**Defense Technology Symposium** in conjunction with the AUSA Warfighter Summit & Exposition July 26, 2022 \* Fayetteville, NC

# Defense Technology Symposium

### Session – Defense Research and Development Resources

Dr. Stephen Lee, Chief Scientist, US Army Research Office

Kathie Sidner, Director of Defense & Military Partnerships, University of North Carolina System

Dr. Veena Misra, Director, Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) Center, North Carolina State University

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# U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND – ARMY RESEARCH LABORATORY

Army Research Office (ARO) - Overview

Dr. Stephen J. Lee Army Research Office DEVCOM ARL Stephen.j.lee28.civ@mail.mil 919-549-4365\_\_



## ARMY MODERNIZATION

To have the best Army in the world, we must have the best Science.

ARO is always looking for answers to the question:

# How will we ensure success in the future?

ARO's work with basic scientific

research drives toward the

20, 30, 40 years from now.

Army's far future capabilities







# A component of DEVCOM ARL, the Army Research Office contributes to Army modernization by focusing on **basic scientific research**.

### **ARO's Mission**

### 1

#### **Build the Future**

Create and direct scientific discoveries for revolutionary new Army capabilities

#### **Solve Existing Problems**

Drive science to develop solutions to existing Army technology needs

### 3

#### Accelerate

Accelerate transition of basic research

4

#### Educate

Educate and train future Army Scientists & Engineers workforce

### 5

#### Prepare

Create technological superiority for U.S. Forces, and prevent adversary technological surprises

### ARL's Mission: To operationalize science for transformational overmatch





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#### ARL's Mission: Operationalizing Science for **Transformational Overmatch**





### ARO ORGANIZED BY SCIENCE



### There are 47 Programs within ARO focused on Science.

Programs are organized into 4 Divisions with DEVCOM ARL's Competencies underlying 100% of the research programs. Competencies and the Army with foundational expertise that is leveraged to develop new opportunities, build programs, and shape future operational concepts.

Sciences of Extreme Materials	Humans in Complex Systems	Electromagnetic Spectrum Sciences
Photonics, Electronics, and Quantum Sciences	Network, Cyber, and Computational Sciences	Energy Sciences
Military Information Sciences	Terminal Effects	Mechanical Sciences
Biological and Biotechnology Sciences	Weapons Sciences	

Competencies ensure transformational overmatch for the future Army







# ARO's Role in the ARL and Army Research Enterprise



### **DEVCOM ARL COMPETENCIES**





**Biotechnology Sciences** 

**Spectrum Sciences** 

**Energy Sciences** 

**Complex Systems** 

**Military Information** Sciences

Competencies ensure transformational overmatch for the Future Army



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### ARO AND OTHER BROAD AGENCY ANNOUNCEMENTS



Award Type	Target	Funding
Single Investigator (SI)	Single-laboratory projects	~\$141K/year for ~3.4 years avg*
Short Term Innovative Research (STIR)	Very high-risk pilot projects	\$60K for 9 mo.
Early Career Awards (formerly Young Investigator Program)	Early-career PIs	\$120K/year for 3 years
Conferences / Workshops / Symposia	Academic State of Science	\$10K-\$30K
Presidential Early Career Award for Scientists and Engineers (PECASE)	Promising future leaders	\$200K/year for 5 years
Defense University Research Instrumentation Program (DURIP)	Instrumentation	\$240K (avg) per award*
Multidisciplinary University Research Initiative (MURI)	Large multidisciplinary programs	~\$1.25M/year up to 5 years
Historically Black College/University and Minority Institution (HBCU/MI)	Minority serving institutions	~\$140K/year for 3 years
Small Business Technology Transfer (STTR)	Multi-phase awards bridging academia & industry	\$150K (6 mo.) to \$1M (24 mo.)
Small Business Innovative Research (SBIR)	Multi-phase research for industry transition	\$150K (6 mo.) to \$1M (24 mo.)

\*FY21 averages; funding level and duration in this award category vary based on scope of project, proposal, evaluations, and PM recommendation.

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### **CONNECTING WITH DEVCOM ARL - ARO**

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND ARMY RESEARCH LABORATORY THE ARMY'S NATIONAL RESEARCH LABORATORY NEWS WHO WE ARE - WHAT WE DO - BUSINESS - CAREERS - OPEN CAMPUS MEDIA CENTER CONTACT US Q HOME

#### **Broad Agency Announcements**

HOME // BUSINESS // BROAD AGENCY ANNOUNCEMENTS

BUSINESS	and the second s
MULTIDISCIPLINARY UNIVERSITY RESEARCH	
	The Broad Agency Announcement is a competitive solicitation procedure
	used to obtain proposals for basic and applied research and the part of
PROTECTION PROGRAM (HRPP)	development not related to the development of a specific system or
ARO SMALL BUSINESS OPPORTUNITIES	hardware procurement.
CONTRACTING	The BAA is described in FAR 6.102 as "Use of Competitive Procedures," and FAR 35.016 as
BROAD AGENCY ANNOUNCEMENTS	"Broad Agency Announcements."
BAA FORMS	Basic Authority – The Competition in Contracting Act of 1984 issued as Public Law 98-369 (98 stat, 1175 et seq.) authorizes use of "general solicitations" or Broad Agency Announcements.
COLLABORATIVE ALLIANCES	The use of general solicitations is limited by CICA to "basic research proposals." Contracts
PARTNERSHIP METHODS AND OPPORTUNITIES	awarded under these general solicitations meet the "full and open" competition requirements o CICA.
SMALL BUSINESS	The type of research solicited under a Broad Agency Announcement attempts to increase
SCIENTIFIC SERVICES PROGRAM	knowledge in science and/or to advance the state of the art as compared to practical application of knowledge.
TECHNOLOGY TRANSFER	
UNIVERSITY AFFILIATED RESEARCH CENTERS (UARCS)	Funding Opportunities – Open Broad Agency
	Announcements
	Long Term BAA

### **ARL/ARO BAA**

www.arl.army.mil/business/broad-agency-announcements

#### **ARO** Areas of Interest

Physical **Sciences** 

**Chemical Sciences** Life Sciences Physics

Engineering Sciences

Electronics **Materials Science** Mechanical Sciences

#### Information **Sciences**

**Computing Sciences Mathematical Sciences** Network Sciences

#### **Technical POC: Name, Email, Phone**







# How Prospective Pls Can Engage with ARO



### **CRITICAL QUESTIONS TO CONSIDER WHEN PITCHING IDEAS**



### Is it basic research?

- What's the scientific question?
- What foundational knowledge is not currently available about the workings of the universe?
- Proposals focused on specific devices/components/technologies are beyond the scope of ARO's mission.

### Is it hard?

- If an "old" question, why haven't we found an answer yet?
- If a "new" question, where's the sticky part?

### Why you? Why now?

- What's been done before? Why wasn't it successful?
- What's novel about your skills/abilities/ approach that makes you think there's a shot at an answer?
- What new advance provides opportunity to make new progress?

### So what? Who cares?

- What impact will the research make on the scientific community?
- What papers will be written because of your efforts? What papers will stop being written?
- What are the potential implications for the future of technology?

### Where's the risk?

- How confident are you that you're asking the right question?
- How will you know when you have an answer? If you find a different answer, will you still learn something?

### What will it take?

• What resources (time, money, infrastructure, personnel, partnerships) are required to pursue the research?



### ARO \_\_\_\_ PROGRAM: HOW TO ENGAGE



 Your 'menu' of ideas
 Suggested initial ideas to share with PM: 3-4 ideas, 1-2 Paragraphs each, 2 pages max
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- 2 ideas aligned with the program (see the BAA)
- 1 idea outside the program
- 1 idea characterized as half-baked, super high-risk, possibly "crazy"
- Submit directly to PM any time via email. Feedback is relatively fast.
- Do not ask "what research does ARO want me to do"

- Provides a well-written scientific question and proposes a novel approach
- Describes the level of risk associated with the effort.
- Identifies the resources required to pursue the research (rough order of magnitude).
- Provides a short bibliography positioning the research in the body of knowledge.
- Submit any time via email.

- Consult the ARO Core BAA for full details on requirements.
- Expands on the discussion in the whitepaper to adequately describe the proposed effort.

Proposal

- Provides a reasonably self-contained description; expert reviewers should not have to heavily consult the literature or supplementary material to understand the question and the approach.
- Submit via grants.gov. Preferred receipt in \_\_\_\_\_ and majority of decision points are in \_\_\_\_.





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# University of North Carolina System

NC Defense Technology Symposium

July 26, 2022

# UNC System – At a Glance



16	Universities
\$2 Billion	Annual research spending
\$56 Million	DoD funded research (FY19)
21,000+	Military affiliated students
Top Secret	DoD facility clearance



# UNC System Major Technology Innovation focus areas

### **Advanced Manufacturing:**

- NCSU Center for Additive Manufacturing and Logistics (CAMAL)
  - Collaboration with Army XVIII Airborne Corps
- NCA&T: Center of Excellence in Product Design & Advanced Manufacturing
  - STTR with NanoTech Labs Inc. funded by Air Force
  - Collaboration with Army Research Lab in hybrid 3D printing





### Tech/IT and Energy:

- NCA&T TECHLAV
  - Air Force Center of Excellence
- UNCC Energy Production and Infrastructure Center (EPIC)





### **Health Sciences:**

- UNC-CH Matthew Gfeller Center
  - \$6M in DOD grants for military and civilian TBI research
  - \$4M congressional funding
  - \$12.5M major gift to establish THRIVE (Veteran TBI/PTSD program)
- ECU Health & Human Performance
  - Collaborations with Army and Navy on TBI, risk injury, prevention and rehab



# **UNC System**



# DOD + Industry Partnerships in Dual-Use Technologies

UNC-led national centers of excellence





### Activities:

- SME access
- Sponsored research
- Engineering design
- Prototype development
- Internships at military commands
- Military fellowships at UNC
- Custom education programs
- APPLIED REFERECH AJJOCIATE, INC. Mrstratifyd

### Outcomes:

- Innovation
- Patents
- Spin-outs
- Prototypes
- Fielded solutions
- Talent pipeline
- Cost savings



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# ASSIST Center Introduction

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### Defense Technology Symposium July 26<sup>th</sup>, 2022











UNIVERSITY OF MICHIGAN



# **ASSIST -** Advanced Self-powered Systems of Integrated Sensors & Technologies

*Vision*: to create <u>self-powered sensing</u>, <u>computing</u>, and <u>communication</u> <u>systems</u> that enable <u>data-driven insights</u> for a smart and healthy world.



- Self-powered
- Physiological, biochemical and environmental sensors
- Wearable, wireless and comfortable
- Informative and continuous data

# ASSIST Capabilities Overview

### **Core Technologies**

SSIST

- 1. Energy harvesting
  - Heat, Mechanical, Sweat/ISF, EM
- 2. Low power sensors
  - Physio, Biochem, Breath
- 3. Low power computing and communications
  - 10s-100s uW SoC, Radios
  - Body-optimized antennas
- 4. Systems
  - Textiles integration
  - Flexible patches

### Opportunities in Self-/Low-Powered Sensing Systems

- Integration into textiles, stretchable patches, traditional cases
- Physiological biometrics
- Biochemical diagnostics
- Breath / skin vapor
- Environmental sensing
- Textiles-integrated sensors and electronics
- Biometrics / environmental sensing and stimulation in VR/AR
- Implantables and energy transfer using ultrasound
- Mental / cognition assessment and maybe even control
- Energy harvesting for health / metabolism

# ASSIST Technologies can Monitor Soldier Health, Fitness and Stress Levels

- Self-powered and/or low-power
- Wearable and wireless
- Multimodal sensing
  - Physiological
  - Environmental
  - Biochemical
    - ► Sweat / ISF
    - Breath
  - Stress

- ► VR/AR
- Actionable data





# NCSU / ASSIST DoD Affiliations















https://news.ncsu.edu/2021/01/nc-state-leads-unc-system-military-partnership/

# **Energy Harvesting Technology Highlights**

#### **Body Heat Body Motion** Ambient RF **Supercapacitors** Li ion capacitors • Flexible Piezoelectrics Ambient Wi-Fi thermoelectrics • High energy Flexoelectrics Novel antennas density on textiles • Liquid metal Low leakage •











# ASSIST's Low Power Multi-Modal Sensors



Eric Topol http://t.co/m4yNon7vA3?amp=1

Bioelectric	E	Biophotor	nic	Inertial			Biochemica	I	Environmental
ow power EOG ow power EDA ry electrodes	<ul> <li>L</li> <li>N</li> <li>M</li> <li>L</li> <li>re</li> <li>re</li> <li>re</li> <li>re</li> <li>o</li> <li>b</li> </ul>	ow power 1ulti- vavelength EDs leart rate, espiratory ate, blood xygen, slee lood press	PPG ep, sure	<ul> <li>Activity</li> <li>Cough</li> </ul>	y ing	•           	New enzymes for lactate, glucose, and uric acid Passive swea interstitial flu collection	s at/ iid	<ul> <li>Gases for air quality and breath</li> <li>VOCs for air quality and breath</li> <li>Particulate matter</li> </ul>
		ultimo	odal s	ensors	and th	eir c	orrelatio	) n	
•	<b>,</b>	2	<i>(</i> )	<b>↓</b>	*		٩	C'	9
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### **Solisi Modular System Platform- Multi-Analyte System**

- Multi-analyte configuration of modular system and custom iPad app deployed to FIU for use in wound monitoring studies in animal model
- System currently undergoing benchtop validation with custom gauze-integrated electrochemical sensors

HET2 Modular System Main Module



# Flexible and Wearable Technologies



# **Flexible Monitoring Patches**







# Low Power Electronics : Multi-Chip Solution



SSIST

### System on Chip

- 566 nW total power
- RISC-V

## Analog Front End Chip

- ECG, PPG, RR, Ozone
- Respiration and EOG always on
- RRtriggers PPG/Ozone

### Energy Management Chip

- Multi-modal: TEG/PV/Piezo
- Four custom voltages outputs

### **Custom Radio Chip**

- BLE4.0 Compliant
- 300 uW total power
- -69dBm sensitivity and 500Kb/s

# Physiological and Environmental Tracking System



# Self-Powered and Clinical Validation Systems





# ASSIST Industry Member Benefits

Level	Shared Benefits $\overbrace{k}^{\text{bound}}_{\text{bound}}$ $i$	Direction	Preferred IP Access
Full	<ul> <li>Networking</li> <li>Access to world-class researchers</li> <li>Input on research project</li> </ul>	<ul> <li>30 voting points</li> <li>Eligible for Chair or Vice- chair</li> </ul>	<ul> <li>1st option for exclusive commercial license</li> <li>Royalty-free research license</li> </ul>
Associate	<ul> <li>selection</li> <li>Multiplied research dollars</li> <li>Reduced rates on sponsored research</li> </ul>	<ul> <li>10 voting points</li> </ul>	<ul> <li>2nd option for exclusive commercial license</li> <li>Royalty-free research license</li> </ul>
<b>Affiliate</b> (Startups)	<ul><li>Early technology insights</li><li>Student engagement</li></ul>	• N/A	•N/A

# Thank You

# For more information:

Contact vmisra@ncsu.edu\_or

- or -

SSIST

Visit assistcenter.org

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### NC Defense Technology Symposium July 26, 2022



# **Mission and Impact**

#### In North Carolina









# **Major Technology and Innovation Centers**



# Quantum Duke Quantum Center

**Biomedical** 



### **Christensen Center for Innovation**

Duke Design Defense and Duke Design Health



Materials

uke



CENTER FOR AUTONOMOUS MATERIALS DESIGN

Partners include: Fort Bragg, Camp Lejeune, Seymour Johnson AFB, Norfolk Naval Base, XVIII ABC, 82 ABD, NSIN

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### AI Enabled Edge Computing, Visualization, and Sensing

Yiran Chen, Helen Li, Maria Gorlalova, and Jeffrey Krolik

Department of Electrical and Computer Engineering Duke University, Durham, NC 27708

Briefing prepared for: Defense Technology Symposium, Fayetteville, NC

July 26, 2022



### Duke AI for Edge Computing Leveraging Next Generation Wireless Networks



# Duke Overview of Federated Learning Group

- **Goal:** Improve the efficiency, robustness and the performance of federated learning system while preserving the privacy and security.
- Funded by NSF and AFRL
- Current Problem sets:
  - High communicational and computational efficiency on edge devices
  - Privacy and security against information leakage and Byzantine attack
  - Reliability and robustness in real world with heterogeneous resource availability on edge devices
- Recent and current projects:
  - FedMask: Mask-based FL system that reduces communication overhead by 32x (Sensys2021)
  - Soteria: Privacy preservation algorithm that mitigates data leakage from gradients (CVPR2021)
- New directions:
  - Improve the efficiency of FL system by applying asynchronous and semi-asynchronous protocols
  - Improve the scalability that is limited by heterogenous and limited on-board resource

# Duke

Heterogeneity-aware semi-asynchronous federated learning system Dr. Hai Li (Email: hai.li@duke.edu)



- Platforms with extremely limited resource and energy can also participate by training smaller models, which improves the scalability.
- Knowledge distillation module allows extreme straggler to train smaller models, which improves the scalability

schedule local training configurations and improve the

efficiency under dynamic onboard resource availability

## Duke Overview of Intelligent Interactive IoT (I^3T) Group

- **Goal:** Make augmented reality (AR) systems robust, intelligent, and user context-aware via new sensing, edge computing, and edge AI algorithms and architectures
- Funded by NSF, NASA, DARPA, IBM, Meta
- Current Problem sets:
  - Robust edge computing-supported Simultaneous Localization and Mapping (SLAM) for mobile AR
  - Robust semantic context awareness with reduced data labeling effort
  - AR user context awareness through eye tracking and wearables
- Recent and current projects:
  - Improved AR spatial awareness via edge-based depth data completion and correction (IMWUT'22)
  - Real-time AR user cognitive context detection with limited user data collection (SenSys'20, IPSN'22)
- New directions:
  - Privacy-preserving edge computing-supported SLAM and semantic context awareness for mobile AR
  - User context-aware mobile AR for mental health

Juke

### Augmented Reality (AR)-assisted Dialectical Behavior Therapy (DBT) Dr. Maria Gorlatova (Email: maria.gorlatova@duke.edu)

#### CONCEPT OVERVIEW

• The efficiency of DBT, developed to treat emotional dysregulation, can be improved via the integration with personalized emotion recognition algorithms and immersive AR experiences



### AR-aided emotional regulation skill acquisition



### AR-aided emotional regulation skill activation

#### STATE OF THE ART AND IMPACT

- DBT is standard-of-care treatment for multiple conditions that affect active duty and veteran populations, including post-traumatic stress disorder (PTSD), depression, and substance abuse
- DBT skill acquisition can be limited when patients resist treatment due to perceived lack of self-efficacy or struggle to complete DBT exercises
- Many patients struggle with activating emotional regulation skills they have learned via DBT at the appropriate times

#### **KEY INSIGHTS**

- AR offers a rich array of new intervention options and user state sensing opportunities that have the potential to significantly improve the effectiveness of DBT
- Rich and immersive personalized AR experiences will improve the effectiveness of DBT skill learning and practice
- Personalized cognitive and emotional state recognition will help target DBT exercises to best benefit the users
- Personalized vulnerability state recognition will enable justin-time adaptive interventions for emotional dysregulation

# Duke Overview of Sensor Array and Multipath (SAM) Group

- **Goal:** Combine physical and statistical models with machine learning methods to improve the sensing performance in complex propagation environments and terrain.
- Funded by DARPA, ONR, and AFRL for radar, sonar, communications, and electronic warfare research
- Current Problem sets:
  - Counter-unmanned aerial systems in urban and complex terrain
  - Active and passive acoustic surveillance for complex multipath environments
  - Electronic protection for HF over-the-horizon radar systems
- Recent and current projects:
  - Neural-network Enhanced Radar Surveillance (NNERS) with Helen Li for DARPA SPiNN program
  - Small Operational Unit Situational Awareness (SOUSA) for DARPA/STO Seedling
- New directions:
  - Intelligent Distributed Expeditionary Acoustic Surveillance (IDEAS)
  - Anti-jam Through-the-Radar Vehicle-to-Everything Communications

Duke

# Intelligent Distributed Expeditionary Acoustic Surveillance (IDEAS) Dr. Jeffrey Krolik (Email: jlk@duke.edu)

CONCEPT OVERVIEW	STATE OF THE ART AND IMPACT
Non-line-of-sight threat detection and localization from UAS- based distributed microphone array	<ul> <li>Expeditionary force protection in urban and complex terrain limited to line-of-sight (LOS) threats</li> </ul>
For expeditionary gunshot detection, counter-UAS, and cued reconnaissance in complex terrain	<ul> <li>Obscured maneuvers, drones, and gunshots often undetected by EO/IR systems</li> </ul>
	<ul> <li>Ground-based acoustic systems limited to LOS target- based sniper detection (e.g. Boomerang)</li> </ul>
	<ul> <li>Lack of cueing necessitates time-intensive search using airborne EO/IR sensors alone</li> </ul>
UAS	KEY INSIGHTS
Enemy UAS Acoustic	Acoustic source detection and localization could provide tactical UASs (e.g. Raven) non-LOS cues for EO/IR sensors
Sniper	<ul> <li>Intelligent autonomy allows UAS to adapt flight paths to prevailing atmospheric sound propagation conditions</li> </ul>
Vehicle	<ul> <li>Super-directive adaptive array and blind-source separation permits suppression of wind and platform engine noise</li> </ul>
Asset	Distributed array processing using multiple UASs permit accurate time-difference-of-arrival source localization

## Duke Collaborative Opportunities with Duke

- Attending Biweekly Athena Seminars: Athena hosts a biweekly seminar series given by Athena PIs, graduate students, and invited guests, open to the public.
- Attending Annual Symposium/Tech Showcase: Athena hosts an annual symposium and tech showcase every summer, open to all industrial and community stakeholders, academic and government collaborators, funding agencies, and invited guests.
- Joining NSF IUCRC for ASIC (Industry-University Cooperative Research Center for Alternative Sustainable and Intelligent Computing, <u>https://asic.pratt.duke.edu/</u>):
  - A multi-site consortium for industrial collaboration funded by the same NSF program.
  - A mini "funding agency" contributed by industrial memberships.
  - Current members: AFRL, NSA/LPS, Thales, Northrop Grumman, SRC Inc., ...
- Directly working with Athena/ASIC PIs
  - Athena/ASIC PIs work with more than 30 different companies and governmental laboratories through various collaboration formats:
    - Gifts, IUCRC memberships, research contracts

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# EPIC R&D Ideas 2022 Energy Production and Infrastructure Center UNC Charlotte

Tuesday, July 26, 2022 Michael Mazzola, Ph.D., P.E. EPIC Executive Director



# **EPIC's Mission**

- Education for Engineers in Energy
- Research and Development
- Economic Development



Albert & Freeman Energy Production and Infrastructure Center

16 tenured or tenure-track faculty in all five departments in the William States Lee College of Engineering
6 research faculty
6 research staff or post doctoral fellows
12 industry members in the EPIC Affiliates Program generating \$215,000 in membership dues supporting education and workforce development
87 undergraduate Energy Concentration students

60+ research grants and contracts under management totaling \$18,946,232



### **Major Research Thrusts**

*Power Management* 

> Tactical Power Distribution

High Power Density Power Converters

### Energy Management

Grid Resiliency & Modernization

Inclusive Approaches in Planning

**Soldier Wearable** 

Energy Infrastructure

> Advanced Construction

Energy Supply Chain



# **Energy Infrastructure**



### Advanced Construction Technology Initiative





# **Power Management**

### Advanced Technologies for Tactical Power Distribution





- 60 kW DC-DC Silicon Carbide Inverter ٠
- Gateway for Hybridized Tactical Grid •





- Sponsor: PM Mobile Electric Power, U.S. Army CERDEC ٠
- Technology: Silicon Carbide Tactical Power Inverter ٠

# **Transportation Electrification**





### Two Units to Be Installed

- The Ritz at Washington Heights, Charlotte
- NC A&T Campus, Greensboro

### Installation in Public Right of Way

- Developing attachment agreements
- NC A&T Campus



- Existing utility pole infrastructure
- Inexpensive upgrade to street or parking lot







# **Energy Management**

### Hot Springs, North Carolina





Key Innovations

- Outage prediction
- Energy management
- Reconfiguration
- Advanced protection





# **Energy Management**













# **Power and Energy Management**

Early Stage R&D: Carbon-ion super capacitor Technology Integration: Body armor Benefit: Reduced soldier load

Concept: Integrate C-ion super capacitors into woven clothing and/or gear such as Soldier Plate Carrier System (SPCS) Soft Ballistic Inserts



- C-ion materials can be interwoven in compatible materials, such as Kevlar and Twaron, and/or ultrahigh-molecular-weight polyethylene used in soft body armor pouches.
- Result: Power & Energy from equipment soldiers already carry. Single-function batteries can be reduced from solider-carried loads.





C-ion based energy storage packs designed, fabricated, and tested by UNCC EPIC



C-lon coated fibers

# Defense Technology Symposium

Session – Defense Research and Development Resources Business Briefs

> Aerosolization Equity Investments, LLC Advanced Materials Manufacturing Nanodiagnostic Technology, LLC

# DEFTECH

### On-site Aerosolization of all chemically, biologically or radiologically contaminated water

Aerosolization Equity Investments, LLC Mr. Kelly Houston 704-756-5494 <u>aeihq@mindspring.com</u> 5 issued utility patents AerosoliZLD <sup>™</sup>

Problem: Presently @ \$33B is spent, across DoD, in trying to effectively deal with contaminated water. Legacy technologies are: complex. labor intensive, extremely expensive, prone to litigation, and known environmental and human performance impacts are tremendously destructive.

- <u>"Aerosolizaton</u>" is the medically understood scientific basis for the global "6 foot social distancing" directive and is therefore extremely well known across DoD.
- <u>"Aerosolization"</u> is: proven, safe, effective, efficient, all natural, immediately deployable, infinitely scalable, operationally overlaying, autonomous, 24/7/365 monitored by drones and extremely cheap to deploy and maintain.



#### Impact & Technical- TRL7

- Simple and mobile contaminated water "dewatering" system which safely remediates high cost water issues and produces a concentrate for ease of final removal.
- Process encapsulates the contaminates/pathogens.
- Systems can be easily and cheaply bundled to increase capabilities.
- Safely deals with all chemically, biologically or radiologically contaminated water or algae.
- Proven on municipal scale and suitable for all public and private facilities.
- Exponentially increases the "drinking water from the air" Atmospheric Water Generation-AWG" equipment's output.

#### Solution Specifics-

- "Aerosolization" is simply "adding air to a solution" for the purpose of adding electro-static charges and oxidizing all particles to make them "salt out of solution" via gravity.
- Eliminates many personnel responsibilities, construction and permitting requirements.
- Reduces installation footprint and base operations.
- Reduces possible environmental litigation across DoD.
- Overlays existing operations.
- Infinitely scalable
- Provides DoD an immediate "zero liquid discharge" capability.
- Makes the newly DoD approved "atmospheric water generating- AWG" equipment exponentially more efficient at making drinking water from the air.
- As a "Dual Use Technology"--immediately allows for domestic "critical mineral mining" for all of DoD's required supplies.
   As a "Dual Use Technology"- immediately protects DoD's domestic
- As a "Dual Use Technology"- immediately protects DoD's domestic supply chain as any DoD supplier can have their deliverables delayed or cut off due to "contaminated water discharge non-compliance".

#### Performance/Benefits-

- @\$30B per year savings, across DoD, once fully deployed and automated.
- All natural process that is extremely well known across DoD and all medical professions.
- Can be mobile or fixed operations.
- Simple to deploy, move and maintain.
- Logistics tail eliminated.
- Eliminates many legacy technologies.
- Reduced base footprint and operational considerations.
- Eliminates "off-base water discharges".
- As a "Dual Use Technology"- @ \$1T is spent domestically in trying to deal with chemically, biologically or radiologically contaminated water or algae. This can be reduced by up to 85%
- As a "Dual Use Technology"- domestic and international deployment can happen simultaneously across both the public and private sector "contaminated water producing" enterprises.

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# Composite Metal Foam



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#### Problem

#### Technology name, picture, and brief description:

 Composite Metal Foam (CMF) is a lightweight, high performance metallic material that looks and works like a heavy-duty bubble wrap.

#### What problem do you solve?

- Military equipment is often exposed to extreme environments of blast/ballistics, fires, impacts, vibrations, and radiation.
- Current materials cannot fulfill the needs of U.S. military equipment, putting the assets and soldiers at risk.



#### Impact and Technical Approach

#### Technology Readiness Level (TRL)

 CMF materials have a TRL and MRL of 5-6, depending on the application.

#### What is the Impact of your Solution?

- CMF can be used to protect assets in airdrops, to produce lightweight vehicle armor and fire-resistant ship hulls, to reduce vibration/noise in aircraft, and more.
- In every use case, CMF would increase performance, efficiency, safety, and durability.



#### Solution Specifics

#### How do you solve the problem?

- CMF offers 100X higher impact energy absorption and 7X higher fire protection at a 3X lower weight than todays materials.
- CMF can be produced from any metal, alloy, or combination and can be fine tuned, both physically and chemically, for point-specific properties.
- AMM can produce CMF in any shape or size and can machine, bolt, weld, or otherwise modify CMF just like any other metal material.



#### Performance

#### End-user payoff/expected operational value/dual-use:

- Using CMF to absorb airdrop landing energy will preserve the vehicles integrity and will prevent the unnecessary destruction of U.S. military assets, as is common today.
- CMF can be used to increase rotorcraft crash protections with single layer, energy absorbing subfloors and seat supports.
- CMF can increase IED protection on ground vehicles.
- CMF can reduce fire spread in marine structures and shipbuilding while remaining as lightweight as aluminum.
- CMF can shield against radiation in vessels with onboard nuclear reactors such as submarines and aircraft carriers.
- CMF can protect against fire and can lighten systems.
- CMF can reduce vibrations and noise in aircraft.

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