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

DEVCOM ARL Overview

Mr. Joe Alexander

Director (A), Sensors & Electron Devices Directorate

DEVCOM Army Research Laboratory

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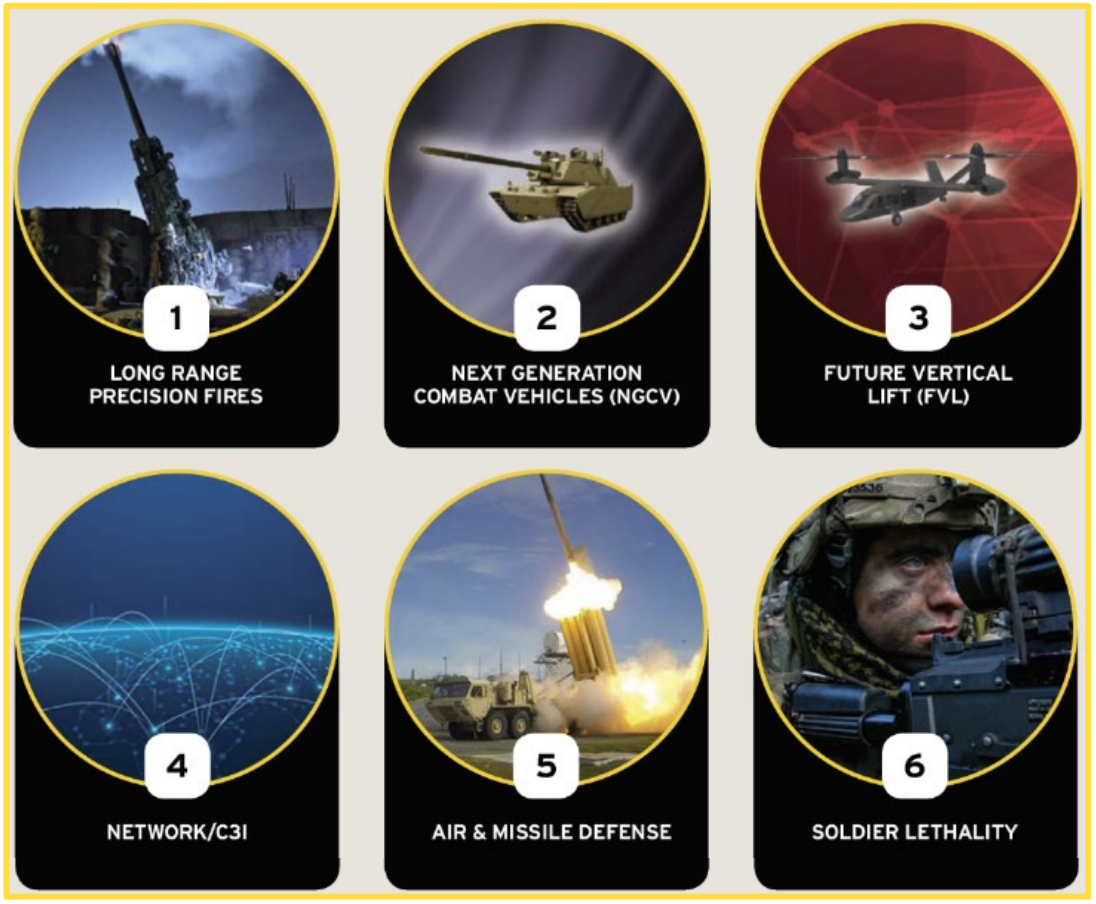
POC: Mr. Joe Alexander, (301) 394-1488

U.S. ARMY MODERNIZATION PRIORITIES

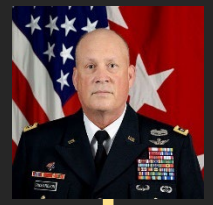
> This is not about success of any one organization or individual. It is about delivering concepts and capabilities that ensure our Soldiers and formations have over-match on a future battlefield. We must stay focused on output.
>
> *- Gen. Mike Murray, CG AFC*

DEVCOM ARL provides the underpinning scientific knowledge that enables transforming capabilities within and across the AMPs



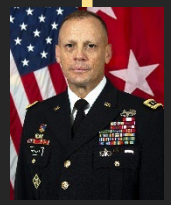
AFC STRUCTURE

ARMY FUTURES COMMAND

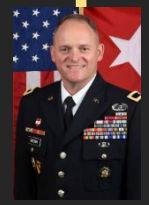


LTG James M. Richardson
Commanding General (A)

LTG Thomas H. Todd, III
Deputy CG (A)



LTG D. Scott McKean
Director



MG Miles Brown
CG

BG Anthony McQueen
CG

FUTURES & CONCEPTS CENTER

FCC PROVIDES THE INTELLECTUAL FOUNDATION AND DISCIPLINED APPROACH TO DESIGN, DEVELOP, AND FIELD THE FUTURE ARMY

COMBAT CAPABILITIES DEVELOPMENT COMMAND

CCDC PROVIDES THE RESEARCH, ENGINEERING, AND ANALYTICAL EXPERTISE TO DELIVER CAPABILITIES THAT ENABLE THE ARMY

MEDICAL RESEARCH & DEVELOPMENT COMMAND

FROM ILLNESS TO INJURY, MRDC PROVIDES RESEARCH AND DEVELOPMENT TO ADDRESS ARMY MEDICAL REQUIREMENTS

ARMY FUTURES COMMAND

FORGE THE FUTURE

FROM PRIVATES TO PHDs

WE ARE
SOLDIERS
CIVILIANS
SCIENTISTS
ENGINEERS
DOCTORS
CODERS
DATA SCIENTISTS/ ARCHITECTS
MEDICAL PROFESSIONALS

26,000 PEOPLE
26 STATES
11 COUNTRIES
5 CONTINENTS

WHERE WE ARE GOING

- Project Convergence (Joint '21, Multi-national '22)
- Soldier Centered Design model
- 2035 AimPoint Force Concept Development
- Assured Position, Navigation, and Timing enhancement
- 9 Research Priority Areas
- Transition Multi-Domain Operations to Doctrine
- Synthetic Training for improved Combat Readiness
- Army Analytical Analysis and Unified Experimentation
- Hypersonic Technology and Mid-Range Fires Capability
- Quantum Technologies, Robotics, Autonomous, and AI
- Army Cloud Migration and MADE
- Team Ignite and Future Studies Program

Talent Management and STEM recruiting

WHO WE ARE

OUR TEAMS

CROSS-FUNCTIONAL TEAMS
8 CFTs ALIGNED AGAINST THE 6 MODERNIZATION PRIORITIES – DELIVERING 31 SIGNATURE SYSTEMS

COMBAT SYSTEMS DIRECTORATE
CSD IS THE FOCAL POINT IN AFC FOR INTEGRATION AND SYNCHRONIZATION WITH ASA(ALT) AND THE 12 PROGRAM EXECUTIVE OFFICES

ARMY APPLICATIONS LAB
ACCELERATES THE DISCOVERY, EVALUATION, & TRANSITION OF DUAL-USE TECHNOLOGY AND BUSINESS PRACTICES FOR AFC

ARTIFICIAL INTELLIGENCE INTEGRATION CENTER
LEADS, INTEGRATES, & SYNCHRONIZES THE ARMY'S AI STRATEGY AND IMPLEMENTATION PLAN

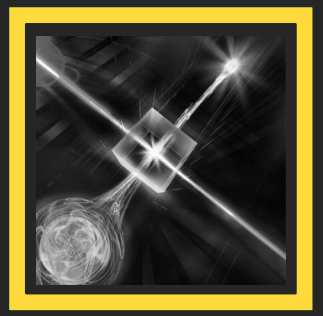
ARMY SOFTWARE FACTORY
INCREASES THE ARMY'S DIGITAL PROFICIENCIES WHILE LEVERAGING AGILE DEVSECOPS PRACTICES AND CLOUD TECHNOLOGIES TO BUILD ORGANIC SOFTWARE

What DEVCOM does

TECHNOLOGY INSERTION

<u>Deliver</u> in support of today's Signature Efforts

TRANSFORMATIONAL



Shape the future with experimental <u>Integrated Capabilities</u>

FOUNDATIONAL

Answer Scientific <u>questions</u> for the future

S&T Investment Areas

DESIGN THINKING and COMPETENCY COHORTS
are key in HOW we do it

DEVCOM ORGANIZATION

U.S. ARMY FUTURES COMMAND COMBAT CAPABILITIES DEVELOPMENT COMMAND

CG DEVCOM

MG Edmond Brown

CSM DEVCOM

CSM Bryan Barker

DCG DEVCOM

BG David Trybula

DtCG DEVCOM

Mr. John S. Willison

S&T Integration Director DEVCOM

Mr. Chris P. Manning

DEVCOM AMERICAS
Forward Element Center
Ft. Sam Houston, TX

DEVCOM ATLANTIC
Forward Element Center
Stuttgart, Germany

DEVCOM PACIFIC
Forward Element Center
Ft. Shafter, HI

Dr. Patrick Baker

DEVCOM – Army Research Lab
Director

Mr. John Hedderich

DEVCOM – Armaments Center
Director

Mr. Jeffery Langhout

DEVCOM – Aviation & Missile Center
Director

Mr. Joseph Welch

DEVCOM – (A) C5ISR Center
Director

Dr. Eric Moore

DEVCOM – Chemical Biological Center
Director

Mr. Douglas Tamilio

DEVCOM – Soldier Center
Director

Mr. Michael Cadieux

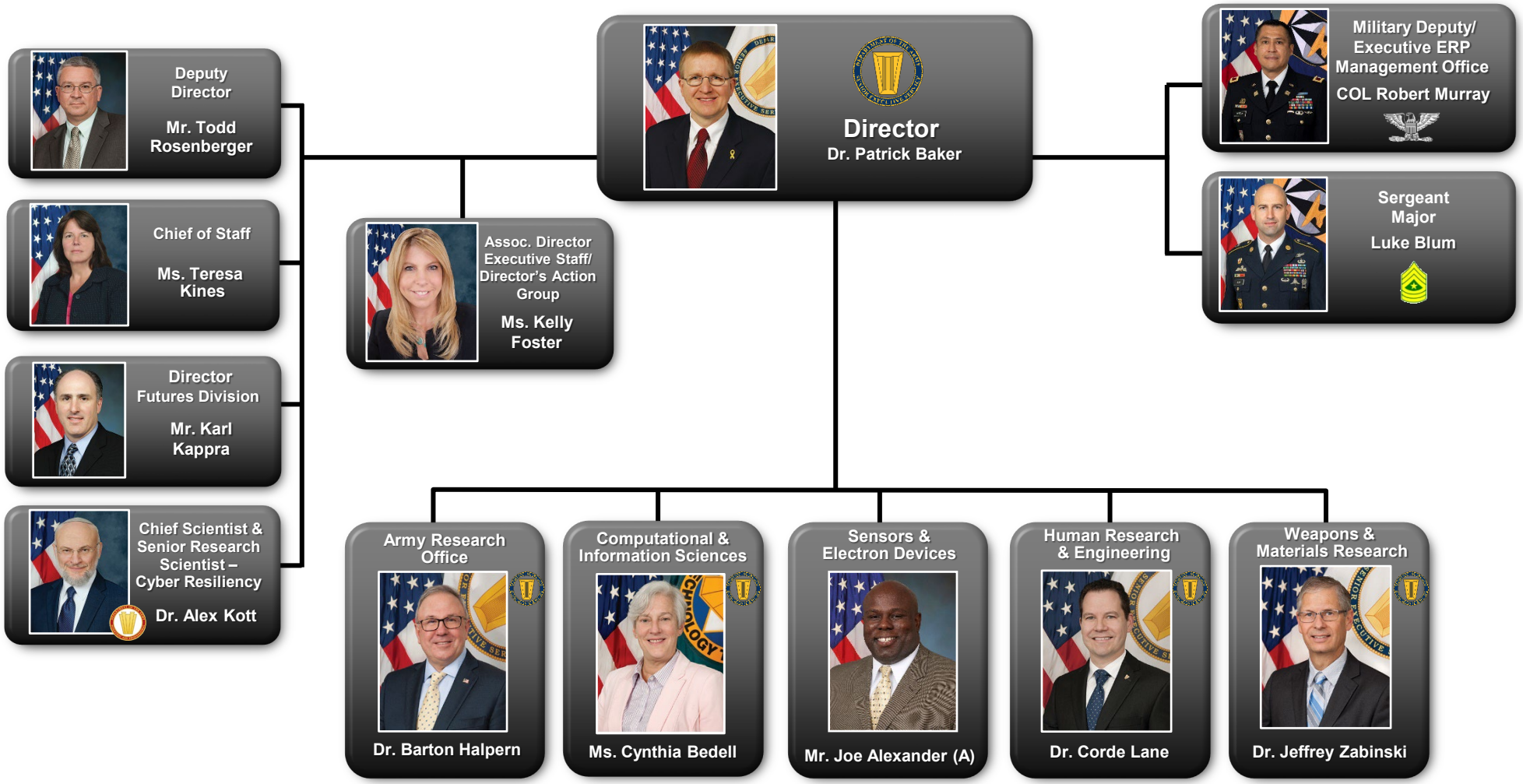
DEVCOM – Ground Vehicle Systems Center
Director

Mr. Patrick O'Neill

DEVCOM – Data & Analysis Center
Director

PREEMINENT LEADERS IN RESEARCH, DEVELOPMENT AND ENGINEERING

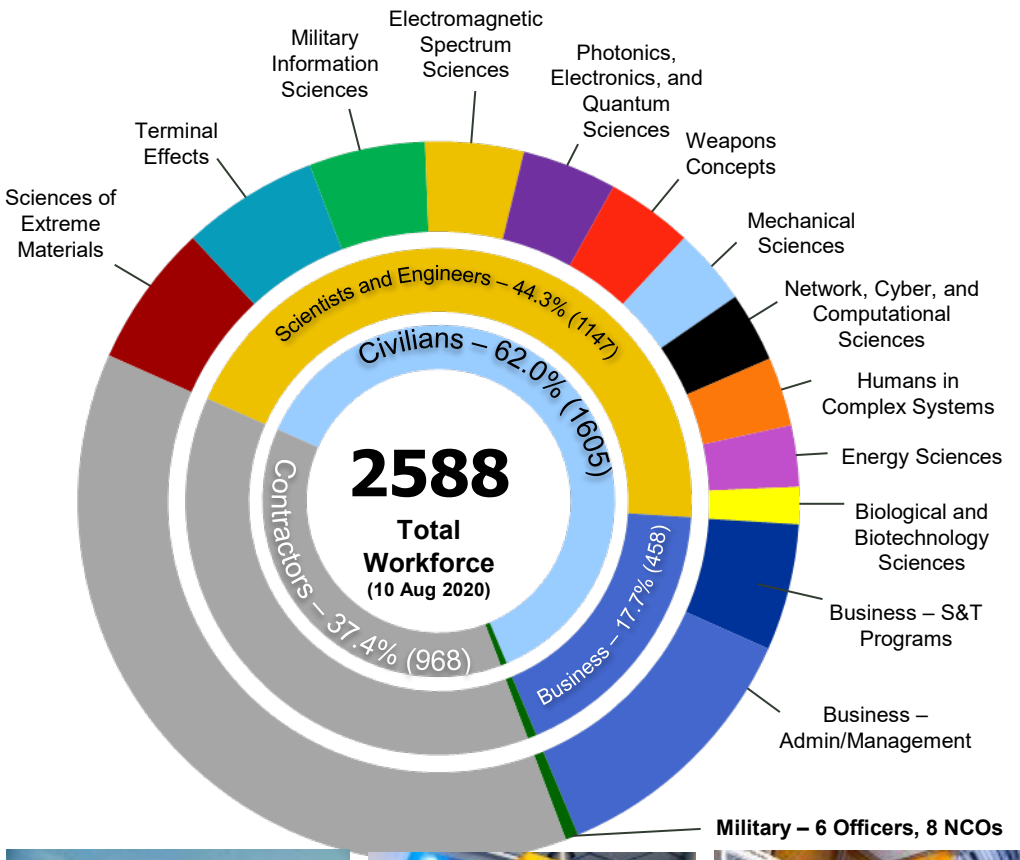
AFC/DEVCOM ARMY RESEARCH LABORATORY



WHO WE ARE

WHO WE ARE: ARL'S PEOPLE AND FACILITIES

People – Diverse Elite Talent

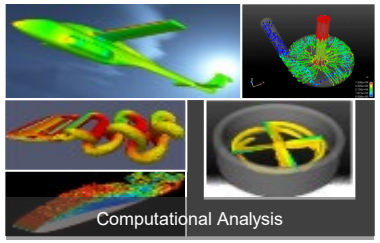



Rodman Materials Research Laboratory


ARL Center for Advanced Polymer Processing (ACAPP) Infrastructure


Synthesis

Facilities – Unique Technical Infrastructure


Computational Analysis


Hover Cage


Network Science Research Laboratory


Information for Mixed Squads (INFORMS) Laboratory


Mechanical Sciences Research Laboratory

Cold Spray Laboratory


Network Science Research Laboratory


Specialty Electronic Materials and Sensors Cleanroom


Next Generation Squad Weapons Development


Energetics Laboratory


Transonic Experimental Facility

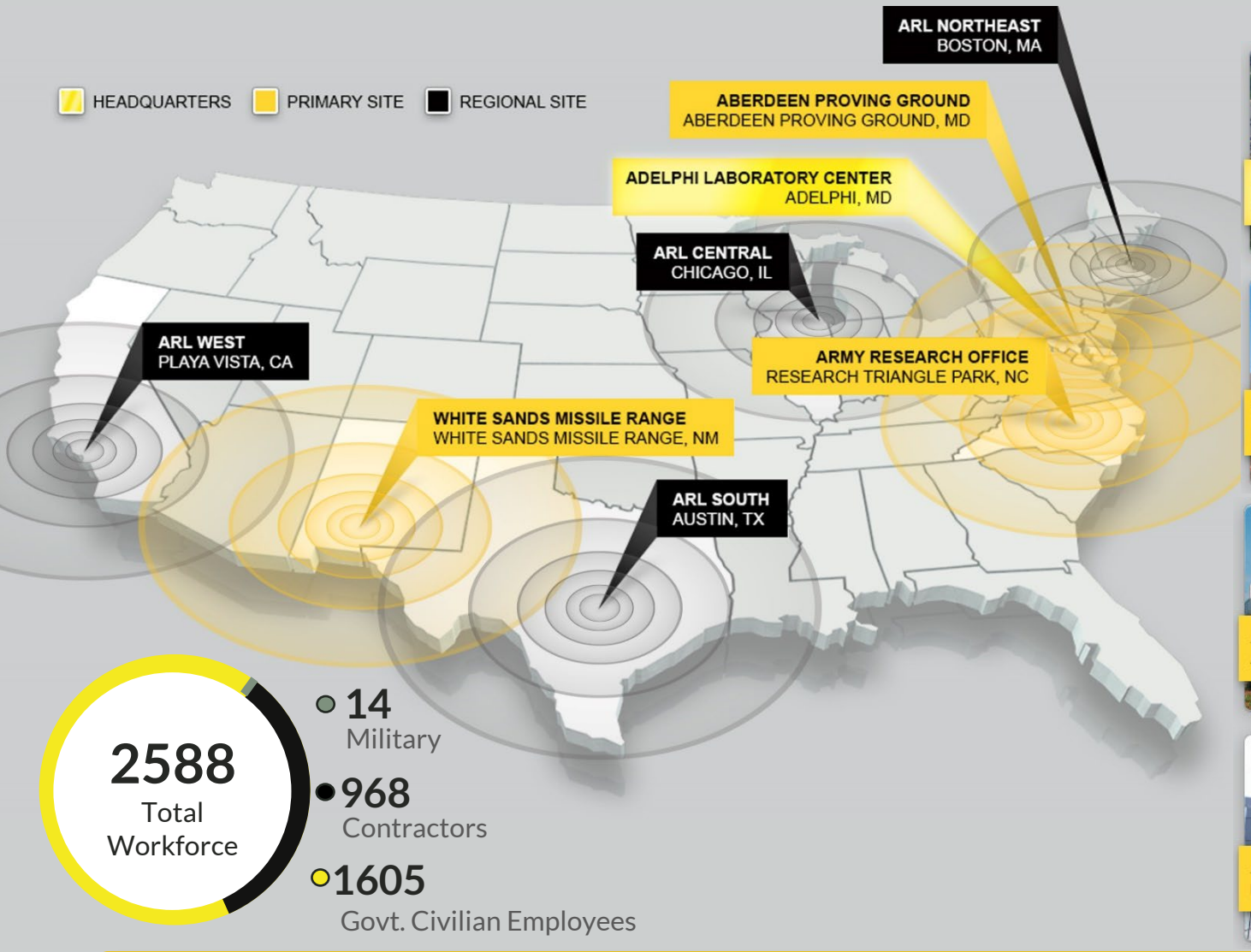

Quantum Network Laboratory


Zahl Physical Sciences Laboratory

Additive Manufacturing Science Center

ARMY RESEARCH LABORATORY

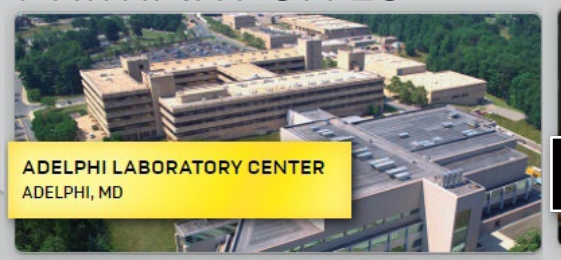
DEVCOM ARMY RESEARCH LABORATORY



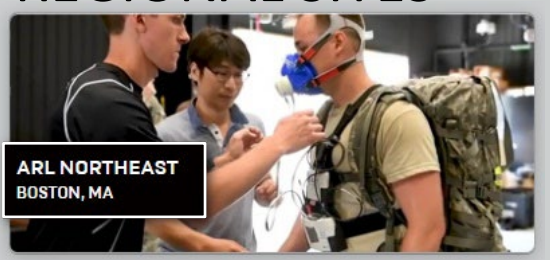
2588 Total Workforce

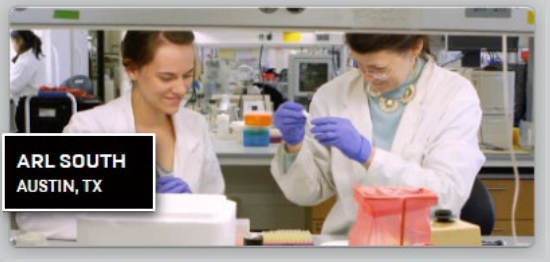
- **14** Military
- **968** Contractors
- **1605** Govt. Civilian Employees

PRIMARY SITES



REGIONAL SITES

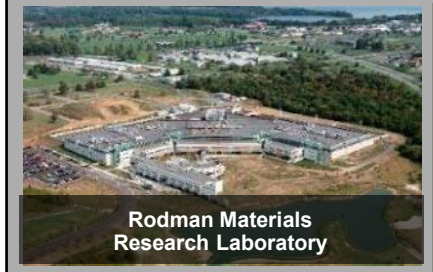


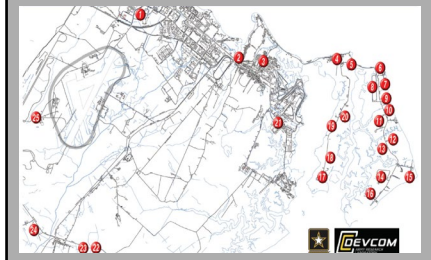


Mission: ***Operationalize Science for Transformational Overmatch***

ARL ARMY-UNIQUE EXPERIMENTAL FACILITIES

Aberdeen Proving Ground


Rodman Materials Research Laboratory

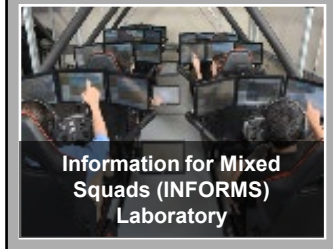


- Human Variability and Behavior
- Human Capability Enhancement
- Integration of Humans and Systems
- Materials and Manufacturing Science
- Soldier and Vehicle Protection
- Battlefield Injury Mechanisms
- Assessment and Analysis Methodologies
- Enhanced Lethality Concepts
- Energy and Propulsion
- Platform Mechanics
- Vehicle Intelligence
- Computational Modeling of Complex Systems
- Real-Time Scalable Data Analytics


ARL Center for Advanced Polymer Processing (ACAPP) Infrastructure

Cold Spray Laboratory


Mechanical Sciences Research Laboratory


Information for Mixed Squads (INFORMS) Laboratory


Transonic Experimental Facility

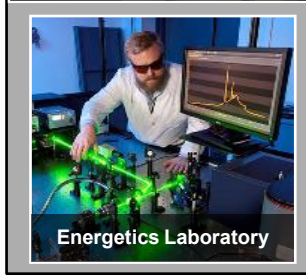

Additive Manufacturing Science Center

Adelphi Laboratory Center


Zahl Physical Sciences Laboratory


Network Science Research Laboratory

- Biotechnology
- Power and Energy
- Electronics
- Photonics
- Cyber Threat Detection and Analysis
- Autonomous Sensing
- Atmospheric Modeling
- Text and Video Analytics
- Sensor and Information Fusion
- Multimodal Sensing and Processing

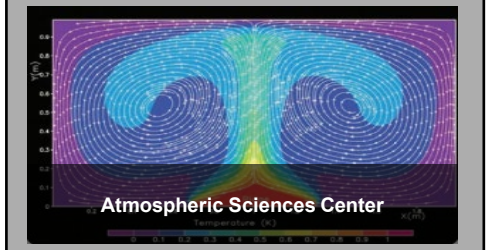

Energetics Laboratory


Specialty Electronic Materials and Sensors Cleanroom


Quantum Network Laboratory

White Sands Missile Range


Mineral Hill


Atmospheric Sciences Center

- Weapons Systems
- Communications & Networks
- Battlespace weather & environmental effects
- Computational science and engineering

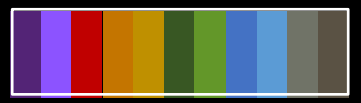
Graces Quarters


Robotics Research Collaboration Campus

A National asset in robotics research:
A 700 Acre collaborative research campus supporting robotics, AI, autonomy, and teaming research for multi-domain operations across land, air, sea, and cyber

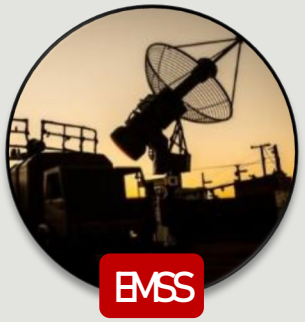
WHAT WE DO

ARL ORGANIZATION ALIGNED BY COMPETENCY

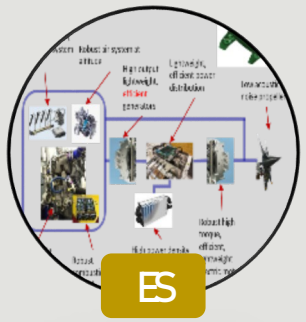
Army Research Office	Computational & Information Sciences	Sensors & Electron Devices	Human Research & Engineering	Weapons & Materials Research
 Dr. Barton Halpern	 Ms. Cynthia Bedell	 Mr. Joseph Alexander (A)	 Dr. Corde Lane	 Dr. Jeffrey Zabinski
 Extramural portfolios aligned to competencies	Network Science & Computational Sciences (NS&CS) Military Information Sciences (MIS)	Competencies Photonics, Electronics & Quantum Sciences (PE&QS) Electromagnetic Spectrum Sciences (EMSS) Energy Sciences (ES)	Humans in Complex Systems (HCxS) Biological and Biotechnology Sciences (BBS)	Weapons Sciences (WS) Sciences of Extreme Materials (SEM) Terminal Effects (TE) Mechanical Sciences (MS)
ALL	AI for Maneuver and Mobility (AIMM) Versatile Tactical Power and Propulsion (VICTOR)	ERPs Foundational Research for EW in Multi-Domain Operations (FREEDOM) Quantum Info. Sciences - Positioning, Navigation, and Timing (QIS-PNT)	Human-Autonomy Teaming (HAT) Transformational Synthetic Biology for Military Environ. (TRANSFORME)	Long Range Distributed & Collaborative Engagements (LRDCE) Emerging Overmatch Technologies (EOT) Physics of Soldier Protection to Defeat Evolving Threats (PSP) Science of Additive Manufacturing for Modular Munitions (SAMM)

ARL COMPETENCIES

Biological and Biotechnology Sciences



Electromagnetic Spectrum Sciences



Energy Sciences

Humans in Complex Systems

Mechanical Sciences

Military Information Sciences

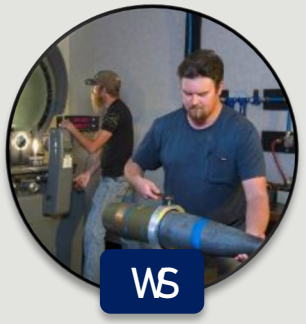
Competencies are the source of all technical work to ensure transformational overmatch

Network, Cyber, and Computational Sciences

Photonics, Electronics, and Quantum Sciences

Sciences of Extreme Materials

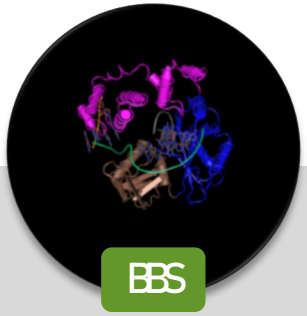
Terminal Effects



Weapons Sciences

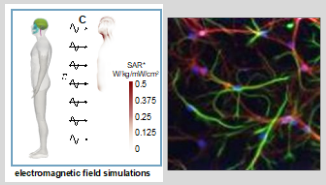
Theory + **Academic Outreach** + **Modeling** + **Experiment** + **Analysis**

ARL COMPETENCIES – FOUNDATIONAL RESEARCH (1/2)

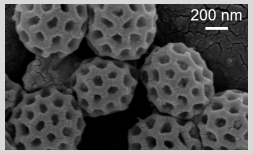


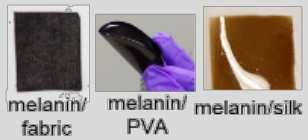
Biological and Biotechnology Sciences

- Advanced bio-effects research

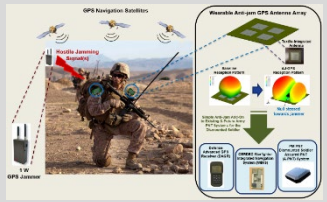


- Foundational synthetic biology, controlled biological synthesis & assembly for materials and sensor platforms



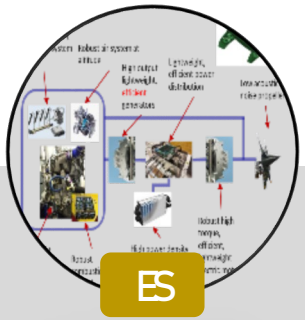


Electromagnetic Spectrum Sciences



- Low-SWaP antenna designs to enhance robustness to GPS jamming
- Next generation RF semiconductor technology for the Army

- Investigating emerging technologies to enable electronic warfare (EW) applications



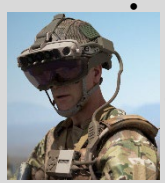
Energy Sciences

- Safe, flexible, damage tolerant, battery technology for Soldier power

- Materials to enable high capacity fast recharge batteries
- Laser protection materials

- Energy supply beyond fossil fuels
- Advanced technologies for wireless power and converting heat into electricity
- Compact light weight electrical power conversion for platform electrification
- Thermal Control

Humans in Complex Systems

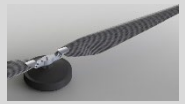


- Improving man-machine team awareness through sensing and integrating Soldier cognition in real-time
- Methods to rapidly reconfigure man-machine teams to meet evolving mission demands

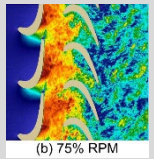
- Soldier-guided machine learning capabilities to out-adapt and out-perform adversaries

Mechanical Sciences

- Improving UAS agility through advanced actuation, design, and controls



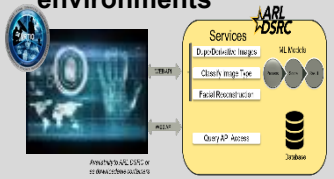
- Data driven approaches for fault detection in vertical lift drive systems; lightweight hybrid gear drives research
- Large-scale modeling of fluid structure interactions to accelerate turbine power developments



Military Information Sciences

- Information representations and machine learning methods for autonomous decision support

- Algorithms for Internet of Things (IoT) phenomena and intelligent systems maneuver in tactical environments

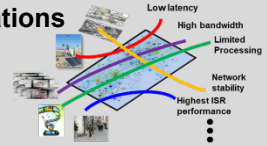


- Information processing infrastructure for actionable intelligence

ARL COMPETENCIES – FOUNDATIONAL RESEARCH (2/2)

Network, Cyber, and Computational Sciences

- Distributed, resilient, secure, networking, and resource-adaptive decentralized computing for multi-domain operations

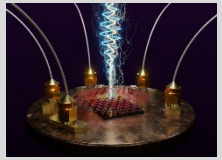


- Methods to protect information in highly mobile, wireless tactical environments

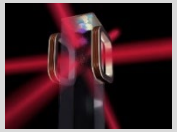
- Physics-Informed Machine Learning for Complex Phenomena

Photonics, Electronics, and Quantum Sciences

- Improved thermal imaging with highly sensitive sensors to microwave radiation



- Novel capabilities needed to yield more accurate, low-SWaP clocks for long holdover in GPS-denied environments

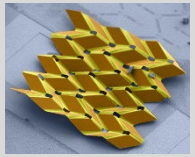


- Sensing to counter adversary camouflage, concealment and deception operations

Sciences of Extreme Materials

- Discover novel building-block materials for disruptive protection

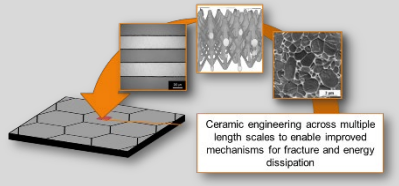
- Design and create new multi-functional and adaptive materials with tunable and extraordinary properties



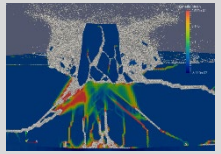
- Explore interactions between materials and intense energy fields (magnetic, electric, pressure, etc.)

Terminal Effects

- New armor mechanisms to defeat advanced projectiles



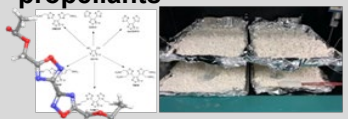
- Experimental and modeling tools that enable armor design and optimization.



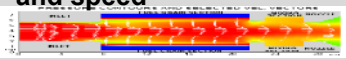
- Advancement of weapon-target interactions to improve munitions effectiveness and efficiency

Weapons Sciences

- Disruptive energetic materials for explosives and propellants

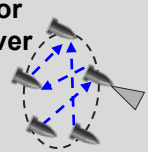


- Novel gun & rocket propulsion tech for improved weapon range and speed



- Aerial systems flight/control/navigation

- Flight and guidance tech for weapon maneuver and assured, collaborative delivery



ARMY PRIORITY RESEARCH AREAS

1 Hypersonic Flight

Aerodynamics, materials, and processes.

2 Quantum

Optimized information transfer, sensing, and communication with unparalleled security.

3 Artificial Intelligence

Increasing speed and agility in which we respond to emerging threats.

4 Autonomy

Maneuverability and off-road mobility of platforms.

5 Synthetic Biology

Reactive and responsive skins/spectrally selective materials/antimateriel properties.

6 Material by Design

Protection overmatch against future threats.

7 Disruptive Energetics

Greater than 2x energetic energy over smaller footprints.

8 Science of Additive Manufacturing

For next generation munitions for increased range and lethality.

9 RF Electronic Materials

Taking advantage of optical and therm… properties of diamond materials for directed energy.

HOW WE TEAM

DEVCOM-ARL PARTNERING & COLLABORATION MECHANISMS

Partnering with Industry, Academia, Army Users, and Government Partners to work on Army relevant problems

Researcher-to-Researcher

Single Investigator Program

Multi-Disciplinary University Research Initiative (MURI)

Collaborative Research Alliances (CRAs)

Historically Black Colleges and Universities/Minority Institutions Program (HBCU/MI)

Educational Partnership Agreements (EPAs)

Cooperative Agreement (CAs)

Other Government Agencies (MOUs, MOAs)

Researcher-to-Soldier

Ignite – Science shaping Concepts, Experimentation / Wargaming / Focus Excursions

Greening and Warfighter Focus/engagement

FAST Program (Field Assist Science and Technology Advisors) across the world

Catalyst Pathfinder

75th Innovation Command – Tech Scouting

Researcher-to-Business

University Affiliated Research Centers (UARC)

Collaborative Technology Alliances

Small Business Innovation Research (SBIR)

Small Business Technology Transfer (STTR)

Army xTech Prize Competition Program

Cooperative Research and Development Agreements (CRADAs)

Patent License Agreements

Test Service Agreements

Software Release Agreements

DoD and Army Manufacturing Technology (ManTech) Programs

DEVCOM Strategic Partnerships Offices provide expert support to create **Tailored Teams**
- right relationship for right problem/opportunity - to accelerate from science, technology, and concepts to **Overmatch** at the **Speed of Relevance**

WIN THE COMPETITION TO "OPERATIONALIZE SCIENCE"

Operationalizing Science for Transformational Overmatch