Enterprise—including all the Services and some Fourth Estate organizations—and the vast array of scientific and technological areas researched within. Extramural partners include organizations as diverse as new startups, established small businesses, major defense prime contractors, and educational institutions.

Many case studies highlight the creative ways that DoD personnel utilize these mechanisms to advance their missions more effectively than they could following traditional Federal acquisition pathways—from the Army using a CRADA to generate training and recruitment data using private-sector expertise (p. 15), to the Air Force using a CRADA to mature a revolutionary type of steel for munitions (p. 43). Conversely, the private sector has benefitted from access to DoD tools and facilities, such as Navy testing equipment used to refine instrument calibration software (p. 31). Many times, one-on-one collaboration between the DoD inventor and private-sector partner—enabled by a CRADA—proved invaluable for a commercialization effort driven by a PLA.

Importantly, many of these projects have resulted in new capabilities for DoD. PLAs have enabled the transfer of technology out of DoD laboratories for subsequent development by industry. Many new tools have then been acquired by DoD for use by the Warfighter, such as a life-saving endovascular balloon for the Air Force (p. 48). Other collaborations have facilitated the acquisition process for major programs (CREATE, p. 57) or supported the development of new policies that improve DoD operations and processes—for instance, a cold weather testing collaboration between the Army and Rowan University has resulted in updates to several construction policies across DoD (p. 22).

The case studies provided in this report motivate and inspire those within DoD to further advance science and technology programs using technology transfer. Working with the government is advantageous for both parties, and barriers to collaboration can be low. Communicating this value to internal and external stakeholders is key to continuing these fruitful collaborations and expanding the use of existing mechanisms. This study demonstrates the value of DoD improving its outreach and promotion of R&D opportunities to the private sector. Active support for the technology transfer community of professionals from key Department constituencies, including increased engagement by program executive offices, would enable better transition of laboratory-developed technologies to the Warfighter.


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***Table 2. List of Successful or Ongoing Case Studies***

| Army | Navy | Air Force | 4th Estate |
|---|---|---|---|

| Technology/Project | Government Partner | Private Sector Partner | Tech Transfer Mechanism(s) | p. |
|---|---|---|---|---|
| Outreach & Recruiting Data Analysis | CCDC Aviation & Missile Center | WonderWorks Exhibits, LLC | CRADA | 15 |
| Tafenoquine (TQ), Anti-malarial | U.S. Army Medical Materiel Development Activity | 60° Pharmaceuticals LLC | PLA, CRADA | 16 |
| Rate-Activated Materials for Physical Therapy Applications | CCDC Army Research Laboratory | Per Vivo Labs | PLA, CRADA | 17 |
| Data Translation and Integration Software | U.S. Army Space and Missile Defense Command | Aegis Technologies Group, Inc. | Software License | 18 |
| Testing of Cost-effective, Rapid-Delivery Satellite Platforms | U.S. Army Space and Missile Defense Command | York Space Systems LLC | CRADA | 19 |
| Self-contained Chemical, Biological, Radiological, and Explosive Sampling Kit | CCDC Chemical Biological Center | QuickSilver Analytics, Inc. | PLA, CRADA | 20 |
| BUILDER Sustainment Management System | ERDC Construction Engineering Research Laboratory | North Pacific Support Services, Inc. | PLA, CRADA | 21 |
| Cold Weather Pavement Testing | ERDC Cold Regions Research and Engineering Laboratory | Center for Research and Education in Advanced Transportation Engineering Systems, Rowan University | CRADA | 22 |
| Water Diagnostics and Purification Systems | ERDC Geospatial Research Laboratory | Newcomer Arms, LLC | PLA, CRADA | 23 |
| Hardened Alternative Trailer Systems (HATS) | ERDC Geotechnical and Structures Laboratory | RedGuard CoverSix Shelters, LLC | PLA | 24 |



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| Technology/Project | Government Partner | Private Sector Partner | Tech Transfer Mechanism(s) | p. |
|---|---|---|---|---|
| Fish Biomonitoring System | U.S. Army Center for Environmental Health Research | Blue Sources, LLC | PLA, CRADA | 25 |
| DNA Sequence Analysis | U.S. Army Criminal Investigation Laboratory | NicheVision Forensics | PLA | 26 |
| Core Body Temperature Algorithms | U.S. Army Research Institute of Environmental Medicine | Equivital LLC (a Hidalgo subsidiary) | PLA | 27 |
| Shock-absorbing Concrete | ERDC Geospatial Research Laboratory | MOUT Solutions | PLA | 28 |
| Monoblock Lasers | CCDC C5ISR Night Vision and Electronic Sensors Directorate | Industry partner | PLA | 29 |
| Nanostructured Materials for Ballistic Applications | Naval Research Laboratory | Nanoarmor, LLC | PLA, CRADA | 30 |
| Measurement Uncertainty Modeling and Analysis Tool | NSWC Corona Division | American Technical Services, Inc. | PLA, CRADA | 31 |
| Crush-Resistant Glass Foam | NSWC Corona Division | Microsphere Material Solutions | PLA, CRADA, EPA, SBIR | 32 |
| Assessment of Cybersecurity Products | NSWC Crane Division | Company “X” | CRADA | 33 |
| Cybersecurity Research & Development | NSWC Crane Division | Center for Applied Cybersecurity Research, Indiana University | CRADA | 34 |
| Ergo Wearable Sensor Kit | NSWC Crane Division | GoX Studio | PLA, CRADA | 35 |
| Instrumented Acoustic Array for Underwater Sensing | NIWC Pacific | BAE Systems Information and Electronic Systems Integration, Inc. | CRADA | 36 |
| Additive Manufacturing Production Capability Validation | NIWC Pacific | HP, Inc. | CRADA | 37 |
| RADAR Retro-Reflector For 1/4 U Nanosatellites | NIWC Pacific | Swarm Technologies | CRADA, SBIR | 38 |



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| Technology/Project | Government Partner | Private Sector Partner | Tech Transfer Mechanism(s) | p. |
|---|---|---|---|---|
| Aviation Harness Quick Release | NAVAIR Patuxent River | Survival Innovations | PLA | 39 |
| Planar Waveguide for Medical Diagnostics | Naval Research Laboratory | Precision Photonics Corporation, MBIO Diagnostics | PLA, CRADA, SBIR | 40 |
| Quantitative Mobility Spectrum Analysis for Hall Effect Measurement | Naval Research Laboratory | Lake Shore Cryotronics | PLA, CRADA, SBIR | 41 |
| Mission Critical Nutrition 40 (MCN-40) | 711th Human Performance Wing | MusclePharm, Inc.; Newcomer Arms, LLC | PLA, CRADA | 42 |
| AF96 Low-Alloy, High-performance Steel | AFRL, Munitions Directorate | Timken Steel | CRADA | 43 |
| MODTRAN® Software | AFRL, Space Vehicles Directorate | Spectral Sciences, Inc. | PLA | 44 |
| Mobile Layered Sensing Exploitation System | AFRL, Sensors Directorate | The Knowledge Design Company | CRADA | 45 |
| Polyhedral Oligomeric Silsesquioxane (POSS) | AFRL, Aerospace Directorate | Hybrid Plastics, Inc. | PLA, CRADA, SBIR | 46 |
| Secure, Cross-Domain Collaboration Gateway | AFRL, Information Directorate | Trident Systems, Inc. | PLA, SBIR | 47 |
| Resuscitative Endovascular Balloon Occlusion of the Aorta | Air Force Medical Support Agency | Prytime Medical Devices | PLA, CRADA | 48 |
| Fiber Optic Combiner | Air Force Academy | Optical Engines | PLA, CRADA, SBIR | 49 |
| Android Tactical Assault Kit | AFRL, Information Directorate | Helios Remote Sensing Systems | Software License | 50 |
| Prostate Cancer Research Study | USU Center for Prostate Disease Research | Genomic Health Inc. | CRADA | 51 |



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| Technology/Project | Government Partner | Private Sector Partner | Tech Transfer Mechanism(s) | p. |
|---|---|---|---|---|
| Radiation Countermeasure | USU Armed Forces Radiobiology Research Institute | Humanetics Pharmaceuticals | PLA, CRADA | 52 |
| Endoscopy Training System | Uniformed Services University of the Health Sciences | Kyoto Kagaku Co Ltd; Limbs and Things, Inc. | PLA, CRADA | 53 |
| Equivac® Hendra Virus Vaccine | Middle-Atlantic Regional Center of Excellence for Biodefense and Emerging Infectious Diseases Research | Pfizer Animal Health (now Zoetis) | PLA, CRADA | 54 |
| Hemostatic Bandages | Uniformed Services University of the Health Sciences | St. Teresa Medical, Inc. | PLA, CRADA | 55 |
| Rapid Shiga Toxin Diagnostic Assay | Uniformed Services University of the Health Sciences | Inverness Medical Innovations, Inc. (now Abbott) | PLA, CRADA | 56 |
| Computational Research Engineering Acquisition Tools and Environments (CREATE) | High-performance Computing Modernization Program | Many | Software License | 57 |
| Virtual Baffle System for Firearms Suppressors | SOCOM, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, and U.S. Army CCDC Armaments Center | LMT Defense | PLA | 58 |



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***Table 3. Classification of Case Studies: Value of Technology Transfer***

a. The collaboration between DoD and private sector enabled technology maturation
b. The private sector gained access to DoD tools or capabilities
c. DoD gained access to private-sector tools or capabilities
d. A license that enabled a product sold to DoD
e. A license that enabled a product sold outside DoD
f. Technology transfer supported acquisition or policy
g. A license that facilitated the creation or growth of a startup

| Army | Navy | Air Force | 4th Estate |
|---|---|---|---|

| Technology/Project | p. | a. Research Collaboration | b. Access to DoD | c. Access to private sector | d. Product sold to DoD | e. Product sold outside DoD | f. Acquisition or Policy | g. Creation of startup |
|---|---|---|---|---|---|---|---|---|
| Outreach Analysis | 15 | | | x | | | x | |
| Anti-Malarial | 16 | x | | x | x | x | | |
| Physical Therapy Materials | 17 | x | | | | x | | |
| Data Translation Software | 18 | | | | | x | | |
| Satellite Testing | 19 | | x | x | | | | |
| CBRNE Testing Kit | 20 | x | x | | x | x | | x |
| Building Management Software | 21 | | x | | x | x | x | x |
| Cold Weather Testing | 22 | x | x | x | | | x | |
| Water Testing and Purification | 23 | x | | | | x | | |
| Hardened Trailer Systems | 24 | | x | | | x | | |
| Fish Biomonitoring System | 25 | x | | | x | x | | x |
| DNA Analysis | 26 | | | | x | x | | |
| Core Body Temp Algorithm | 27 | | | | x | x | | |
| Shock-absorbing Concrete | 28 | | | | x | x | | x |
| Monoblock Lasers | 29 | | | | x | | | |
| Nanostructured Materials | 30 | x | | x | | | | x |
| Measurement Tool | 31 | | x | | x | x | | |
| Glass Foam | 32 | x | | x | x | x | | x |



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| Technology/Project | p. | a. Research Collaboration | b. Access to DoD | c. Access to private sector | d. Product sold to DoD | e. Product sold outside DoD | f. Acquisition or Policy | g. Creation of startup |
|---|---|---|---|---|---|---|---|---|
| Cybersecurity Products | 33 | x | x | x | | | x | |
| Cybersecurity R&D | 34 | x | | | | | x | |
| Wearable Sensor Kit | 35 | x | x | | | x | x | |
| Underwater Sensing Array | 36 | x | | | x | | x | |
| Additive Manufacturing | 37 | x | | x | | | x | |
| Nanosatellite Reflectors | 38 | x | x | x | | | | |
| Harness Quick Release | 39 | | | | x | x | | |
| Medical Diagnostics Sensors | 40 | x | | | x | x | | x |
| Hall Effect Measurement | 41 | x | | | x | x | | |
| Meal Replacement Powder | 42 | x | | | x | x | | |
| High-performance Steel | 43 | | | x | | | x | |
| Radiative Transport Software | 44 | | | | x | x | | |
| Situational Awareness Develop. | 45 | | x | | | x | | |
| POSS Materials | 46 | x | | x | x | x | | x |
| Cross-Domain Gateway | 47 | | | | x | x | | |
| Endovascular Balloon | 48 | x | | | x | x | | x |
| Fiber Optic Combiner | 49 | x | | | x | x | | x |
| Situational Awareness Software | 50 | | | | x | x | x | |
| Prostate Cancer Study | 51 | x | | x | | x | | |
| Radiation Countermeasure | 52 | x | | | x | x | | x |
| Endoscopy Training System | 53 | x | | | x | x | | |
| Hendra Virus Vaccine | 54 | x | | | | x | | |
| Hemostatic Bandages | 55 | x | | x | | x | | x |
| Shiga Toxin Assay | 56 | x | x | | x | x | | |
| High-performance Computing | 57 | | x | | | | x | |
| Firearms Suppressors | 58 | | | | x | x | x | |



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***Table 4. List of On-Hold, Inconclusive, or Cancelled Projects***

| Army | Navy |
|---|---|

| Technology/Project | Government Partner | Private Sector Partner | Tech Transfer Mechanism(s) | Status |
|---|---|---|---|---|
| Rate-Activated Materials for Footwear Closure Systems | CCDC Army Research Laboratory | Hickies, Inc. | PLA | Inconclusive |
| Rate-Activated Materials for Ankle/Knee Braces | CCDC Army Research Laboratory | GoX Studio, LLC | PLA, CRADA | Inconclusive |
| Rate-Activated Materials for Helmet Chin-straps | CCDC Army Research Laboratory | VICIS, Inc. | PLA | Inconclusive |
| Rate-Activated Materials for Automotive Head/Body Restraints | CCDC Army Research Laboratory | Dilatant | PLA | Inconclusive |
| Ultra-High-Molecular-Weight Polyethylene (UHMWPE) Ballistic Materials | CCDC Soldier Center | Several companies | CRADA | Inconclusive |
| Simulations to Explore Enhancements for Directed Energy, Fires, and IAMD Concepts | U.S. Army Space and Missile Defense Command | Raytheon Network Centric Systems | CRADA | Inconclusive |
| Lightweight Thin-Film Solar Cell with Periodic Optical Nanostructure | Naval Research Laboratory | AmberWave, Inc. | CRADA | Inconclusive |
| Polysiloxane Non-Skid Coating Formulation Development | Naval Research Laboratory | Randolph Products, LLC | CRADA | Inconclusive |
| Solar Cell Materials | NIWC Pacific | InnovaLight | PLA | Cancelled |
| Electro-Optical Microelectronic Transducer | NIWC Pacific | Lumedyne Technologies | PLA, CRADA | On-hold |

Table 4. Inconclusive: Projects that are generally still in the development phase and may generate a useful product or output in the future. On-hold or cancelled: projects that have no clear pathway to commercialization or have been dropped by one or both partners



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# Outreach & Recruiting Data Analysis

## *CCDC Aviation & Missile Center (AvMC)*

***CRADA***

### Objective

- CRADA with WonderWorks Exhibits, LLC.
- Provided the US Army with science museum venues to highlight Army technology to the public since 2014. Wonderworks provides interactive experiences related to science and technologies
- Army exhibits at WonderWorks museums in Pigeon Forge, TN; Panama City, FL; and Syracuse, NY.
- Vehicles, simulators, career navigator kiosks, and Decide to Lead (officer virtual reality application).

### Benefits to DoD and Warfighter

- Major customer is Assistant Secretary of the Army for Manpower and Reserve Affairs, Army Marketing Research Group.
- They provide funding to the Army Game Studio at the CCDC Aviation & Missile Center to develop public outreach products utilizing virtual, interactive, and multimedia technologies like video game platforms.
- Army gains valuable marketing data generated by visitors interacting with the technology: real-time data that answers "What attracted the users and why?"

### Impact

- The WonderWorks museums have up to 550,000 visitors annually.
- Public experiences the Army interactive displays and are educated on aspects of soldiering and Army technologies.
- Army impact is access to the public and generation of large data sets to optimize Army outreach and recruitment efforts via educational and social networking technology.
- The museums also serve as venues to test new recruitment assets and methodologies.



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# Tafenoquine (TQ), anti-malarial

## *U.S. Army Medical Materiel Development Activity (USAMMDA)*

***PLA, CRADA***

### Objective

- An FDA-approved weekly, oral, prophylactic drug for the prevention of malaria in nonimmune Service Members with normal enzymatic activity (G6PD).
- TQ was synthesized at the Walter Reed Army Institute of Research and developed by USAMMDA through a CRADA with 60° Pharmaceuticals LLC (60P).
- PLA allowed 60P to market TQ and CRADA enabled collaboration on clinical trials and marketing activities.
- First FDA-approved anti-malaria prophylactic drug in over 18 years; effective against all stages of the parasite.

### Benefits to DoD and Warfighter

- Malaria is a top infectious disease threat to deployed Service Members.
- In Army, 694 malaria cases over the last 10 years
  - Number of lost duty days: ~ 7-30 days each event ( ~13,000 person-days)
  - On average, 1 death every 3 years.
- TQ should enhance the survivability and sustainability of U.S. Forces by preventing malaria in 90% of personnel.
- TQ weekly dosing should improve compliance compared to daily prophylactic drugs.

### Impact

- TQ will be commercially available (as Arakoda™) Q4 2019.
- Approved in Australia and the United States, with plans to expand to Europe, Canada, New Zealand, and Japan. 60P will market the drug to Government, business, and vacationing travelers visiting malaria endemic regions.
- Although currently approved for adults, 60P is planning a pediatric clinical study to expand access to protect children.
- FLC award in April 2019.



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# Rate-activated materials for physical therapy applications

## *CCDC Army Research Lab (ARL)*

***PLA, CRADA***

## Objective

- Resistance bands are commonly used during fitness and physical therapy (PT) exercises.
  - Traditional simple rubber construction provides only one resistance rating per band with no dynamic response.
- ARL has invented a rate-activated tether (RAT) technology
  - Contain shear-thickening fluid that stiffens at high strain rate.
  - Pull slowly, the tethers stretch. Pull quickly, the tethers resist.
- Per Vivo Labs (PVL) signed a CRADA with ARL to develop and study effectiveness of RAT tech in resistance bands.
- Partially-exclusive PLA to commercialize resulting products.

## Benefits to DoD and Warfighter

- PVL worked to optimize handle-coupling geometry and define performance metrics for PT applications.
- CRADA allowed PVL/ARL to share testing methods, performance data, and technical insights without barriers.
- RAT tech allows a user to obtain peak performance in a particular PT movement using just one band.
  - PVL is incorporating accelerometers to measure peak output, important for quantifying progress of patients during rehab.
- The U.S. Department of Veterans Affairs and DoD together employ 1000s of physical therapists with ~ 1M patients/yr.

## Impact

- RAT product development allowed PVL to hire two additional employees with more needed as production ramps.
- Through July 2019, PVL has sold a few hundred units for use by commercial and governmental customers.
- Equipment needed to manufacture and dispense non-Newtonian fluids was not commercially available:
  - PVL designed the equipment in-house, developing new IP.
  - They are now ready to scale production to 1000s units/yr.
- This project has advanced critical knowledge of RAT straps applicable in other fields of use, including joint braces, apparel straps, and harness straps.



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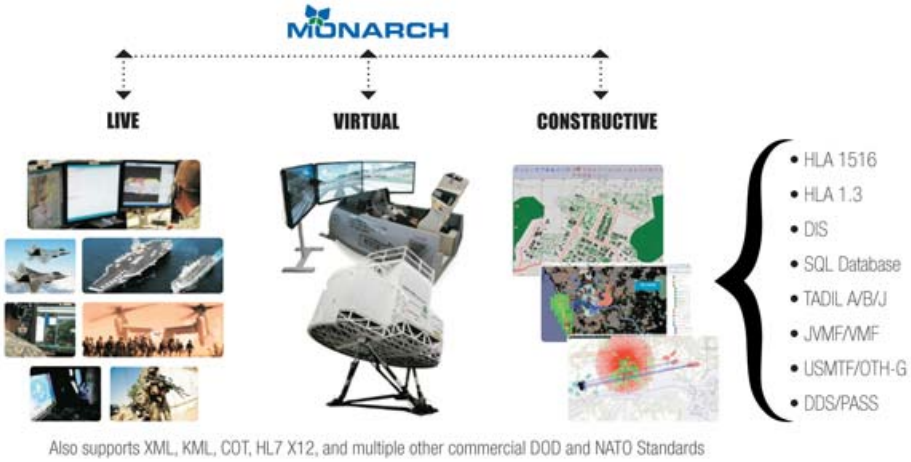
# Data Translation and Integration Software

## *U.S. Army Space and Missile Defense Command (SMDC)*

***Software License***

### Objective

- Interoperability is a key feature of DoD information systems.
- Jointed Embedded Messaging System (JEMS) is data translation and integration software owned by SMDC and utilized across DoD for tactical systems:
  - USARCENT, tactical combat systems.
  - TRADOC, realistic simulation-based training.
- Aegis Technologies Group, Inc. (ATG) recognized value in JEMS for commercial uses and signed a software license for a specific version of JEMS for a 5-year period.




### Benefits to DoD and Warfighter

- ATG developed commercial software, Monarch, from JEMS with a focus on healthcare and first responders. Provides:
  - More than 400 network protocol modules allow legacy systems to communicate with new technologies and systems.
  - Seamless emergency operations management.
  - Efficient communication across municipalities.
  - Translation of data from ambulance directly to patient charts.
- If Monarch meets a future DoD capability requirement, ATG will provide it under a GPL.
- After license ends, option for CRADA to allow collaborative, targeted maturation to meet future warfighter needs.

### Impact

- Software license with ATG makes DoD interoperability capabilities, developed for the warfighter, available to civilian first responder and healthcare communities.
  - Enables communications across municipalities.
  - Used at Johns Hopkins Hospital, Children's National Medical Center, and Vanderbilt University Medical Center.
  - Interfacing multiple vital-monitoring systems into a single “dashboard app” for remote monitoring.
  - Integrating hospital admissions system with maternity department’s wristband infant/parent tracking system.



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Testing of cost-effective, rapid-delivery satellite platforms

## *U.S. Army Space and Missile Defense Command (SMDC)*

***CRADA***

### Objective

- Satellite networks are essential for many DoD functions:
  - Imaging for all-weather, day/night situational awareness.
  - High-speed global communications.
- Development of standard satellite platforms could greatly shorten time needed to deploy these assets.
- York Space Systems LLC (YSS) has developed a standard platform satellite, "S-Class".
  - Max payload of 85 kg (170 kg total, payload + platform).
- YSS signed a CRADA with SMDC to facilitate the first launch of the S-Class platform and flight qualify it for use.

### Benefits to DoD and Warfighter

- CRADA allowed close collaboration of SMDC and YSS:
  - SMDC provided programmatic and technical advice, secured the launch with other government agencies and processes.
  - YSS shared technical capabilities and approaches.
- Demonstrated:
  - Unmanned autonomous operations.
  - Rapid deployment and pre-launch checkout.
  - Bolt-on electric propulsion system.
  - User tablet and iPhone interfaces for remote monitoring and control of the satellite.

### Impact

- Flight qualification means YSS's cost-effective, rapid-delivery standard satellite platform now available for DoD and commercial customers.
- YSS has agreements with several launch providers.
  - Will launch 10 satellites with 4 customers.
- YSS will train SMDC and other DoD personnel on the satellite communications and operations.



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Self-contained Chemical, Biological, Radiological, and Explosive Sampling Kit

## *CCDC Chemical Biological Center (CBC)*

***PLA, CRADA***

## Objective

- Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) forensics requires sampling that:
  - Minimizes contamination
  - Works on a variety of surfaces
  - Applicable to a variety of analytes
- CBC invented a self-contained kit, BiSKit (Biological Sampling Kit), to facilitate CBRNE sampling.
- QuickSilver Analytics, Inc. (QS) signed a CRADA and PLA with CBC to mature and commercialize BiSKit tech.

## Benefits to DoD and Warfighter

- CRADA allowed QS to utilize CBC for subject matter expertise, independent testing, and product improvements.
- BiSKit contains everything needed to sample wet/dry surfaces for bacteria, viruses, and toxins while minimizing exposure of operators to potentially-toxic materials.
- BiSKit and related kits have became the preferred choice for collecting chemical-biological forensic samples for DoD, civilian, and international customers.
  - Transitioned to DoD Program of Record in 2014.
  - 50-60 US first responder organizations.
  - In use in Five-Eyes countries and elsewhere.

## Impact

- Tech transfer agreements were vital for QS to become and remain economically viable and competitive.
  - Allowed QS to sustain eight full-time jobs.
- 3500 BiSKits sold.
- Royalties to CBC: $117,000.
- QS has expanded line to over 70 forensic components with National Stock Numbers as manufacturer of record.
- Current CRADAs (2019) with CBC to develop new products and improve production methods.

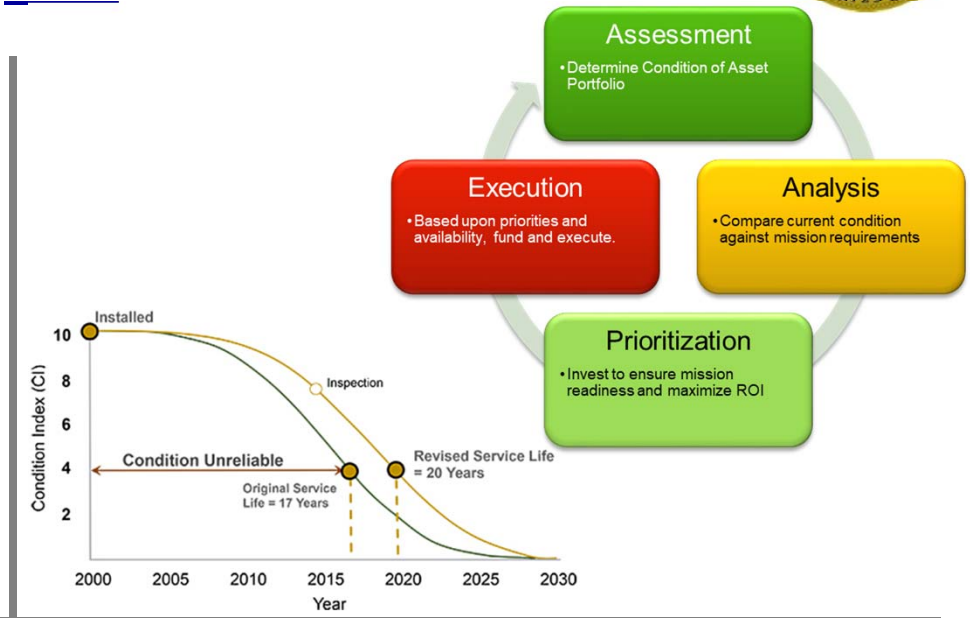


Distribution Statement A: Approved for public release. Distribution is unlimited.

# BUILDER Sustainment Management System

## *ERDC Construction Engineering Research Laboratory (CERL)*

***PLA, CRADA***




## Objective

- Traditional building inspection regimes are calendar-based:
  - Non-strategic and reactive.
- CERL developed BUILDER, a web-based software application, to assess buildings and infrastructure.
  - Systems-based models of infrastructure and initial inspection info to calculate a Condition Index (CI) that evolves with time.
- CERL enters into both PLAs and CRADAs with BUILDER.
  - Several companies have signed one or both.
- North Pacific Support Services, Inc. (NPSS), a small business licensee, signed a PLA and CRADA in 2010.

## Benefits to DoD and Warfighter

- PLA: Right to sell commercially (outside gov't).
- CRADA: Access to source code, structure databases; ability to make custom modules interoperable w/ other software.
- BUILDER provides a systematic means of analyzing data to improve risk management across infrastructure portfolios.
  - Highlights investment opportunities to stretch limited resources.
  - Balances mission vs. budget based on mission requirements.
  - Provides course-of-action analysis.
- In use across DoD and the Federal gov't.
  - Ex: Air Force modelling funding scenarios to 2050, developing plans that reduce deferred maintenance by $40+B over 30 yr.

## Impact

- PLA, CRADA with CERL allowed NPSS to continue as a viable company.
  - BUILDER was the only product
  - CRADA allowed access to CERL staff for technical support; NPSS can communicate customer needs back to CERL S&Es.
- Royalty payments to CERL since 2010: $23,500.
- NPSS has 35+ customers, including:
  - Joint Base Elmendorf Richardson, Alaska Air National Guard
  - Cities of Anchorage, Alaska and Boulder, Colorado
  - Alaska Native Corporations



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# Cold Weather Pavement Testing

## *ERDC Cold Regions Research and Engineering Laboratory (CRREL)*

***CRADA***

### Objective

- Operating effectively in the Artic presents challenges in constructing, maintaining, and retrofitting horizontal and vertical infrastructure.
  - Thawing soils weaken foundations and causes frost heave.
  - Pavement must withstand heavy loads yet remain flexible to handle heave/settlement caused by varying temperatures.
- CRREL has signed a CRADA with Rowan University's Center for Research and Education in Advanced Transportation Engineering Systems (CREATEs) to solve some of these challenges collaboratively.

### Benefits to DoD and Warfighter

- CRADA has enabled many opportunities for technical exchange between CREATEs and CRREL:
  - CRREL/CREATEs project teams synch via monthly tele-conferences and in-person interim project reviews.
  - CRREL's Heavy Vehicle Simulator is on-loan to CREATEs.
  - CRREL/CREATEs are updating DoD specifications in the Unified Facilities Criteria, Unified Facilities Guide Specifications, and Tri-Service Pavements Working Group manuals.
  - Field data has been integrated in the software used to design and evaluate pavements for roadways and airfields (PCASE).
- Innovations will enable DoD to rapidly and sustainably project forces in austere, cold regions more effectively.

### Impact

- At least seven scholarly/technical publications with CRREL/CREATEs coauthors.
- Rowan university students intern at CRREL and industrial fellows work with both CREATEs and CRREL.
  - Increases depth of collaboration and technical insight.
- CREATEs team has established other partnerships with NJ DOT, US DOT, Federal Highway Admin., and businesses.
  - CREATEs is also updating specifications for several local and state transportation departments.
- Success of this collaboration has lead to increased funding from NJ DOT and new funding from US Army.



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Water Diagnostics and Purification Systems

## *ERDC Geospatial Research Laboratory (GRL)*

***PLA, CRADA***

### Objective

- Commercially-available water quality analysis and purification systems have limitations for field use by the military:
  - Mostly stationary and not field portable.
  - Inline water analyses are not net-accessible, not geo-tagged.
- GRL invented the Water Diagnostics Operations Gear (WaterDOG) and the Water Assessment and Purification Systems (WAsPs) to provide these capabilities.
- Newcomer Arms, LLC (NCA) signed a PLA and CRADA to develop turn-key systems for sale commercially and to DoD.

### Benefits to DoD and Warfighter

- WaterDOG: geo-tagged, networked sensing system reports real-time water quality diagnostics pre- and post- water treatment in a portable package.
- WAsPs: Compact, portable water purification system that works seamlessly with WaterDOG.
- PLA enabled NCA, a small company, to quickly mature the technology into a turn-key system.
- CRADA gave NCA access to critical information about the systems while building a working relationship with the inventors.

### Impact

- This project allowed NCA to grow and expand their product line in support of:
  - Training and equipping military personnel at the Ocala, FL U.S. Army Reserve Center facility.
  - Equipping ranger units for international anti-poaching activities.
- More than 10 WaterDOG units sold to domestic and international military customers.
- Development of commercial WAsPs nearly complete (summer 2019).



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Hardened Alternative Trailer Systems (HATS)

## *ERDC Geotechnical and Structures Laboratory (GSL)*

***PLA***

### Objective

- During the 2010s, forced entry, small-arms, and ballistic attacks increasingly impacted personnel in and around U.S. embassies abroad.
  - Department of State (DoS) recruited ERDC GSL to design, prototype, and blast test HATS to meet DoS standards.
- The specifications were patent-protected to provide security and control over the sensitive design.
- PLAs are used to assert quality control and transfer ongoing design updates to manufacturers.
- RedGuard CoverSix Shelters, LLC is an example licensee.

### Benefits to DoD and Warfighter

- PLA of HATS yielded a new product/market for licensees while making tech available to gov't customers.
- HATS modules provide an affordable physical force protection system to enhance the survivability of U.S. embassy and industry personnel in hostile threat situations.
  - Modularity and ISO-compliant dimensions enable standardized shipping and handling.
  - Can be stacked to create multi-level buildings.
  - Can serve as housing or offices.

### Impact

- Among all licensees, at least 211 HATS units sold and are in use globally.
  - Redguard has sold 23 HATS.
  - PLA for HATS enabled DoS as a customer.
- RedGuard is a leading global supplier of blast-resistant modular buildings.
  - Operates facilities in 8 states and Canada, ~280 employees.
  - Primarily oil, gas, and petrochemical industry customers, but also defense and security sectors.
- Royalties paid to GSL since 2016: $11,000



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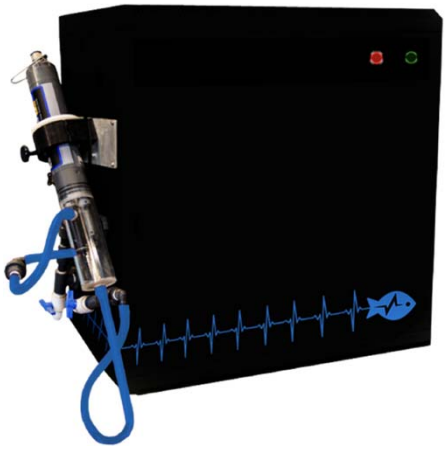
# Fish Biomonitoring System

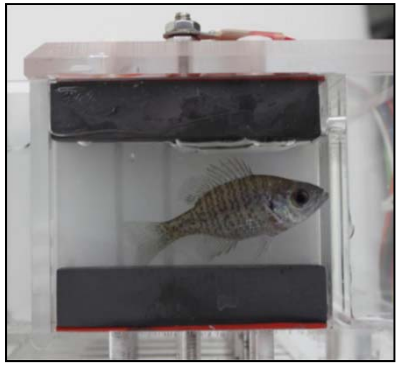
***U.S. Army Center for Environmental Health Research (USACEHR)***

***PLA, CRADA***

## Objective

- Drinking water quality is incredibly important for DoD, both on bases and in the field.
  - Many tests for contaminants are specific to only one or a few toxins.
- USACEHR invented a fish biomonitoring system (FBS) to detect a broad array of water contaminants.
  - Monitors vital signs of bluegill fish – e.g. electrical signals of muscles – and algorithm determines if the fish are healthy.
- Blue Sources, LLC (BSL) discovered the FBS at a tech transfer event; signed a PLA (2015) and CRADA (2016).





## Benefits to DoD and Warfighter

- CRADA was vital for allowing collaboration with inventor at USACEHR to mature the FBS into a commercial system.
- Product from PLA provides a new capability for DoD:
  - Turn-key device that serves as early-warning of toxins in water.
  - Responds to 1000s of contaminants at low levels, in real-time.
  - Can be setup anywhere: in field, on post, on ships.
- Prototype units at Fort Detrick, Aberdeen Proving Grounds, and in New York operating for 10+ years.
  - These existing systems detected at least two pollution events.
- Launch of BSL's commercial system will allow wide-scale deployment.

## Impact

- Exclusive license has allowed BSL to exist as a small company.
- Two new jobs created so far; will be 20 FTEs within 2 yrs (service technicians, manufacturers).
- FBS and monitoring-as-a-service is available for sale immediately (2019) to public water utilities and DoD.
  - Companies pay a subscription fee for monitoring and replacement of fish every two weeks.



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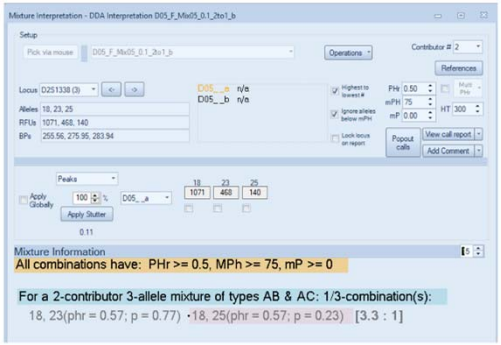
# Forensic Identification Using DNA Analysis

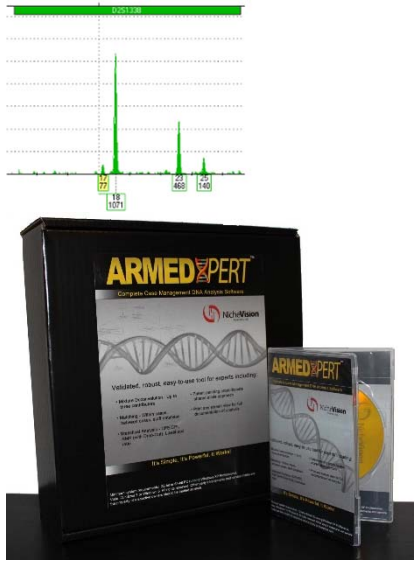
## *U.S. Army Defense Forensic Science Center (DFSC)*

***PLA***

### Objective

- Tools to facilitate forensic identification through DNA of individual(s) involved in crimes was needed.
- Forensic samples with DNA from multiple people are more difficult to analyze than single-person DNA samples.
  - Manual calculations to analyze such mixtures were slow and error-prone.
- NicheVision Forensics (Niche) was the selected licensee to commercialize an algorithm from DFSC that simplified and standardized the analysis.
  - Technology transfer support provided by U.S. Army Medical Research and Development Command (USAMRDC).




### Benefits to DoD and Warfighter

- DoD can resolve more crimes, especially those with complex samples (~80% contain DNA from multiple people).
- Niche matured the visual-basic algorithm into a Windows-based software application, ArmedXpert™.
- ArmedXpert™ resolves DNA mixtures in crime evidence, automating many tedious, time-consuming, and error-prone manual tasks related to analysis of evidence.
  - Per-sample analysis time reduced by ~75%.
  - Data quality assurance and sample contamination tools.
  - Construct deduced profiles and provide strength-of-the-evidence statistics.

### Impact

- ArmedXpert™ is used daily by approximately 30 US crime labs and labs in Italy, Africa, and Costa Rica. DFSC was the first customer.
  - Helps both victims and accused.
  - Has been used in thousands of cases.
- Success with ArmedXpert™ led directly to a relationship with the Army for development of STRmix (next-generation DNA forensics software) and other products (PACE, MixturACE).
- DFSC, USAMRDC won a 2015 FLC Technology Transfer Award.
- PLA allowed Niche to grow by two employees to develop ArmedXpert™.



Distribution Statement A: Approved for public release. Distribution is unlimited.

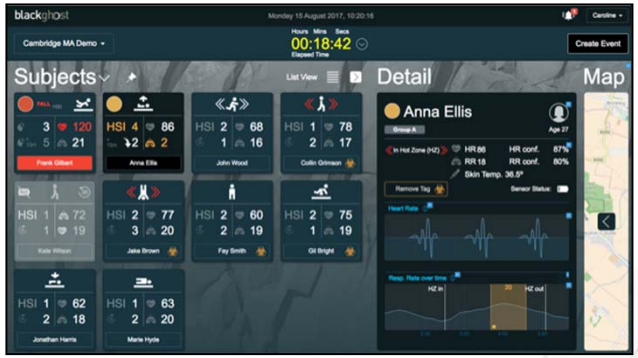
# Core Body Temperature Algorithm

## *U.S. Army Research Institute of Environmental Medicine (USARIEM)*

***PLA***

### Objective

- Core body temperature is crucial for monitoring physiological response to stress, but difficult to measure:
  - Invasiveness of accurate sensors.
  - Variation between skin and core body temperatures.
- USARIEM invented the Estimation of Human Core Temperature (ECTemp) algorithm:
  - Calculates core temp from sequential heart rate data.
  - Field-tested to be highly accurate in all conditions.
- Equivital LLC (a Hidalgo subsidiary) has a non-exclusive PLA to incorporate ECTemp into physiological monitors.




Black Ghost team dashboard

LifeMonitor sensor harness

### Benefits to DoD and Warfighter

- Equivital uses the ECTemp algorithm as part of the Black Ghost physiological monitoring package:
  - Sensors (LifeMonitor wearable), software, and communications.
  - ECTemp is key for Equivital's predictive heat stress index algorithm.
  - Enables real-time monitoring of trainees/Warfighters during training sessions or missions, and can compare individual to group performance.
- In use across the Services.
- Only wearable tech company that is FDA approved (510k) with an "intrinsically safe" sensor technology.
  - Important for CBRN community.

### Impact

- Equivital has access to three major sectors because of this technology:
  - Clinical (hospitals, diagnostics, sports performance)
  - Industrial safety (oil/gas, manufacturing, worker safety)
  - Military (US, global military)
- Sales, 2016-2019: several million dollars to U.S. military, thousands of units.
  - Ex. Army National Guard, Civil Support Teams
  - In use for training, combat, and research.



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# Shock-Absorbing Concrete

## *ERDC Geotechnical and Structures Laboratory (GSL)*

***PLA***

### Objective

- Warfighters typically fire over 300 M rounds of ammunition at over 2,000 firing ranges every year.
  - Accumulation of lead in groundwater and soil on ranges could pose a massive environmental burden.
- To mitigate the lead waste issue, researchers at GSL invented shock-absorbing concrete (SACON).
  - Low-density, fiber-reinforced, foamed concrete
  - Minimizes ricochets, captures bullets without cracking.
- MOUT Solutions has a PLA to produce SACON for use in small-arms training facilities for DoD.

### Benefits to DoD and Warfighter

- PLA ensures SACON is available commercially for use in rifle ranges, bunker trenches, and training villages.
- MOUT has worked with Army (Fort Polk), the Marines (29 Palms), and Navy SEALs (Virginia Beach).
- U.S. Army estimates that use of SACON (from all sources) saves $180 M every year in soil cleanup costs.

### Impact

- Company exists because of PLA and SACON as a product.
  - Owner/operator of MOUT previously managed SACON production facility, was able to take ownership.
  - 5 full-time employees.
- All DoD branches have used and are continuing to use the technology.
- Also in use by private shooting range operators and various law enforcement entities.
- Military sales by MOUT in 2018: $1.4 M



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# Monoblock Lasers

## *CCDC C5ISR Night Vision and Electronic Sensors Directorate (NVESD)*

***PLA***

### Objective

- Tactical range finders require a laser that is physically robust, lightweight, and highly dependable.
- CCDC C5ISR NVESD invented a laser with no moving parts for this use:
  - Compact size, lightweight
  - Very low energy consumption
- Signed a PLA with an industry partner to produce commercial units.

STORM unit (PEO Soldier)

FLIR targeting gimbal

### Benefits to DoD and Warfighter

- Quickly found use in lightweight, multifunctional laser systems designed to operate on individual and crew-served weapons:
  - Small Tactical Optical Rifle Mounted (STORM).
- Later adapted for use as the laser transmitter in gimbal systems on aircraft:
  - Range-finding and infrared illumination for targeting.
- These lasers are extremely robust.
- High repetition rate allows for fire control applications.

### Impact

- PLA improved domestic industrial base
- Approximately 20,000 units produced to date (2019).
- Additional high-end market in space applications

- Distribution Statement A: Approved for Public Release.



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# Nanostructured Materials for Ballistic Applications

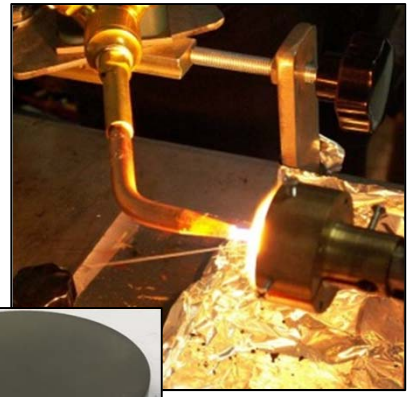
## *Naval Research Laboratory*

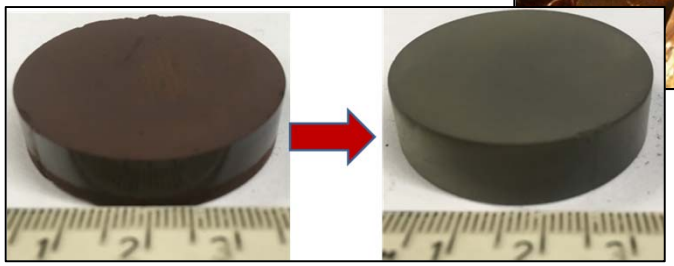
***PLA, CRADA***

## Objective

- Technical ceramics (carbides, nitrides, borides) have excellent properties for ballistics applications:
  - Mechanically tough
  - Lighter than metals, potentially cheaper
- But processing requires high heat, high pressure, and post-processing machining.
- NRL invented a method for preparing these materials without those deficits.
- PLA to Nanoarmor, LLC, along with two CRADAs for continued tech maturation.

High temperature performance testing





Core-shell ceramics

## Benefits to DoD and Warfighter

- This technology is an ambient-pressure, low-temperature manufacturing process that reduces processing time and energy costs while allowing tunable properties.
- CRADAs allowed company to scale up the technology and deliver prototypes to potential customers for T&E in:
  - Ballistics applications
  - 3-D printing in arbitrary shapes, including high temperature, extreme environments (zirconium carbide)
- Nanoarmor developed process to go from lab-scale to 100+ kg in a few months.

## Impact

- CRADA allowed moving much faster than standard government funding cycles.
- Nanoarmor has hired 3 people to advance this technology.
- 10+ potential DoD customers have expressed interested.
  - Anticipate DoD or commercial customer in CY 2019.



Distribution Statement A: Approved for public release. Distribution is unlimited.

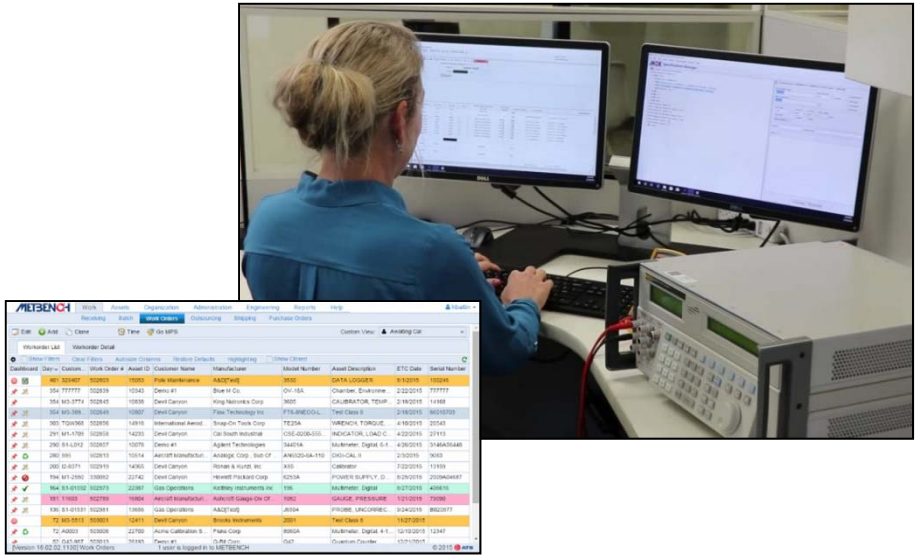
# Measurement Uncertainty Modeling and Analysis Tool

## *NSWC Corona Division*

***PLA, CRADA***

## Objective

- The Navy maintains a test equipment inventory of more than 1.6M assets: e.g. pressure gages, flowmeters, frequency counters, signal generators.
  - Navy personnel perform more than 450K calibrations per yr.
- NSWC Corona developed METBENCH, automated tool calibration procedures, to increase calibration efficiency and eliminate errors.
- American Technical Services, Inc (ATS) licensed METBENCH procedures and under a CRADA, developed their own software interface to utilize them.



## Benefits to DoD and Warfighter

- The CRADA gave ATS access to the diverse suite of instruments and equipment used by the Navy.
- ATS software enhances the quality of measurements performed with Navy METBENCH and directly enhances reliability, traceability, and maintainability of test instruments.
- Enables automatic cost/benefit analysis of calibration standards utilization, reducing acquisition/sustainment costs.
- Automated procedures reduce the skill level and time required to perform rapid, accurate calibration operations.
  - Ex: Pearl Harbor Naval Shipyard anticipates conducting 1,500 more calibrations per year.

## Impact

- Initial PLA allowed ATS to transition from a service company to one with a software product.
- METBENCH saved the fleet $65 million from 2011-2017, and ATS software will further expand this savings in the future.
- Commercial version is called *MOX* ; licenses to date: >$1 M.
  - Pacific Gas and Electric, Florida Light and Power, SoCal Edison.
  - Y12 National Security Complex.
- FLC Award for Excellence in Technology Transfer, 2016.



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# Crush-resistant Glass Foam

## *NSWC Corona Division*

***PLA, CRADA, EPA, SBIR***

### Objective

- NSWC Corona invented a process to create glass foams with excellent, tunable properties.
- Corona used multiple mechanisms to spin-out this tech:
  - Section 219 NISE funding for initial development.
  - Disposition of Equipment award with DLA to acquire equipment.
  - EPA with UC Riverside for testing.
  - Successful formation of startup, Microsphere Material Solutions (MMS), in 2015 FedTech cohort, then PLA with MMS.
  - CRADA with MMS for further development.
  - SBIR phase I award to MMS.

### Benefits to DoD and Warfighter

- Crush-resistant foam is used in many Naval applications:
  - Needs high-strength, low density, and machinability.
  - This material is a plug-and-play replacement for syntactic foams traditionally used.
  - Reduces overall vehicle weight, increases payload, and enables smaller vehicles.
- PLA and CRADA moved tech from TRL 3 to TRL 8 with 3 new applications co-developed with Corona S&Es.
- MMS has sold foam to unmanned underwater vehicle company, Riptide, for use by SOCOM and to NSWC Carderock for testing in classified applications.

### Impact

- MMS exists as a company because of these tech transfer activities.
  - In addition to SBIR award, also $400k via Maryland Industrial Partnerships grant to support commercialization.
- Funds to Corona via CRADA: $6k to date.
- MMS continues to fabricate and test dozens of lab-scale and commercial-scale samples and has begun experimenting with different feedstocks as well as creating bi-layer foams.
- FLC Award for Excellence in Technology Transfer, 2018.



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Assessment of Cybersecurity Products

## *NSWC Crane Division*

***CRADA***

### Objective

- Anti-Tamper (AT) encompasses activities intended to prevent and/or delay exploitation of critical program information in DoD systems.
- NSWC Crane, a leader in AT capabilities and the assessment of security products, uses CRADAs to engage the civilian security industry to assess and enhance their technologies for use within the DoD.
  - Several partners have been small businesses.
  - Allow two-way technology and knowledge exchange.

### Benefits to DoD and Warfighter

- CRADAs allow companies to collaborate with world-class mathematicians, security analysts, and engineers to advance the field of system security.
- For example, “Company X”:
  - CRADA with Crane from 2014 to 2018.
  - Developed tech for COTS field-programmable gate arrays to be an alternative to custom application-specific integrated circuits.
  - This advance will save the U.S. Government significant resources while simultaneously increasing security.

### Impact

- Company X grew significantly due to advances in its products arising through the CRADA.
  - Currently supports AT capabilities in 20+ major programs.
  - Undergoing negotiations for 10+ additional defense programs.
- AT is essential across many civilian platforms, including communications and networking devices, financial databases, internet-based technologies, critical infrastructure control systems, and autonomous systems.



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# Cybersecurity Research & Development

## *NSWC Crane Division*

***CRADA***

### Objective

- The Navy recognizes the need to integrate cybersecurity efforts with the engineering process for critical systems:
  - Need to define cybersecurity first principles in a way that is technology agnostic and time invariant.
- NSWC Crane, a leader in cybersecurity for Navy, has had two CRADAs with Indiana University's Center for Applied Cybersecurity Research (CACR) since 2016.
  - Initial CRADA aimed to develop cybersecurity principles.
  - Follow-on CRADA will improve capabilities in the areas of software assurance and trusted artificial intelligence.

CRADA signing ceremony

### Benefits to DoD and Warfighter

- The initial CRADA (2016-2018) resulted in several notable outputs with impact across DoD:
  - Published the Information Security Practice Principles (ISPPs).
  - Developed a framework for understanding and using cybersecurity assessments, the Cybersecurity Assessment Parameter Profile (CAPP), released on DTIC.
  - Piloted an evaluation of tools including the Principles-based Assessment Cybersecurity Toolkit (PACT).
- Also used NISE/219 funding to hire two IU collaborators as Temporary Faculty to deepen the collaboration.

### Impact

- CACR maintained visibility as experts in applied cybersecurity in diverse fields, including defense.
- Resulted in several publications for Crane and IU personnel.
- Early positive results from PACT attracted Congressional and DoD-wide attention, leading to OSD-funded follow-on effort:
  - $7M over FY 2019 and FY 2020.
- Crane is receiving funding to use these tools for several programs of record, demonstrating operational utility of the CRADA outputs.



Distribution Statement A: Approved for public release. Distribution is unlimited.

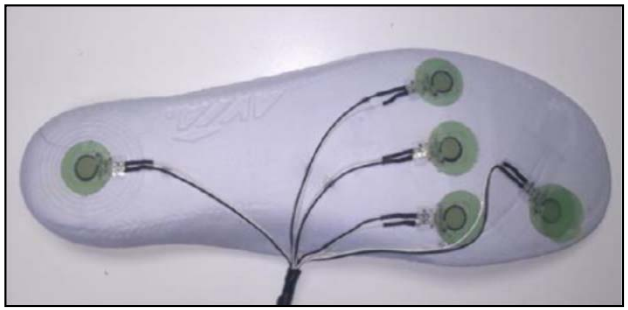
# Ergo Wearable Sensor Kit

## *NSWC Crane Division*

***PLA, CRADA***

## Objective

- Ability to measure foot power, not just steps and stride, provides a richer array of useful data about a user's biomechanical and physiological state.
  - Combined with software algorithms, the sensor data can measure form, fatigue, force, and rate of exertion.
- NSWC Crane invented such a sensor in shoe insoles.
- PLA to GoX Studio for the sensor in 2015, with a CRADA to co-develop prototypes and refine manufacturing process with Crane S&Es.



## Benefits to DoD and Warfighter

- CRADA gave GoX access to equipment and SMEs in the Crane Composites Shop to optimize prototypes and deliver a minimum viable product (April 2017).
- Wearable biomonitoring system (with hear-rate sensors and a GoX algorithm) provides 95% of the accuracy of a VO2 mask or instrumented force plate without bulky equipment.
- Insole tech was included in two military human performance experiments: Army's HIPO (Human Integrated Performance Optimizer) project and SOCOM's TALOS (Tactical Assault Light Operator Suit) prototype exoskeleton.

## Impact

- Lessons from HIPO/TALOS projects will inform future GoX developments and DoD hyper-enabled operator systems.
- GoX partnership with the Army led to commercial sales of related parts of the tech (software and algorithms), opening door to a range of industrial and consumer products.
  - Insoles currently in use with 3 corporate customers to assess ground reaction forces on workers.
  - 2 Government agencies have purchased Ergo kits that use insoles as part of the system to evaluate exoskeletons.
  - In early discussions with a commercial exoskeleton developer.
- Available to consumers as SmartRun insole in the future.



Distribution Statement A: Approved for public release. Distribution is unlimited.

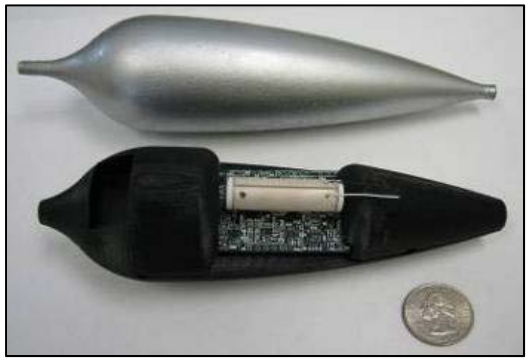
# Instrumented Acoustic Array for Underwater Sensing

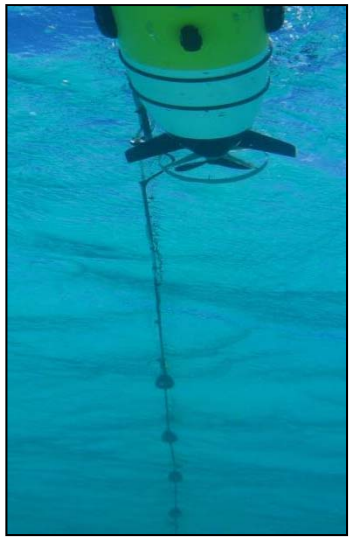
## *NIWC Pacific*

***CRADA***

## Objective

- Low-power, lightweight, passive acoustic underwater surveillance systems have many civilian and military uses.
- The Navy had an existing system, but improvements were needed.
- NIWC Pacific entered a CRADA with BAE Systems Information and Electronic Systems Integration Inc. to improve existing tech (2008-2013).





## Benefits to DoD and Warfighter

- Developed a high-sensor count acoustic array system for underwater sensing and data collection.
  - Surface-suspended with a bottom mooring for operation in high ocean currents.
  - Wide aperture, horizontally towed configuration also created.
- Improvements from CRADA work were incorporated into existing Navy arrays.
- CRADA technology was key to an engineering development model created by BAE for transition to a larger acquisition program of record.

## Impact

- Over $600K received by Navy lab.
- Over $70M in revenue for BAE Systems from transition and commercialization of technology developed during CRADA.
  - Pursuing other transition opportunities with tech derived from CRADA.
- CRADA technology used by Northeastern University to collect data on marine life.
  - Fish mapping, school behavior, underwater noise pollution
- Commercial applications for towed and moored arrays:
  - Marine resource management and environmental assessments.
  - Sensing underwater animal acoustics



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Additive Manufacturing Production Capability Validation

## *NIWC Pacific*

***CRADA***

## Objective

- The U.S. Marine Corps has many critical assets that are not well-supported by the traditional supply chain.
  - Exacerbated by the expeditionary mission of the Corp.
  - For example, certain components of the Amphibious Assault Vehicle are known to fail, with replacements difficult to attain in emergent situations.
- HP Inc. (HP) entered into a CRADA with NIWC Pacific to test the military utility of HP Metal Jet additive metal printers (2018).

## Benefits to DoD and Warfighter

- HP 3D Metals Team manufactured components for the Marines of 1st Marine Logistics Group, who then applied them to performance evaluations in operational conditions.
- Answer the questions:
  - Can additive manufacturing overcome supply chain constraints?
  - Does the tech have utility when separated from established supply chain nodes?
- The CRADA allowed the collaborators to conduct continuous experimentation, accelerate technology adoption, and perform risk reduction with a commercial system.

## Impact

- This effort supported the rapid fielding of cutting-edge technology by assessing the military utility in parallel with the technology development process.
- USMC is maintaining an ongoing collaboration to conduct assessments of additional applications:
  - USMC will embed Marine representatives at Parmatech Corporation, an HP Metal Jet partner.
  - Marines will train on the HP Metal Jet equipment.
  - Continue to develop warfighter-relevant solutions to USMC supply-chain issues.



Distribution Statement A: Approved for public release. Distribution is unlimited.

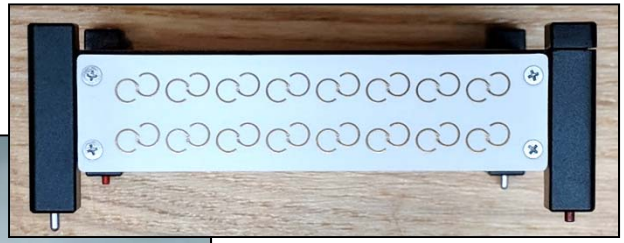
# RADAR Retro-Reflector For 1/4 U Nanosatellites

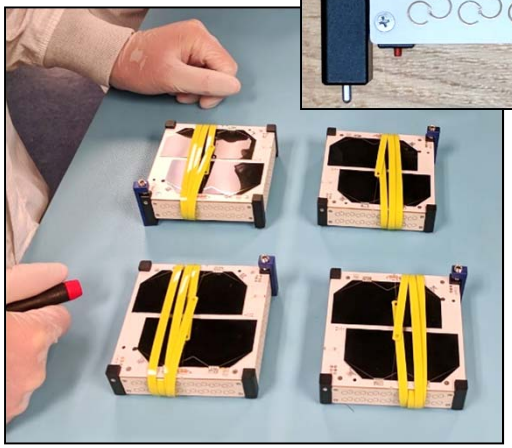
## *NIWC Pacific*

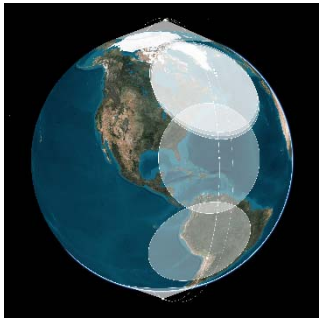
***CRADA*, *SBIR (NSF, USAF)***

## Objective

- Constellations of nanosatellites in low-Earth orbit are a promising approach for many military applications:
  - Remote sensing, imaging
  - Global network connectivity (IoT)
- Unfortunately, they may be difficult to track by conventional radar due to small size.
- NIWC Pacific entered a CRADA with Swarm Technologies to develop reflectors for Swarm's nanosatellites (10 cm x 10 cm x 2.5 cm).
- Swarm already supported by phase I and II SBIR (NSF).







## Benefits to DoD and Warfighter

- Navy investment of $230 k of NISE Tech Transition funds (Section 219) for S&E labor.
- CRADA gave NIWC S&Es access to Swarm's satellites to design custom radar reflectors specific to this application.
  - Work has lead to 1 patent for NIWC, with another filing soon.
  - IP will be available for Swarm (potential for PLA) or for intramural DoD use.
- Economics afforded by constellations of nanosatellites enable sensing and data return at a cost 1/10th to 1/100th of incumbent satellite data providers while greatly enhancing survivability relative to a single, full-sized satellite.

## Impact

- Association with Navy lab and subsequent successful launch/radar tracking enhanced credibility of SWARM.
- In 2019, SWARM closed Series A financing of $25 M to:
  - Continue software/hardware integrations for customers.
  - Increase their constellation from 9 (proof-of-concept) to 150 satellites, providing global, continuous coverage.
- With 10+ partner companies, SWARM has demonstrated:
  - Diagnostics and emergency messaging from connected vehicles.
  - Tracking shipping containers across oceans.
  - Water monitoring and text messaging in remote communities.
  - Operations in GNSS denied environments (with USA SMDC).



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Aviation Harness Quick Release

## *NAVAIR Patuxent River*

***PLA***

### Objective

- Previously, aircrews were attached via a tether with a carabiner on their vest.
- Navy engineers invented a quick release integrated into the harness itself.
- Patent license to Survival Innovations
- PMA 202, Aviation Life-Support Equipment, at PAX River qualified the product as a piece of Navy gear.

### Benefits to DoD and Warfighter

- Provides the aircrew a positive, one-pull release from the aircraft in the event of emergency for aircraft egress.
- The Quick Release has been integrated into the Army, Navy, AF, and Marines air crew ensemble (V-22, C-130, helicopters, etc.)
- Has been used successfully during emergency egress events.

### Impact

- Survival Innovations added 10 new jobs to manufacture, perform inspections, and to provide product configuration for several harness designs.
- Has sold 15,000 – 20,000 quick releases to DoD (to date).
- Pursuing a Technical Standard Order authorization with FAA for commercial use.
- Applications in search and rescue, border patrol, tree stands, etc.



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Planar Waveguide for Medical Diagnostics

***Naval Research Laboratory***

***PLA, CRADA, SBIR***

## Objective

- Field-robust medical laboratory testing is an urgent need for both military and civilian medical personnel.
- NRL developed a biosensor based on planar waveguide optical sensors for such an application.
  - Prototype was too expensive, not robust, and not repeatable.
- NRL signed a CRADA with Precision Photonics Corporation (PPC) to mature the prototype and develop inexpensive, disposable diagnostic cartridges.
- In 2009, the device was spun out of PPC as MBio Diagnostics, who continued to develop the product.

## Benefits to DoD and Warfighter

- The CRADA and PLA gave PPC and MBio direct access to the NRL researchers to maximize the maturation of the tech.
  - The rugged, compact device provides rapid (1-20 min), 'point-of-care' medical diagnostics in a field operational setting.
  - Much cheaper than traditional medical laboratory equipment.
- Phase II SBIR from DARPA (2018) for the development of a portable, multiplexed immunoassay system for sepsis.
- Developing counter-terrorism applications in collaboration with a prime contractor funded by BARDA.
- Agreements in place for acute cardiac triage, fast DNA detection, and traumatic brain injury.

## Impact

- The PLA enabled MBio to exist; currently 40 employees.
  - On track to grow to 500 employees by 2025.
- $45M of equity and non-dilutive financing.
- Total valuation of MBio estimated at several hundred $M.
- Commercial sales of water testing line began in 2018.
  - Expect ~$1M revenue in 2019.
- Second product line, for animal health, launched in 2019.
- Working with clinicians at Walter Reed Medical Center to identify additional important medical applications within DoD.



Distribution Statement A: Approved for public release. Distribution is unlimited.

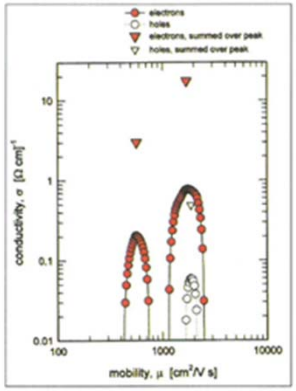
# Quantitative Mobility Spectrum Analysis for Hall Effect Measurement

## *Naval Research Laboratory*

***PLA, CRADA, SBIR***

## Objective

- Electronic transport properties (i.e., Hall coefficient, mobility, carrier concentration and type) are critical to characterizing novel semiconductor materials and structures.
- Lake Shore Cryotronics (LSC) won phase I and II SBIR awards from AFRL to develop a commercial, turn-key, integrated Hall measurement system (HMS).
- As part of the phase II SBIR, LSC agreed to integrate Quantitative Mobility Spectrum Analysis (QMSA) capability invented by NRL via a PLA.
  - QMSA algorithms required maturation for commercial use.




Quantitative Mobility Spectrum Analysis (QMSA)

## Benefits to DoD and Warfighter

- CRADA with NRL gave access to the inventor of QMSA, facilitating development of an easy-to-use commercial software package.
- High-quality HMS from LSC have facilitated the development of high-speed, multilayer semiconductors and heterostructures used in many advanced electronics applications relevant to DoD:
  - Microprocessors
  - Photovoltaics
  - Organic electronics
  - Thermoelectrics

## Impact

- LSC hired 2-3 additional employees to support the HMS line.
- LSC has continued to evolve its HMS offerings through 3-4 generations.
  - QMSA continues to be an option on all HMS sold by LSC.
- LSC HMS systems sold worldwide and to DoD-related labs:
  - MIT Lincoln Lab
  - Kirtland AFB, AFRL
  - Raytheon Vision Systems
  - Lawrence Livermore and Sandia National Laboratories

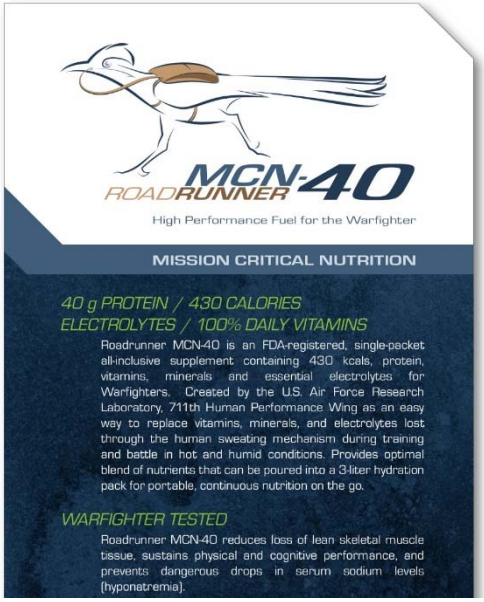


Distribution Statement A: Approved for public release. Distribution is unlimited.

# Mission Critical Nutrition 40 (MCN-40)

## *711th Human Performance Wing*

***PLA, CRADA***




### Objective

- Meal, Ready-to-Eat (MRE) has been the standard self-contained, individual field ration, but each weighs between 1.0 and 1.5 pounds and takes up significant volume.
- 711th HPW and MusclePharm, Inc. codeveloped a powdered meal replacement in a CRADA.
- Newcomer Arms, LLC has a PLA to sell MCN-40 to both DoD and civilian customers.

### Benefits to DoD and Warfighter

- Single-package powder supplement, simplifies rucksack.
- One serving: 40 grams of hydrolyzed protein, 430 calories, vitamins, minerals, and electrolytes.
- Would allow special operators to reduce pack weight by increasing planned duration between MRE consumption:
  - On a 5-day mission, 10 MREs (15 lbs) would be reduced to 5 (7.5 lbs), supplemented by MCN-40.
  - Saved weight equivalent to six additional magazines, or 180 rounds of ammunition extra.

### Impact

- All American Pharmaceutical produces MCN-40 in Billings, Montana. Full-rate production by end CY2019.
- As of winter 2019, more than 16,000 units have been ordered by civilians (cross-fit, individuals, gym communities).
- Globally, the protein supplement market was valued at $2.7 B in 2016 and will reach $3.9 B by 2023.
- Civilian market includes hikers, athletes, health and fitness users, pilots, fire fighters, race car drivers, hunters.
- Navy SEALs are interested in a large supply.



Distribution Statement A: Approved for public release. Distribution is unlimited.

# AF96 Low-alloy, High-performance Steel

## *AFRL, Munitions Directorate*

***CRADA***

## Objective

- ES-1 Steel was standard for ground-penetrating munitions.
  - Expensive ($7 per lb)
  - Contains tungsten and cobalt: global security threat
- AFLCMC/EBD issued call to reduce cost 10%.
- AFRL/RW invented AF96 steel.
  - No tungsten or cobalt
  - Equally strong, tough
  - Fairly cheap ($1.5 per lb)
- CRADA with Timken Steel enabled production quantities needed to conduct initial T&E.

Sled test

## Benefits to DoD and Warfighter

- Testing proved exceptionally positive. In two years:
  - 100 lb TRL-2 laboratory sample to …
  - … 240,000 lb of steel and TRL-7 weapons tested in an operational environment.
- Compared to ES-1, AF96 is easier to process and friendlier for the environment.
- Maintains high strength/toughness even at low temps.
- All materials sourced from ally countries.
- Material costs for BLU-137/B reduced more than 50%.

## Impact

- CRADA allowed the laboratory, industry, and the acquisition office to rapidly transition through TRLs to minimize risk.
  - FLC Excellence in Technology Transfer Award, 2018
- Subsequent $900 M contract with Superior Steel (under a government-purpose license) for use in BLU-137/B.
- Upcoming follow-on CRADA with U.S. Steel to explore manufacturability and workability.
- Additional projects for use in armored vehicles, replacement parts, and 3-D printing are on-going.



Distribution Statement A: Approved for public release. Distribution is unlimited.

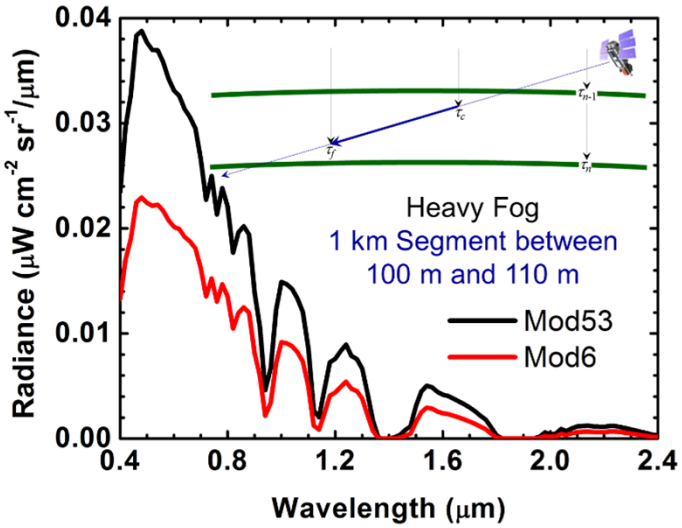
# MODTRAN® Software

## *AFRL, Space Vehicles Directorate*

***PLA***

### Objective

- Many remote sensing applications require modeling of radiative transport (RT) through the atmosphere.
- MODTRAN® RT physics model simulates spectral measurements across lines-of-sight through the lower atmosphere, even through stratified, horizontally homogeneous atmospheres.
- Since 2009, Spectral Sciences, Inc. (SSI) has had an exclusive license to distribute the MODTRAN® software.
- Tech was co-developed by SSI and AFRL, with two jointly-owned patents.




### Benefits to DoD and Warfighter

- Applicable to all types of ultraviolet, visible, infrared and longer-wave sensor platforms and under a wide range of weather conditions.
- Applications include remote sensing, measurement / data analysis, scene simulation, algorithm development, climate modeling, and sensor design.
- Using MODTRAN® algorithms, satellite spectral imagery can extract the reflective signature of materials and objects on the Earth for more accurate sensing or target acquisition.

### Impact

- PLA enabled sales of MODTRAN® version 5, 2009-2016.
- SSI modernized MODTRAN® to version 6 under a Rapid Innovation Fund contract in 2012-2016.
- Four sublicensees sell MODTRAN® as embedded code.
- 800+ copies of the software distributed royalty-free to Tri-Service warfighter instrument applications and to US Gov't (NASA, DOE, USGS, NOAA).
- Sold commercially to 300+ companies and 150+ universities.
- $400,000 in sales, over $500,000 in maintenance fees, and $150,000 in royalties to AFRL.

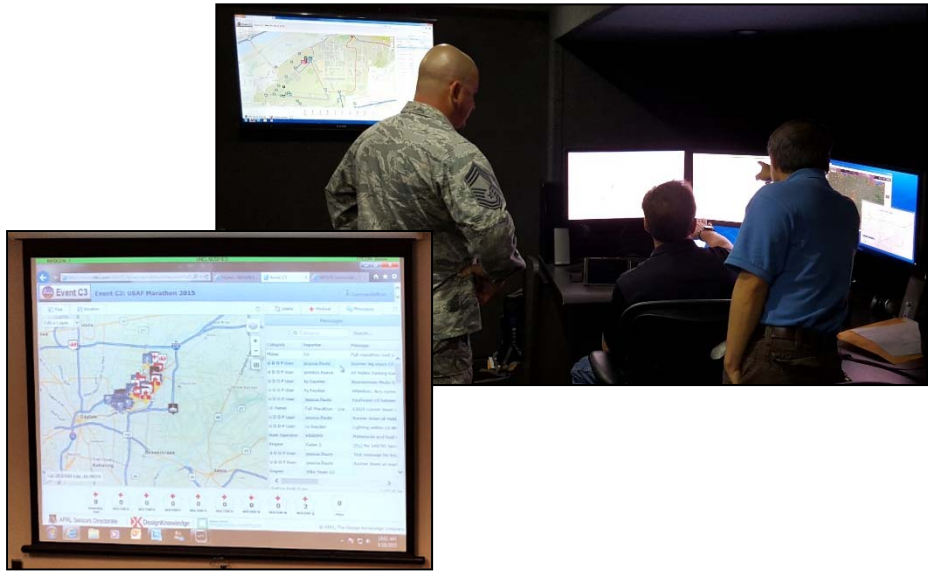


Distribution Statement A: Approved for public release. Distribution is unlimited.

# Mobile Layered Sensing Exploitation System

## *AFRL, Sensors Directorate*

***CRADA***



## Objective

- Security forces, fire fighters, and incident management personnel require real-time situational awareness (SA) and decision support tools.
- The Knowledge Design Company (TKDC) developed the MOLES software to provide these tools.
  - Provides a map of an area of-interest coupled with a suite of real-time sensor data from linked users.
- TKDC signed a CRADA with AFRL/RYO to demonstrate MOLES at the 2015, 2016, and 2017 USAF Marathon and AFRL Tech Warrior events

## Benefits to DoD and Warfighter

- MOLES enables security and incident management command centers to track user data (GPS position, physiological monitors, threat sensors, etc) for tracking and responding to events and threats.
- CRADA gave TKDC access to proprietary AF first-responder sensor suites so MOLES could be tested in a relevant system and environment.
- In return, AF benefits by having direct access to improvements to MOLES software and overall IP and by providing a means of direct collaboration with TKDC.

## Impact

- AFRL received ~$50,000 for personnel and labor.
- Exposure from CRADA events resulted in productive contacts with emergency services and police/fire departments to support their command and control needs.
  - At least two contracts signed with civilian sector with others in-discussion.
  - Potential contract with AF in-discussion.
- MOLES adds to capabilities TDKC can sell to customers for SA systems (base awareness, first-responders, etc), so they can expand corporate footprint to new customers.



Distribution Statement A: Approved for public release. Distribution is unlimited.

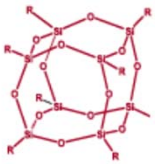
# Polyhedral Oligomeric Silsesquioxane (POSS)

## *AFRL, Aerospace Directorate*

***PLA, CRADA, SBIR***

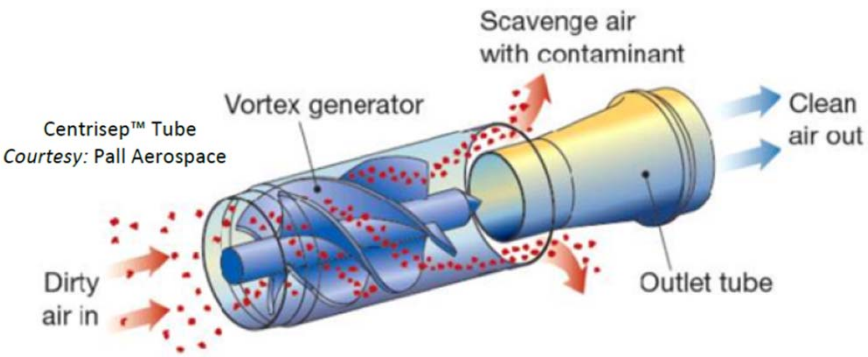
## Objective

- POSS is a class of silicon-containing chemical building blocks providing nanometer-scale control to dramatically improve the properties of polymers, colorants, and fillers.
- The technology and Hybrid Plastics, Inc. were spun out of AFRL/RQ (early 2000s).
- The molecular technology was acquired via a PLA.
- Early in development, 2 CRADAs allowed Hybrid to provide 1+ kg quantities to AFRL/RQ S&Es for research.
- Hybrid has had 12-13 Phase I and 8-9 Phase II SBIR grants from several Fed agencies, including DoD.



**Hybrid Plastics™**

Superior Technology for Superior Products




## Benefits to DoD and Warfighter

- Multiple Technology Investment Agreement contracts (worth $20+ M) via Title III of the Defense Production Act ensured a strategic supply.
- Under investigation for several defense applications:
  - UV-curable hemostatic gel
  - Fire-retardant materials
  - Optical coatings
- Deployed widely in Pall Aerospace Centricep™ helicopter engine filter tubes.
  - 30% lighter than previous filters
  - Up to 10% greater engine thrust

## Impact

- Hybrid Plastics has grown to 20+ employees.
- Currently have 265 products with 16 available commercially at the ton scale.
- Commercial applications ranging from biomedical, electronics, aviation, and engineering materials.
- Hybrid won a Tibbetts Award in 2015 from the Small Business Administration for successful SBIR awardees.



Distribution Statement A: Approved for public release. Distribution is unlimited.

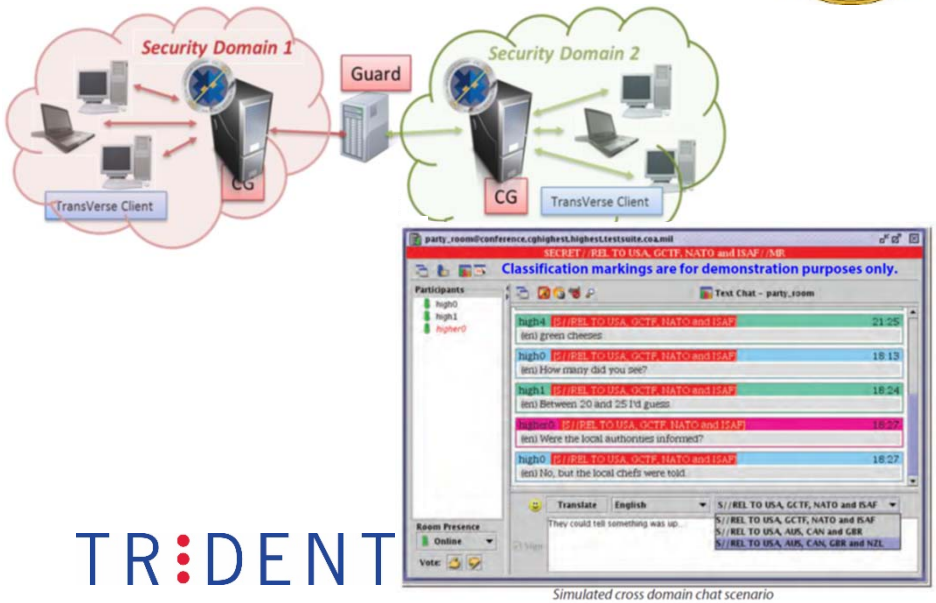
# Secure, Cross-domain Collaboration Gateway

## *AFRL, Information Directorate*

***PLA, SBIR***

## Objective

- National and international disaster or military responses depend on real-time coordination between DoD components, coalition partners, and civilian organizations.
- Chat rooms, voice (and video) over IP (VoIP) and multi-user white boarding are key collaboration tools.
- These require secure, cross-domain communications networks.
- Trident Systems, Inc. developed Collaboration Gateway (CG) to enable such capabilities; a critical component of CG is a guard interceptor coinvented with AFRL/RI.




Simulated cross domain chat scenario

## Benefits to DoD and Warfighter

- CG meets rigorous DoD-wide and NSA comms standards.
- Allows users on different network infrastructures to interact, communicate, and collaborate in real-time.
  - Language translation plug-ins available.
  - DoD-specific protocols enable better performance with low-bandwidth connections.
- Enables users at different security levels to communicate and interact.
  - Real-time filtering to catch non-secure/sensitive comms.
- In use across several combatant commands.

## Impact

- $2+ M in sales to military customers, including renewals.
  - Subject to ITAR export controls, but also sold to certain Five-Eyes countries.
- On-going DoD funding to move to Android platform.
- Civilian interest for business-to-business applications in energy, medical, and financial industries.



Distribution Statement A: Approved for public release. Distribution is unlimited.

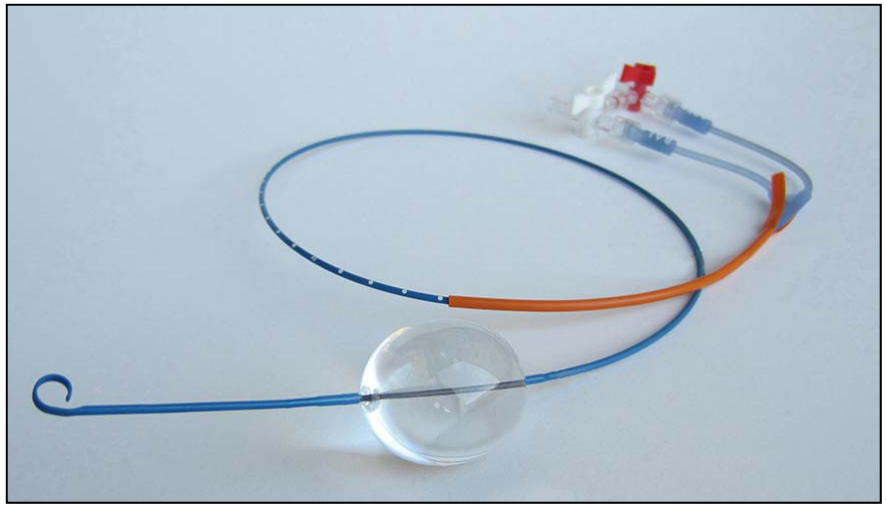
# Resuscitative Endovascular Balloon Occlusion of the Aorta

## *Air Force Medical Support Agency*

***PLA, CRADA***

## Objective

- 91% of all potentially survivable combat deaths are related to hemorrhage
- Controlling noncompressible torso hemorrhage is a major need to decrease preventable deaths on the battlefield.
- Collaboration with University of Michigan startup company, Pryor Medical, via a CRADA led to joint patent.
- Changed name to Prytime Medical Inc.
- 2015: FDA 510(k) clearance for ER-REBOA™ Catheter.



## Benefits to DoD and Warfighter

- Recent field study in combat surgeries (*J. Trauma Acute Care Surg*., 85 (1), Supplement 1.) showed:
  - 95% aortic occlusion (19/20)
  - Systolic bp increased an average of 56 mm Hg
  - 100% survived transport to next level of care
- Now considered a permanent piece of standard equipment by AF special ops surgical teams.

## Impact

- $7.4 M outside investment
- Prytime Medical now has 14 employees.
- In use in Level I trauma centers in large urban cities around the nation.
- Military sales: $1,500,000
- Commercial sales: $9,300,000
- 2018 contract with Army for continued clinical trials and device improvement: $14.3 M



Distribution Statement A: Approved for public release. Distribution is unlimited.

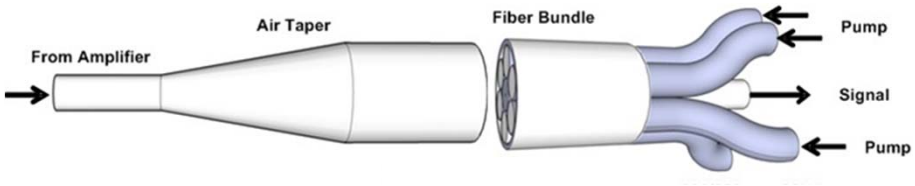
# Fiber Optic Combiner

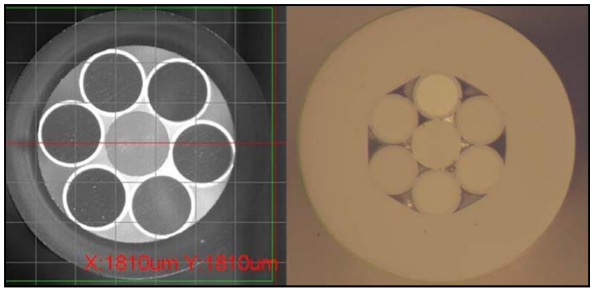
## *Air Force Academy*

***PLA, CRADA, SBIR***

## Objective

- Semiconductor-pumped fiber lasers have applications including sensing, communications, and directed energy.
- For high-power application, an all-fiber pump-power combiner requires:
  - large pump cladding diameters with intact core
  - preserving polarization extinction ratio
- During a CRADA with USAFA, Optical Engines (OE) licensed methods to precisely etch glass for combiner applications.
- During subsequent SBIRs, OE produced 2 additional patents while perfecting a combiner design.




## Benefits to DoD and Warfighter

- Fiber lasers possess high efficiency, compact size and low weight, reliability, and ruggedness.
- In use for LIDAR applications (remote sensing) via major primes (Lockheed, Lincoln Labs, Raytheon).
- Sold to DoD labs for R&D of directed-energy laser weapons.
  - 100s of kilowatts demonstrated

## Impact

- Initial PLA allowed creation and survival of OE as a start-up.
- Follow-on funding: $6,800,000 (primarily from NASA).
- In 2018:
  - Military sales: ~ $400,000
  - Commercial sales: ~$2,100,000
  - About ¾ of company sales based on combiner technology
- Used by NASA for planetary radar and deep-space communications
- Used by Dept. of Energy in studies of chemical reactions and fundamental particle physics.



Distribution Statement A: Approved for public release. Distribution is unlimited.

# Android Tactical Assault Kit

## *AFRL, Information Directorate*

***Software License***

## Objective

- ATAK is a useful software collaboration and communication situational awareness application that runs on an Android mobile operating system on a smartphone or a tablet.
- AFRL licenses ATAK to tens of companies for use as a standard display for a host of remote sensing platforms.
- Helios Remote Sensing Systems (Helios) uses ATAK in several products via a software license.
  - Sales to Fed gov't royalty-free (GPL).
  - Sales to commercial customers generate royalties to AFRL.

## Benefits to DoD and Warfighter

- ATAK licenses provide a standard, approved, and tested display platform.
  - Significantly reduces development and sustainability costs of individual projects.
  - Updates from AFRL improve platform for all users.
- Helios has incorporated ATAK in several platforms:
  - Maneuver Assurance Radar System developed for U.S. Army and U.S. Marines provides 360° imaging for squad-level SA.
  - Sense-Through-The-Wall radar
  - Foliage Penetration (FOPEN) radar

## Impact

- Availability of ATAK has been a significant benefit in allowing Helios to focus on core requirements of programs.
  - Saved hundreds of labor hours.
  - Sustainment costs reduced via ATAK updates pushed by AFRL.
- Helios was able to win contracts with specified output display capability:
  - DARPA (2 contracts)
  - Army Pathfinders
- Access to civilian market in first responders: fire fighters, SWAT teams, police.



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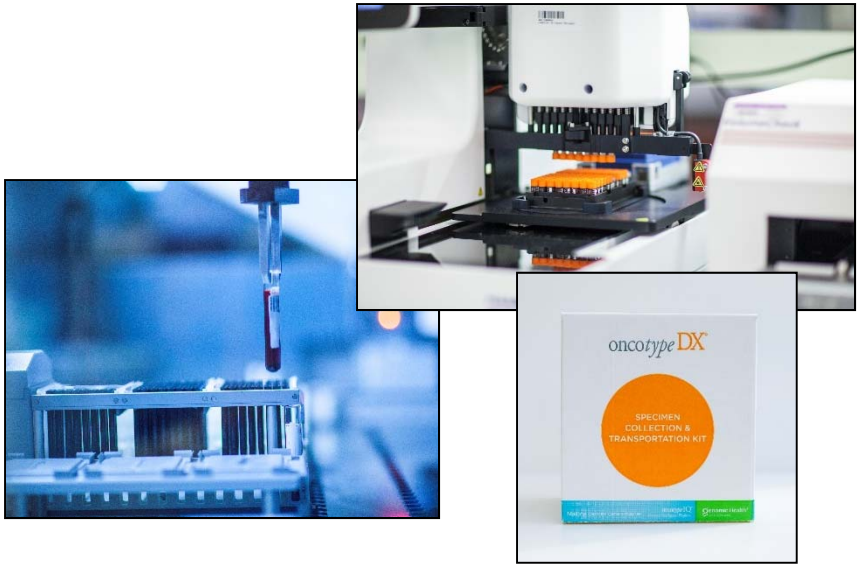
# Prostate Cancer Research Study

## *USU Center for Prostate Disease Research*

***CRADA***

### Objective

- 160,000 men in U.S. diagnosed every year with PC.
- Aggressive treatment (surgery, radiation) is over-used.
  - Need a test to optimize treatment based on actual risk
- CPDR entered a CRADA with Genomic Health Inc. to conduct a clinical study of the Oncotype DX® genomic prostate cancer test.
- Demonstrated two important results:
  - Validated test vs. biomarkers and biopsy pathology.
  - Similarly predictive of outcomes in both Caucasian and African-American men.




### Benefits to DoD and Warfighter

- Oncotype DX® enables physicians to put many low- to intermediate-risk patients on active surveillance:
  - Reduces over-treatment.
  - Saves time, money, discomfort, anxiety.
- Identifies patients who could benefit from more aggressive treatment.
- From 2005-2014, 1,046 cases of PC diagnoses in active duty military.
- In 2007, 12,000-13,000 cases of PC diagnoses among veterans.

### Impact

- Oncotype DX® is now covered by Medicare and many private insurance companies in the U.S.
- Genomic Health has secured partnerships and licenses with global companies (90 countries served).
- Rougly 30,000 tests sold every quarter.
- The DX® portfolio has been used to guide treatment decisions for more than 1 M cancer patients worldwide.
- Genomic Health is involved with 20% of the PC market (2018).



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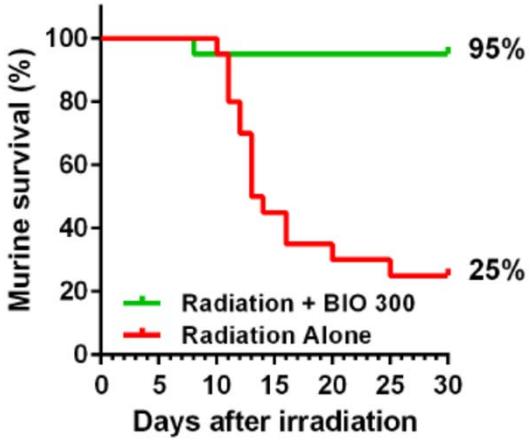
# Radiation Countermeasure

## *USU Armed Forces Radiobiology Research Institute (AFRRI)*

***PLA, CRADA***

### Objective

- Medical countermeasures (MCM) are agents that protect against accidental or intentional exposure to radiation.
- Currently, there are no FDA-approved prophylactic MCMs to protect against exposure to radiation.
- AFRRI discovered that genistein, a plant-derived molecule, counters cellular radiation damage.
- Humanetics Pharmaceuticals (HC) signed two exclusive PLAs and two CRADAs with AFRRI to commercialize genistein and developed a unique nanosuspension formulation (called BIO 300).




BIO 300 provides a significant survival advantage (mouse study)

### Benefits to DoD and Warfighter

- BIO 300 enhances survivability before or after radiation:
  - Taken prophylactically before a possible radiation event (warfighters and first responders).
  - Taken post-exposure after a radiation event (civilians).
- Investigational New Drug application with FDA granted to develop BIO 300 for acute radiation syndrome, supported by numerous preclinical and clinical studies.
- BIO 300 has a second use in tandem with anti-cancer radiotherapy: sensitizes tumors while protecting healthy tissue to improve outcomes.
  - On-going clinical trial in lung cancer.

### Impact

- BIO 300 has allowed HC to grow into a successful company:
  - $15 M private equity investments.
  - $26 M total Federal funding from DoD, National Institutes of Health, Biomedical Advanced Research and Development Authority, and NASA.
- On-going contracts with DoD as MCM: Joint Warfighters Medical Research Program, Congressionally-Directed Medical Research Program, and AFRRI.
- On-going NIAID contract to study BIO 300 for civilian use.
- Completed a $1.7 M grant from the National Cancer Institute to study BIO 300 in cancer radiotherapy.



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# Endoscopy Training System (ETS)

## *Uniformed Services University of the Health Sciences (USU)*

***PLA, CRADA***

### Objective

- Virtual reality training and assessment tools cannot recreate the realistic feel of performing actual surgery.
- USU invented and patented a physical model to train and assess endoscopic surgery skills for medical students.
- A CRADA between USU and two companies – Kyoto Kagaku Co Ltd and Limbs and Things, Inc. – allowed for collaboration to modify the prototype into a production quality product and to develop additional functionality.
  - The commercial product, enabled by a PLA, is called the Endoscopy Training System (ETS).

### Benefits to DoD and Warfighter

- The CRADA allowed collaboration needed to develop and launch ETS within four months of the PLA execution.
- ETS is a low-technology tool for objective assessment and training of endoscopic skills.
- Saves time and money while reducing the risk inherent in medical training:
  - Allows surgeons to practice and gain proficiency in flexible endoscopy skills without risk to patients.

### Impact

- ETS has been validated in real-world training and clinical settings:
  - Prior to using ETS, only 18% of residents with no colonoscopy experience passed an endoscopy surgery exam.
  - After training with ETS, 100% of the residents passed.
- ETS has enhanced the education and training of military, U.S. Public Health Service, and civilian surgeons in the skills required to perform endoscopy.
  - Sales to USU, U.S. and international medical schools.



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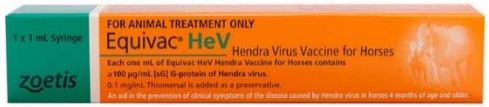
# Equivac® Hendra Virus Vaccine

## *Middle-Atlantic Regional Center of Excellence for Biodefense and Emerging Infectious Diseases Research (MARCE)*

***PLA, CRADA***

### Objective

- Hendra and Nipah virus, endemic to Oceania, are listed as Category C agents on CDC's list of Bioterrorism Agents:
  - Both are highly lethal in farm animals (pigs, horses).
  - Cause lethal infections when transmitted to humans via animals.
- Researchers from Australia, Pfizer Animal Health, and MARCE collaborated (via a CRADA) to develop vaccines for Hendra and Nipah.
  - Commercialization rights assigned to Pfizer via PLA.
  - Pfizer Animal Health spun out into Zoetis (2013).
- Equivac® Hendra vaccine (HeV) sold in Australia since 2012.



### Benefits to DoD and Warfighter

- HeV provides protection to horses against a disease which previously had no preventative or therapeutic agents.
- All human infections with Hendra virus have occurred following exposure to infected horses, so vaccinating horses can break the chain of transmission to humans.
  - Roughly 500,000 horses have been vaccinated with HeV.
- Provides a tool for threat reduction of a future outbreak or bioterrorism event.

### Impact

- Collaboration between MARCE and Australian researchers resulted in multiple high-profile publications and >$6 M in funding from National Institutes of Health.
- This vaccine development work paves the way for a human-use vaccine for both Hendra and Nipah viruses.
  - Could also result in a vaccine for pigs, which have previously been devastated by Nepah outbreaks in southeast Asia.



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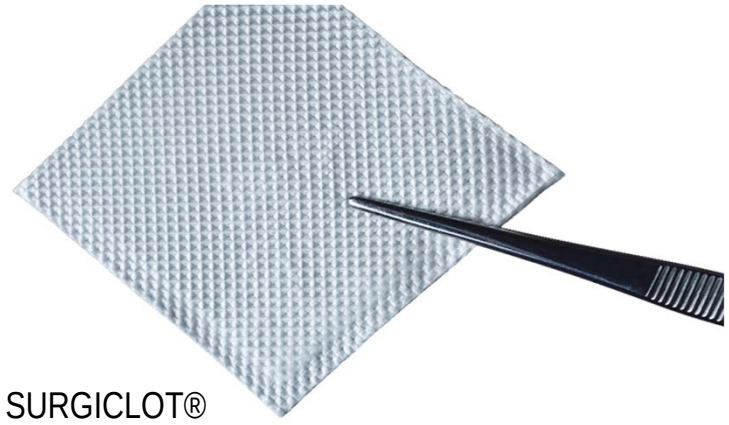
# Hemostatic Bandages

## *Uniformed Services University of the Health Sciences (USU)*

***PLA, CRADA***

### Objective

- Control of hemorrhage is the initial step in first aid, surgery, and field trauma care.
  - Existing hemostatic bandages swell post-surgery, causing complications or requiring removal.
- Collaboration between USU and Virginia Commonwealth University led to the invention of a new hemostatic bandage.
  - Patent covers both the formulation and method of manufacture.
- In 2010, an entrepreneur founded St. Teresa Medical, Inc. (STM) to commercialize the hemostatic bandage.
  - Signed a PLA and CRADA with USU.



SURGICLOT®

### Benefits to DoD and Warfighter

- CRADA enabled the USU inventor to help develop a viable commercial product alongside STM scientists.
  - Performed nearly 20 pre-clinical and clinical studies in a variety of surgical and non-surgical settings.
- The design enhances hemostatic efficacy, so is highly effective at stopping bleeding in surgical settings.
  - Only hemostatic dressing specifically approved for cancellous bone bleeding during surgery (once CE Mark approved).
- Reduces surgery time, as fast clotting time and translucency of the seal decreases re-bleeding.

### Impact

- The company, St. Teresa Medical, Inc. was founded specifically to license this invention and to commercialize it.
  - Employs 5–10 full-time and part-time employees, in addition to consultants.
  - 11 additional patents produced during development.
- First product, SURGICLOT®, has been subject to human trials in the UK, Norway, and India and is currently awaiting a CE Mark in Europe (expected early 2020).
- FLC Excellence in Technology Transfer award (2017).



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# Rapid Shiga Toxin Diagnostic Assay

## *Uniformed Services University of the Health Sciences (USU)*

***PLA, CRADA***

### Objective

- Shiga toxin-producing E. coli (STEC) cause ~265,000 infections per year in the United States.
  - Can result in acute diarrhea, hemorrhagic colitis, and life-threatening hemolytic uremic syndrome (HUS).
- Two types of Shiga toxin exist (Stx1, Stx2) each associated with related, but distinct, outcomes and treatments.
- Cell culture assays needed to ID presence, strains of STEC.
  - Accurate, but require at least 24 hours to be effective.
  - Existing toxin detection kits not sensitive and slow.
- USU invented a rapid diagnostic assay to meet this need.

### Benefits to DoD and Warfighter

- PLA with Inverness Medical Innovations, Inc. (now Abbott) to commercialize the assay, followed with a CRADA that enabled the commercial partners to access the inventors and utilize critical USU resources.
- Only rapid test that detects STEC toxins directly from samples.
  - Provides actionable results to optimize patient treatment pathway within 10–30 minutes (vs. 24 hr for cell culture).
  - Approved for sale by FDA and worldwide, via CE Mark.
- The assay is available for use by DoD during outbreaks of STEC, such as occurred in USMC trainees (2017) and in Europe, affecting U.S. Army supply lines (2011).

### Impact

- Rapid ID of STEC strains is essential for implementation of control measures, for effective and timely outbreak responses, and to detect new and emerging serotypes.
- Currently, two commercial products based on this tech:
  - Shiga Toxin Quik Chek™ and Shiga Toxin Chek™.
  - Manufactured by TechLab.
- Abbott sold 2,539 kits (Q3 2018), ~10,000/yr.



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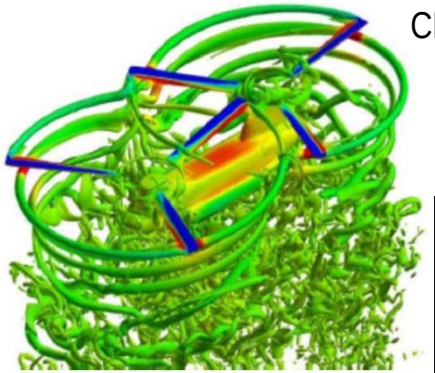
# Computational Research Engineering Acquisition Tools and Environments (CREATE)

## *High-Performance Computing Modernization Program*

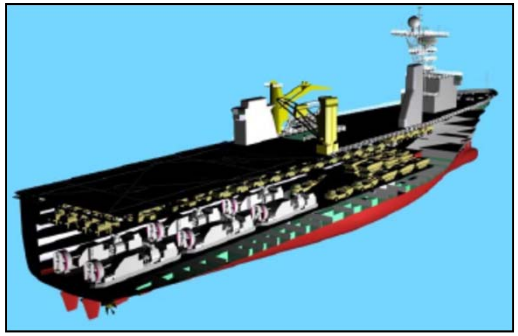
***Software License***

## Objective

- CREATE is a set of physics-based, high-performance computing (HPC) tools to enable development of innovative vehicle and weapon systems.
  - Improve effectiveness/efficiency of T&E by virtual proving ground:
  - Reduction of cycle time through computational prototyping.
  - Generation of design options for rapid trade-space exploration.
  - Analysis tools to assess the feasibility of design options.
- CREATE is available to industry/university partners through a time-limited software license via DoDI 5230.24 authority.
  - Licensing model retains DoD control, but shares the capability.



CH-47F virtual testing



LX(R) concept design

## Benefits to DoD and Warfighter

- CREATE tools support all stages of acquisition from rapid early stage design to full life-cycle sustainment and modifications across the warfighting arsenal:
  - Air Vehicles: concept design, fixed- and rotary-wing.
  - Ships: concept design, shock vulnerability, hydrodynamics.
  - Radio Frequency Antennas: electromagnetics and integration.
  - Ground Vehicles: design and evaluation.
  - Mesh and Geometry generation
- Future improvements/modules will model rocket design, space performance, hypersonics, electronic warfare.

## Impact

- HPC and CREATE physics-based simulation software enables a paradigm change for Defense acquisition:
  - Conceptual design support -- complete system parameter surveys (e.g., LX(R), above: 22,000 conceptual designs produced and evaluated in a period of 3 months.)
  - Acquisition decision support via high fidelity virtual test and analysis (e.g., CH-47F Block-II Upgrade, above: 700+ virtual tests to assess modifications to new Advanced Rotor Blade.)
- In use across acquisition community, industry, and academia:
  - 2000+ active licenses.
  - 100+ DoD organizations.
  - 70+ weapons systems.



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# Virtual Baffle System for Firearms Suppressors

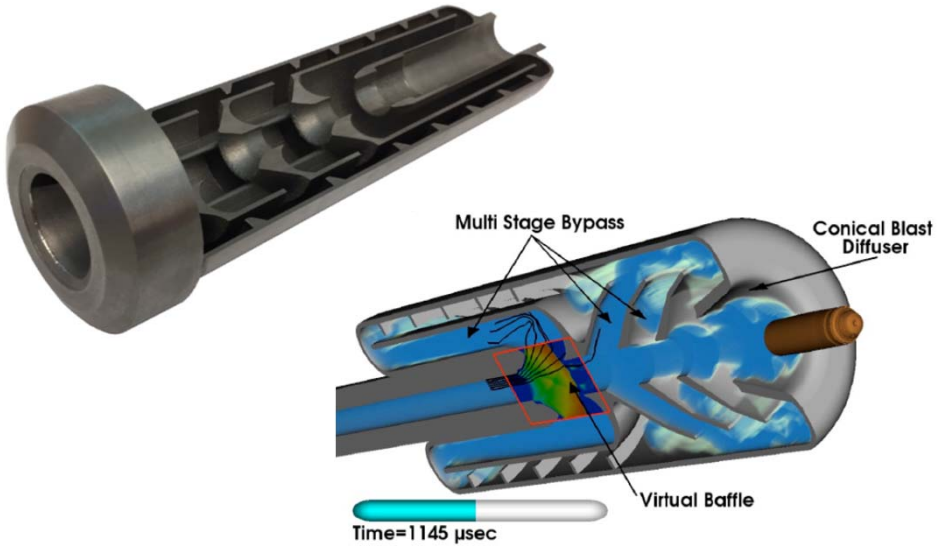
## *Optimization of Small Arms Signature Suppression (OSASS) team*

***PLA***

Lawrence Livermore National Laboratory

## Objective

- Traditional suppressor technology has barely evolved in 100 years, despite significant drawbacks:
  - Limited duration of use and limited operating lifetime
  - Blowback, operator impairment.
- SOCOM approached Lawrence Livermore National Laboratory (LLNL), Oak Ridge National Laboratory, and U.S. Army CCDC Armaments Center (formerly ARDEC) to form an interagency group (OSASS) to advance suppressor design and performance for the 21st century.




## Benefits to DoD and Warfighter

- The OSASS team used innovative tools to design a revolutionary new suppressor :
  - Coupled structural-hydrodynamic and combustion modeling on supercomputers for virtual prototyping and design.
  - Additive manufacturing for rapid prototyping.
  - Novel materials.
  - Real-time feedback from SOCOM operators.
- Virtual Baffle System® flow-through suppressor functions completely differently from all previous suppressors:
  - Minimizes blowback, cycling rate, and thermal load.
  - Accomplished while still mitigating acoustic and flash signatures.

## Impact

- First practical suppressor for persistent military use:
  - Withstands 1000-round, single-trigger-pull machine gun test.
  - Functions for the lifetime of the barrel with minimal servicing.
  - Conventionally manufactured from typically-used materials
- Suppressed weapons would significantly reduce debilitating hearing loss, one of the most prevalent injuries in the military.
- Patented by LLNL and licensed to LMT Defense.
  - Sold commercially to: OGA, law enforcement, foreign militaries.
  - In development via Joint Service Small Arms Program and Next Generation Squad Weapon programs.
  - Transitioning to use by SOCOM.



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# Value Proposition of DoD Technology Transfer Mechanisms

## Questionnaire

The study will investigate how technology transfer benefits the DoD as well as the DoD's private sector partners. No sensitive or proprietary business information will be shared in the report unless explicitly authorized by the relevant business partner.

For the Patent License Agreement (PLA) or Cooperative R&D Agreement (CRADA), identify and quantify benefits, where possible, to include:

- Contact information for the T2 partner organization and the DoD Lab representative responsible for initiating and/or tracking the project.
- Briefly describe the technology, including how the DoD IP or collaboration enables it.
- Did the partner make a commercial product, provide a service involving the technology, or transition the technology to a DoD platform?
- Who is using the technology inside or outside the DoD?
- Were any jobs created as a result of the PLA or CRADA? If so, estimate how many and describe the basis for this estimate?
- What were the non-monetary benefits (if any) provided to the DoD? In other words, has the technology:
    - Enhanced capability, lethality, or survivability?
    - Reduced labor hours or other costs?
    - Reduced acquisition or sustainment costs?
    - Improved reliability, maintainability, or availability?
    - Any other improvements/benefits not listed above?
- Describe and/or quantify the financial return, if any, including royalty payments to the Service.
- Is the partner selling this product or providing this service now? Please estimate the quantity sold to the DoD and/or to the private sector.
- How did the business partner identify the market need within the DoD?
- To what extent did the PLA or CRADA help the company become/remain economically viable or more competitive in the market?
- Is the licensee continuing to work with the DoD?
- Did / does the business partner need assistance reaching a particular market within the DoD?


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