

UNCLASSIFIED



U.S. Army Research, Development and Engineering Command



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

U.S. Army Research Laboratory

Dr. Alexander Kott

UNCLASSIFIED



U.S. ARMY
RDECOM
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

U.S. Army Research Laboratory

ARL



Mission

Innovative science, technology, and analyses to enable full spectrum operations.

Vision

America's Laboratory for the Army: Many Minds, Many Capabilities, Single Focus on the Soldier



Making today's Army and the next Army obsolete

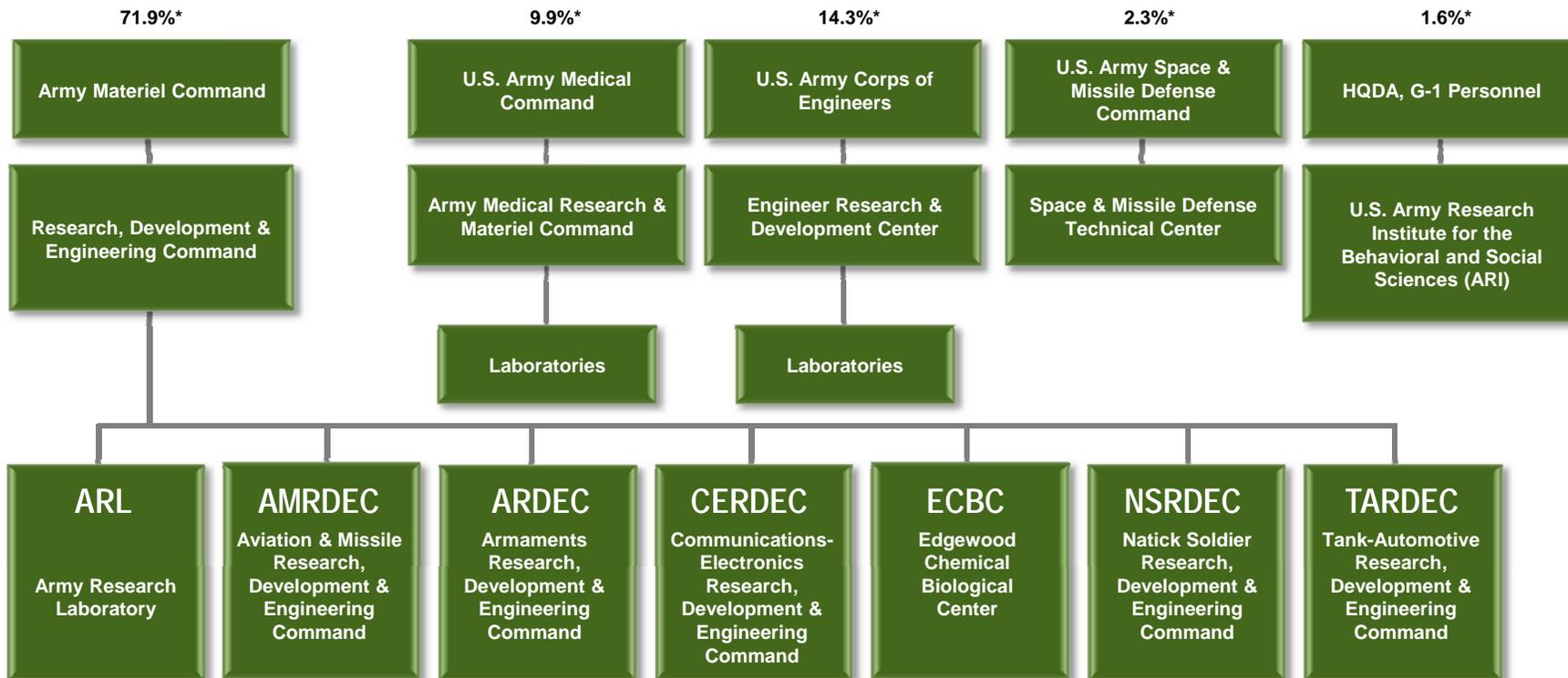
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.



Army S&T Enterprise



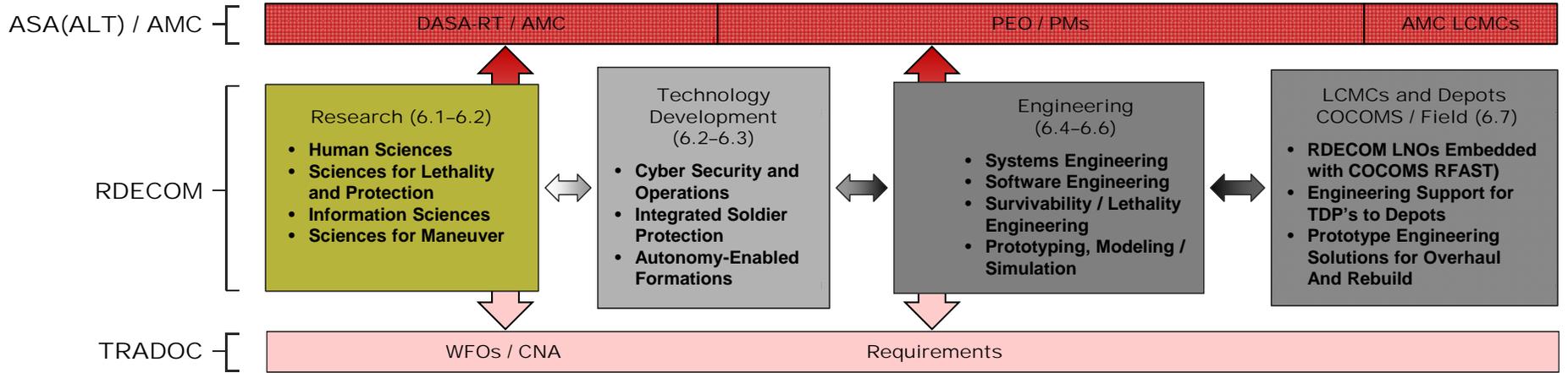
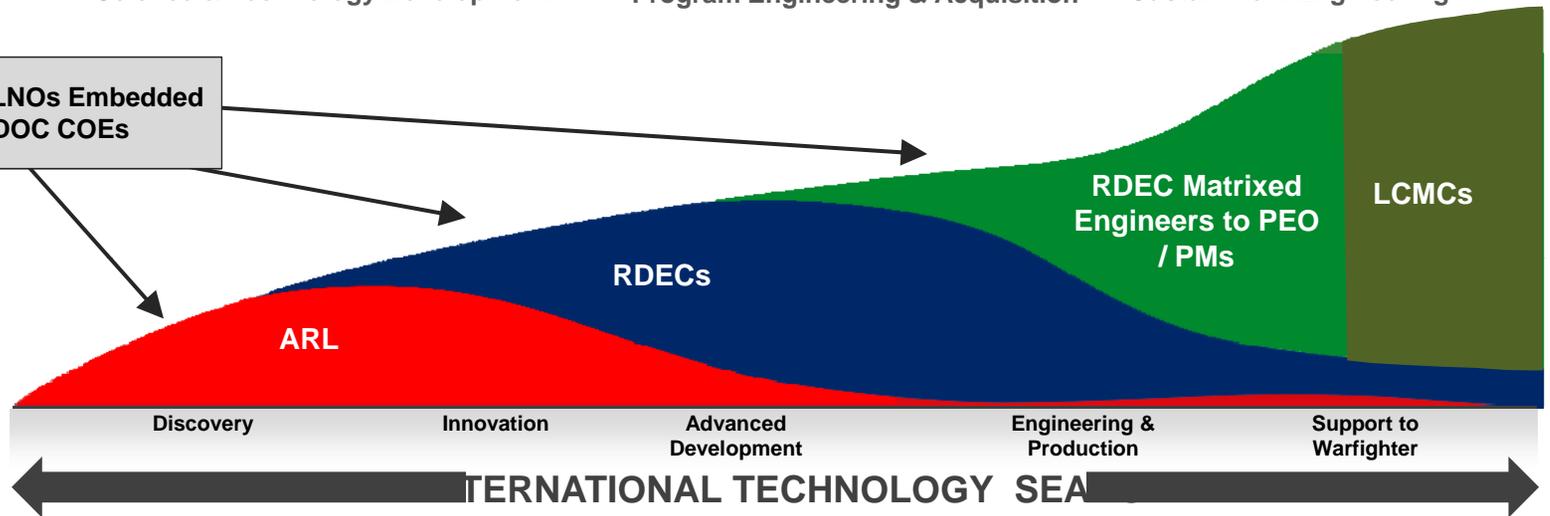
* Percent of S&T core program executed



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.



ARL / RDEC LNOs Embedded in TRADOC COEs



Basic Research: Steering and oversight of the systematic study to increase fundamental knowledge and understanding in physical, engineering, environmental, and life sciences related to long-term national security needs.

Research Areas:

- Chemistry
- Physics
- Life Sciences
- Network Science
- Environmental Sciences
- Materials Sciences
- Mechanical Sciences
- Mathematics
- Computing Science
- Electronics

Partner Exemplars: NIST, NSF, DARPA, AFOSR, ONR, Academia

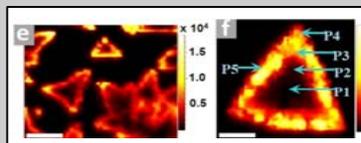
Collaborative Research: Synergistic basic and applied research consortia focused on addressing emerging as well as long-enduring technical challenges of unique Army interest.

Research Areas:

- Nanotechnology (UARC-MIT)
- Biotechnology (UARC-UCSB)
- Training and Simulation (UARC-USC)
- Neuroscience (CTA – DCS Corp)
- Micro Autonomous Systems & Robotics (CTA – BAE GDRS)
- Network Sciences (CTA & ITA – BBN)
- Multi-scale Materials (CRA – JHU & Univ. of Utah)
- Cyber Security (CRA – Penn State)

DISCOVER

Penn State University



Two Dimensional Materials

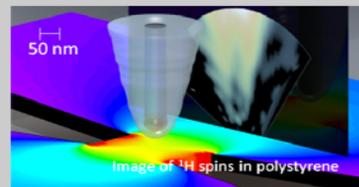
University of Illinois, Urbana-Champaign



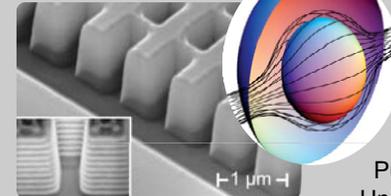
First demonstration of tailored mechanical-to-chemical energy conversion in solid materials

INNOVATE

University of Washington and IBM - Almaden



Single Nuclear Spin Nuclear Magnetic Resonance



Optical Negative Index Metamaterials

Purdue University

TRANSITION

Omni-directional mirror incorporated into hollow core fiber, allowing high-power IR laser guiding

MIT

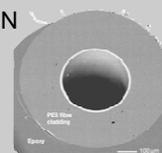


Conventional Mirror



Omnidirectional Mirror

ISN



Madigan Army Research Center, Walter Reed Army Medical Center

OmniGuide, Inc



Human Sciences: Basic research, applied research, and development focused on gaining a fundamental understanding of warfighter performance enhancement, training aids, and man-machine integration.

Key Research Challenges:

- Group Formation and Behaviors
- Cybernetics
- Social Cybernetics
- Human Perception, Physical & Cognitive Performance
- Human Brain Network & Structure Function
- Human Systems Integration Tools and Methods
- Immersive and Adaptive Simulation

Partner Exemplars: ARDEC, AMRDEC, CERDEC, NSRDEC, TARDEC, ARI, MPMC, JIEDDO, PEO-STRI, ICB, ICT, ITA, Network Science CTA, Robotics CTA, Cognition and Neuroergonomics CTA, Carnegie Mellon U, Duke, Georgia Tech, Johns Hopkins, Stanford, UCSD, UCF, Alion, DAS, UK, Germany, Taiwan, Italy...

DISCOVER



Virtual Humans Interacting Realistically (ICT)



Brain-based "Neurotechnologies"

INNOVATE

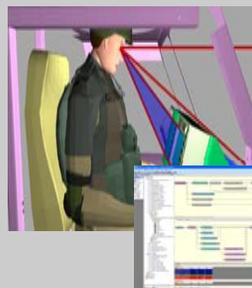


Measures of Interacting Physical and Cognitive Burden



Quantifying Network Performance of Commanders & Collaborative Teams

TRANSITION



Human Systems Integration Modeling Tools



Mobile Counter IED Trainer (MCIT) (ICT)

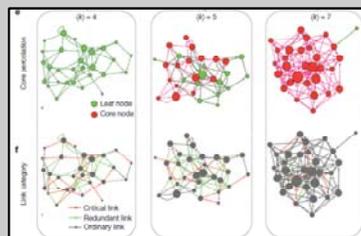
Information Sciences: Basic research and applied research focused on gaining a fundamental understanding of information generation, collection, assurance, distribution, and exploitation.

Key Research Challenges:

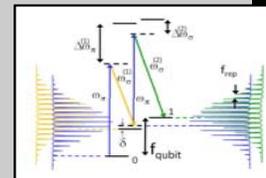
- Cyber Offense and Defense
- Quantum Information Science
- Hybrid Device & Component Physics
- Electronic Warfare & Directed Energy
- Communication Science
- Information at Tactical Edge

Partner Exemplars: CERDEC, NSRDEC, UMD, UPenn, UIUC, RPI, UDel, IBM, Raytheon/BBN, IARPA, DARPA, SOCOM, USCYBERCOM

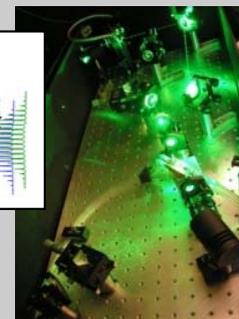
DISCOVER



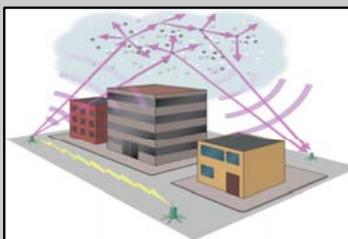
Control of Complex Networks
 NS CTA - Northeastern



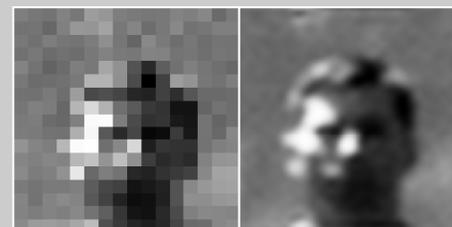
Atom Spintronics



INNOVATE



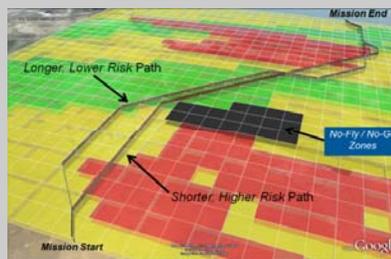
Ultraviolet Communications



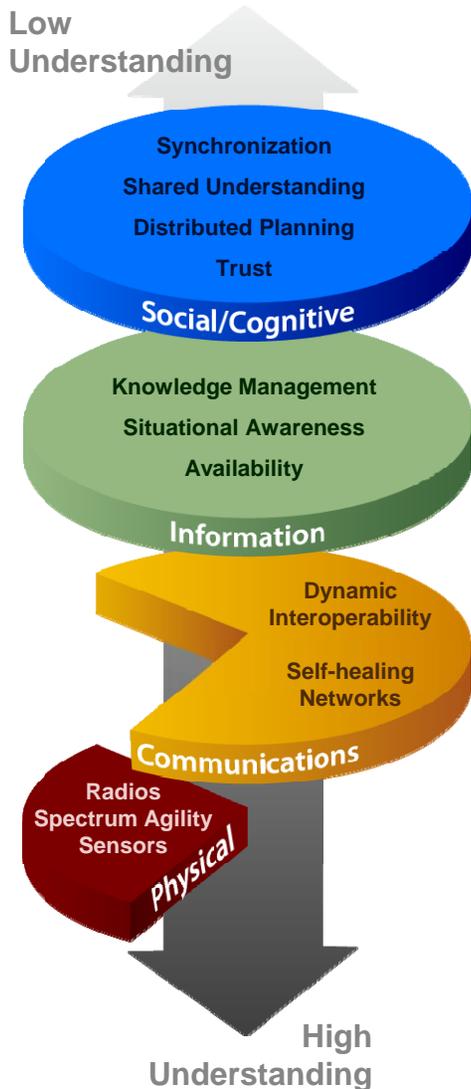
Super-resolution Imaging

TRANSITION

MyWIDA



UTAMS
 Affordable Mortar & Rocket Localization (PM RUS)



Collaborators

In-House

Network Science CTA

BBN Technologies, Pennsylvania State Univ., U. Illinois-Urbana Champaign, Rensselaer Polytechnic Univ., UC Riverside, CUNY, U. Delaware, U. Southern California, UC Santa Barbara, UC Davis, UC Santa Cruz, Northeastern Univ., IBM, ArtisTech

- Human Cognition & Decision Making in Networks
- Composite Trust
- Sociotechnical Network Operations
- Network-Enabled Cognition

HRED/CISD

Network and Information Science ITA

UK: Cranfield Univ., Imperial College, Royal Holloway Univ. of London, U. Aberdeen, U. Cambridge, U. Southampton, U. York, Cardiff Univ., IBM UK, Logica CMG, Roke Manor Research, Systems Engineering & Assessment

- Info Protection, Delivery, and Fusion in Wireless Networks

SEDD/CISD

US: Carnegie Mellon Univ., CUNY, Columbia Univ., Pennsylvania State Univ., Rensselaer Polytechnic Univ., UCLA, U. Maryland, U. Massachusetts, BBNT Solutions, Boeing, Honeywell, IBM Research Associates

- QoI-Aware Hybrid Networking
- Wireless Emulation for Mobile Ad Hoc Networks (MANETs)
- Mobile Network Modeling Institute

SEDD/CISD

Army High Performance Computing Research Center

Stanford Univ.

Institute for Collaborative Biotechnologies (ICB) UARC

UC Santa Barbara, Caltech, MIT

- Dynamic Networks
- Cognitive Radio for Intelligent Networking

CISD

ARO MURIs and SI Programs

Ballistics Science: Basic and applied research focused on gaining a fundamental understanding of emerging technologies that support weapon systems, protection systems, and injury mechanisms affecting the warfighter.

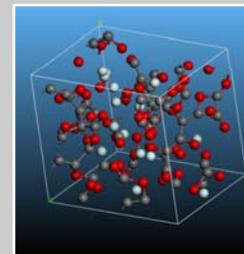
Key Research Challenges:

- Ballistics – Interior , Exterior & Terminal
- Scalable Effects
- Protection – Armor, EM, APS, Blast, Platform Structures
- Cyber and Electronic Warfare
- Injury Biomechanics
- High Strength, Ultra Light Materials

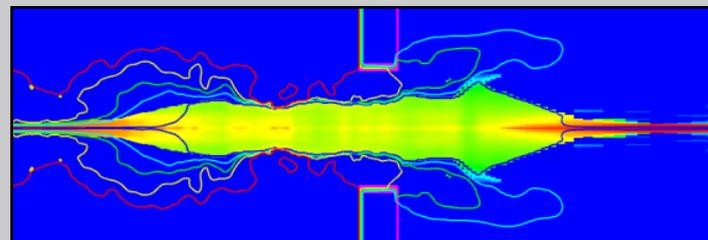
Partner Exemplars: ARDEC, TARDEC, AMRDEC, Sandia National Laboratories, United Kingdom DSTL, BAE Systems, Lawrence Livermore National Laboratory, Australian Defence Science and Technology Organization, University of Maryland, Johns Hopkins University...

DISCOVER

Poly-CO, a future energetic material with an estimated power of 7 X RDX



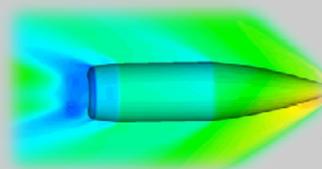
INNOVATE



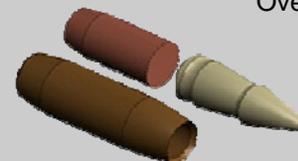
Fundamental failure mechanisms for future armor development

TRANSITION

M855A1 Enhanced Performance Round
 Over 5 million rounds shipped to theater



ARL



ARL, ARDEC, ATK, PM MAS

Materials Science: Basic research and applied research focused on gaining a fundamental understanding of structural, electronic, photonic, and energy materials & devices.

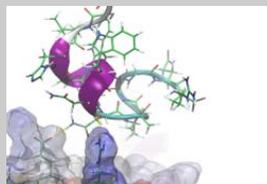
Key Research Challenges:

- Materials in Extreme Environments
- High Field Responsive Materials
- Hierarchical Designed & Fabricated Materials
- Semiconductor Materials & Devices
- Generation After Next Electronics
- Biological Sciences
- Transformational Optics

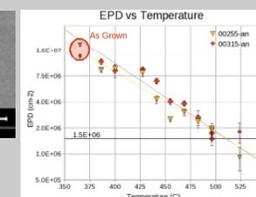
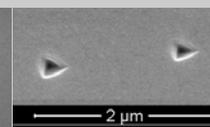
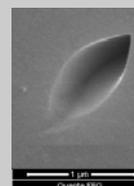
Partner Exemplars: CERDEC, ECBC, TARDEC, NSRDEC, ARDEC, AMRDEC, DARPA, Dept of Energy, PEO-Soldier, PEO-IEW&S, PEO-Ground Combat Systems, PEO-Chemical & Biological Defense, PEO-Ammunition, SERDP, SOCOM, JIEDDO, DTRA

DISCOVER

Understanding IR Material Defects

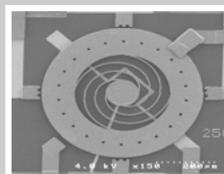


Bio-physical Modeling



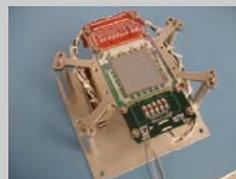
INNOVATE

MEMS TBI Sensor

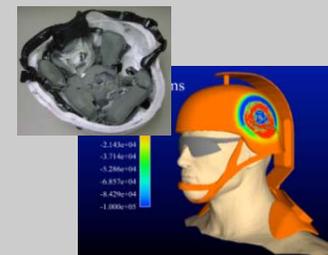


Through Thickness Ceramic Tile Reinforcement

TRANSITION



C-QWIP IR Detector Production line @ L3



Concurrent Design & Processing – Enhanced Combat Helmet Production

METHODOLOGY DEVELOPMENT

Assessment and Analysis:

Development and application of analytical tools and methodologies to quantitatively assess the military utility of Army, DoD, and select foreign combat systems.

Technical Challenges:

- Ballistic Effectiveness
- Personnel Armor Susceptibility
- Platform Armor Susceptibility
- Information Systems Vulnerability
- System of System Analyses
- Human Performance Enhancement Assessment

Partner exemplars: ATEC, PEOs and PMs, AMSAA and other analysis agencies, RDECs, MRMC

ARL conducted a series of experiments that uncovered the nature of Li-ion batteries' fire hazards—which can be lethal within seconds—and quantified their extent.

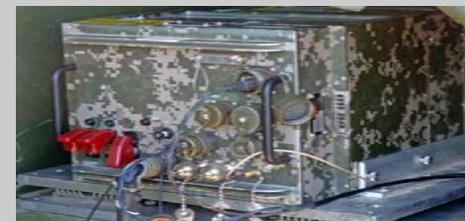


INNOVATE



QRC-335 (400) pod

Optimized Modular EW Network (OMEN)



TRANSITION

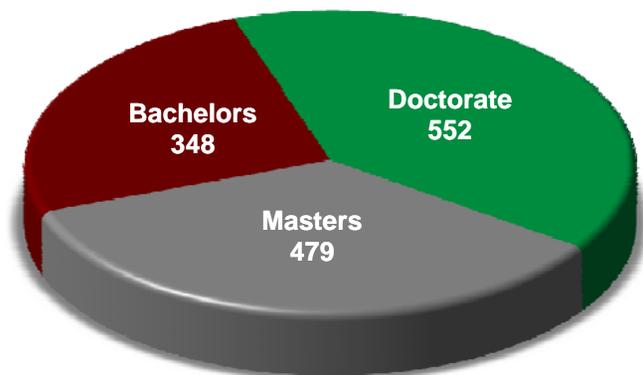


ARL SMEs observed soldiers to assess protection, detection, reaction, restoration

At NIE, ARL analyzed hardware, assessed units' cyber defense posture, performed penetration testing, & recommended mitigations.



S&E Degree Distribution



Civilians

Total	1980
S&E	1379

Military

Officer	17
Enlisted	21

Contractors

Full-Time	1027
Part-Time	53

309	Electrical/Electronics Engineers
197	Mechanical Engineers
193	Physicists/Physical Scientists
165	Computer Scientists/Engineers
99	General/Industrial Engineers
92	Chemical Engineers/Chemists
79	Materials Engineers
58	Engineering Psychologists
47	Aerospace Engineers
45	Operations Research Analysts
40	Mathematicians/Statisticians
15	Meteorologists
10	Neuroscientists
10	Biologists
7	Biomedical Engineer
13	Other
210	E&S Technicians
90	Post-Docs



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ARL

BACKUP

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.



The Honorable Heidi Shyu, Assistant Secretary of the Army for Acquisition, Logistics, and Technology, and ARL's Mr. Ronald E. Meyers on acceptance of Thomas Reuters Top 100 Innovator's Award.

Thompson-Reuters 2012 "Top 100 Global Innovators"

Army R & D Lab of the Year - 2004 & 2006

Army R & D Collaboration Award – 2003, 2006, 2008 (4)

11 (of 80) Army's Greatest Inventions Awards

82 (of 351) Army RDA Awards 2004 – 2011

3 Wilbur Payne Awards for Best Army Analysis

NATO Scientific Achievement Award

10 Presidential Rank Awards

2 Vice-Presidential Hammer Awards (Pay for Performance & Fed Lab)

Presidential Early Career Award for Scientists & Engineers

SPIE President's Award

3 IEEE Awards – Harry Diamond, Hans Karlsson, & Peter Mark

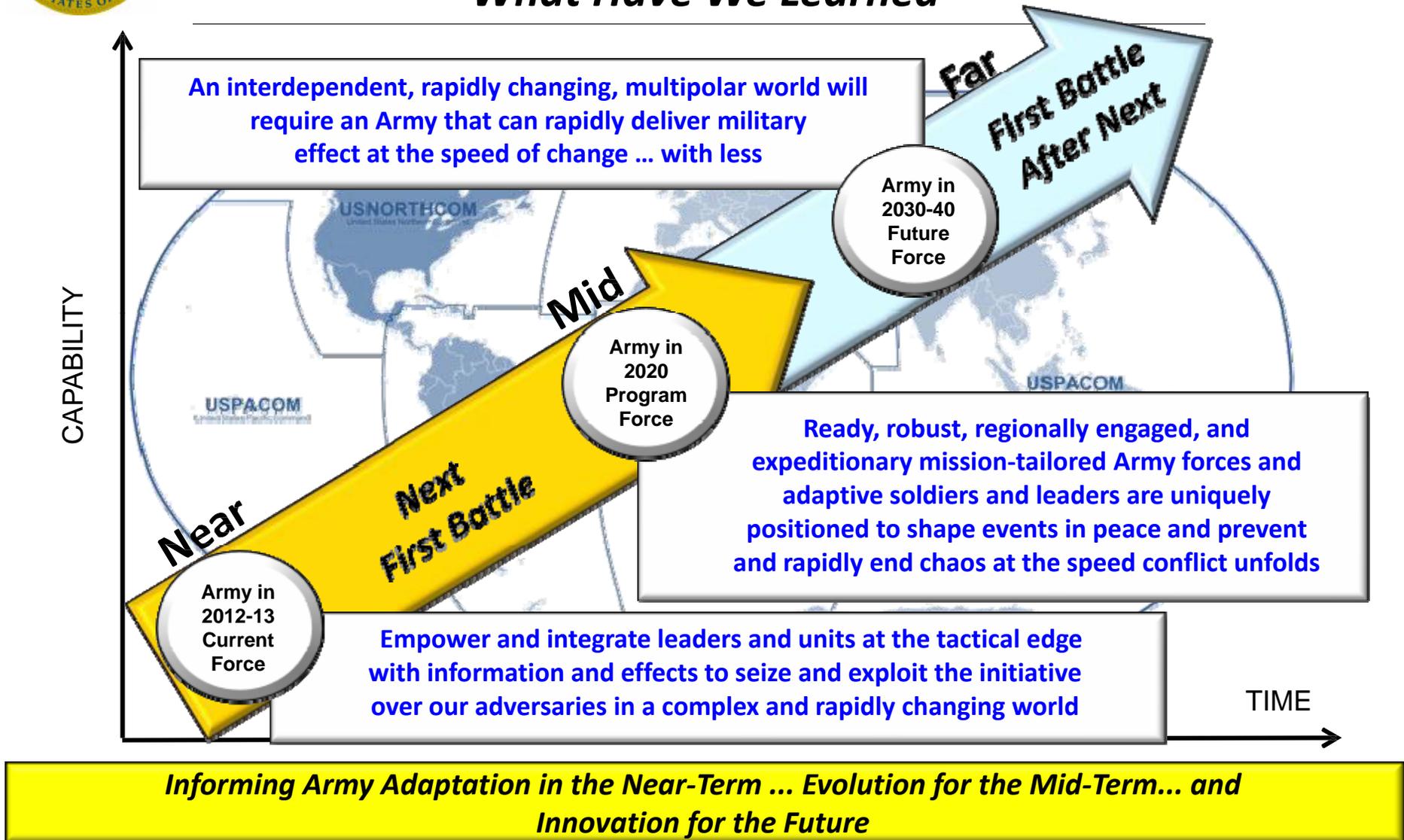
American Helicopter Society – Howard Hughes Award

62 Fellows in Professional Technical Societies

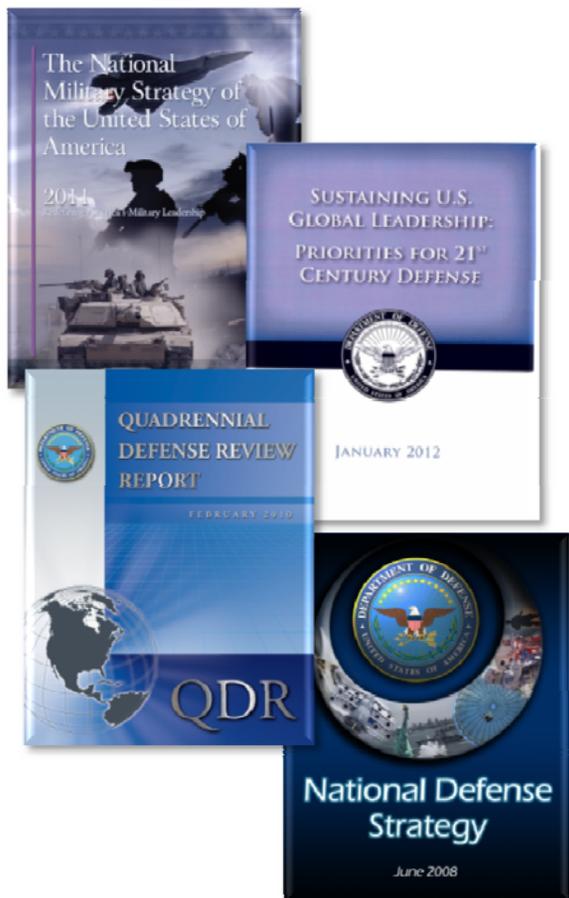


Army Campaign of Learning

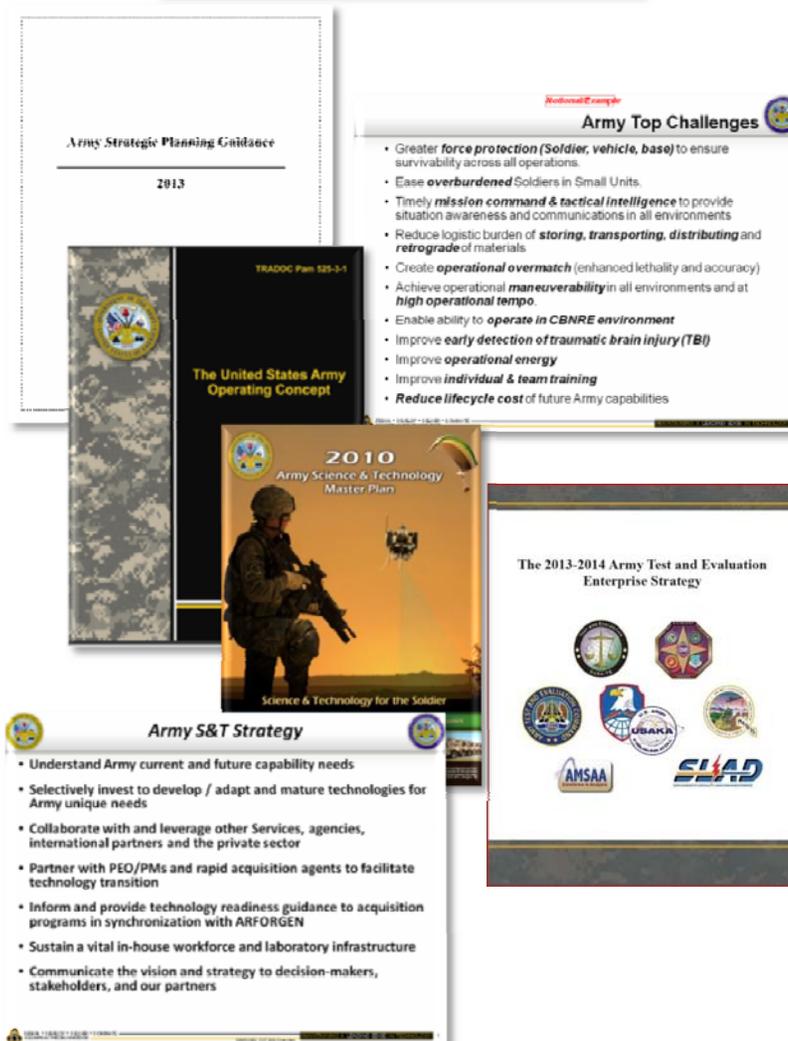
What Have We Learned



DoD Guidance and Priorities



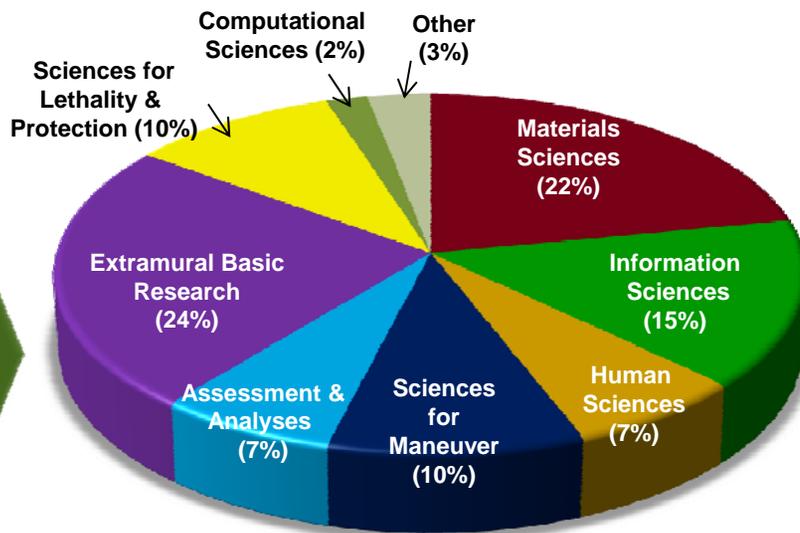
Army Guidance and Priorities



- 6.1 \$294M
- 6.2 \$284M
- 6.3 \$20M
- 6.6 \$53M
- 6.7 \$12M
- SBIR/STTR \$29M
- Reimbursable \$313M
- PEOs/PMs \$37M
- DARPA \$198M
- Other \$23M

FY13 Funding *

* Excluding \$668M Direct Cite



ARL S&T Campaigns

\$1,263M

- Academia (URI, SI) \$149M
- UARCs \$44M
- Collaborative Alliances \$65M
- In-House \$538M
- SBIR/STTR \$29M
- OGA's \$72M
- Industry \$366M