MISSION: Identify, develop and demonstrate technology options that inform and enable effective and affordable capabilities for the Soldier

VISION: Providing Soldiers with the technology to Win

Current Force

Enabling the Future Force

未来的军队

Future Force

Deployable Force Protection Adaptive

Red Team

Advanced Rotary Wing Aerial Delivery

Sling Load Net

Autonomous Mobility Appliqué System

Video from Unmanned Aerial Systems

Cyber tools

Next Generation Rotorcraft

Neuroscience

High Energy Lasers

Combat Vehicle Prototyping
Roles of Science and Technology

S&T's Impact on Technology Maturation

Technology Maturity

Quick Reaction

Innovate Technology Options TRL 4-6

Investigate Technologies TRL 3-5

Fundamental/Disruptive Technologies TRL 1-3

1-2 Years

Experimental Prototyping & Improve Current Systems
- Drive Down Technical Risk
- Inform Achievable Requirements

2-4 Years

Manned-Unmanned Teaming

High Energy Laser – Tactical Vehicle Demonstrator

Joint Multi-Role Technology Demonstrator

4-8 years

Innovate Technology Options
Advanced Development Research

INNOVATE

6-15 years

Investigate Technology
Applied Research

INNOVATE

10-30 years

Fundamental Research
Basic and Early Applied Research

DISCOVER

Quick Reaction

Prototyping and Improving Current Systems TRL 6/7

Technology Maturity

Near

Mid

Far

Technology Frame

1-2 Years

2-4 Years

4-8 years

6-15 years

10-30 years

Time

S&T's Impact on Technology Maturation

Technology Maturity

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Time
Army Investments by Portfolio
FY17: $2.4B*

**Soldier/Squad**
Personnel, Training, Human System Integration, Dismounted mission equipment and power & energy

**Air**
Advanced Air Vehicles; Unmanned Aerial Systems; Manned/Unmanned Teaming

**Medical**
Combat Casualty Care, Infectious Disease mitigation, clinical/rehabilitative medicine

**Innovation Enablers**
High Performance Computing; Environmental Protection; Base Protection; Studies; Technical Maturation Initiatives; Procurement

**Lethality**
Offensive/Defensive kinetic (guns, missiles), Soldier Weapons, Directed Energy (HEL) weapons

**Ground Maneuver**
Combat/tactical ground platforms/survivability; unmanned ground systems; austere entry; power & energy

**Basic Research**
Materials Science; Medical/Life Sciences; Quantum/Info Science; Autonomy; Networks

**C3I**
Secure Comms-on-the-Move; Cyber/EW; Sensors; Cyber; RF Hardware/Software Convergence; Assured PNT

**Army Investments FY17**
- **BA1** $429M
- **BA2** $908M
- **BA3** $930M
- **BA4** $70M
- **BA6** $37M
- **BA7** $62M

*Does not include $59M Procurement As of PB17

DESIGN • DEVELOP • DELIVER • DOMINATE
SOLDIERS AS THE DECISIVE EDGE

MAINTAINING A LEADING EDGE IN TECHNOLOGY

Approved: Distribution A – 18 April 2017
Priority Investment Areas

- Army S&T Portfolio focus towards acceleration of priority technologies

- Priority technologies include:
  - Capability Enablers for 2026 and beyond
  - Decide Faster
  - Manned-Unmanned Teaming
  - Asymmetric Vision
  - Survive and Project Indirect Fires
  - Chief of Staff of the Army (CSA) Priorities

<table>
<thead>
<tr>
<th>CSA Priorities</th>
<th>New Combat Vehicle</th>
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</thead>
<tbody>
<tr>
<td>Armor</td>
<td></td>
</tr>
<tr>
<td>Future Vertical Lift</td>
<td>Aviation Protection</td>
</tr>
<tr>
<td>Infantry Support Technology</td>
<td>Networks</td>
</tr>
<tr>
<td>Autonomy</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>Cyber/Electronic Warfare</td>
<td>Additive Manufacturing</td>
</tr>
<tr>
<td>Assured PNT</td>
<td>Robotics</td>
</tr>
<tr>
<td>Air &amp; Missile Defense</td>
<td></td>
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</tbody>
</table>
A cross-domain offensive capability (Sword) and a mobile, organic, Anti-Access/Area Denial (A2/AD) defensive capability (Shield), underpinned by Manned-Unmanned Teaming, to achieve operational dominance in the future.

**Manned-Unmanned Teaming**

(Enhanced Mobility)

**Asymmetric Vision**

(Improved Situational Understanding)

**Decide Faster**

(High Operational Tempo)

**Seek out and destroy enemy elements in dense urban terrain**

**Seize and control key terrain**

**Support partner forces**

**Defend populations**
Mannned-Unmanned Teaming S&T Concept

MUM-T focuses on teams of manned and unmanned, autonomous vehicles, working in concert with mounted and dismounted forces
- To sense, close with, and destroy enemy elements
- Influence populations
- Seize and occupy terrain

Example Technology Areas
- Unmanned Ground Vehicles (UGV)
- Unmanned Air Vehicles (UAV)
- Command-and-Control (C2)
- Networks
- Communications
- Reliable PNT
- Soldier Interface
- Lethality
- Manned Vehicles
- Cyber Protection
- UGV/UAV Self Protection
Purpose:
Develop and demonstrate the effectiveness of MUM-T across multiple operational scenarios:
• Soldier use of micro Unmanned Ground Vehicle (UGV) / Unmanned Aerial System (UAS)
• Dismounted maneuver supported by multi-mission UGV
• Armed UGV wingman operating with manned vehicle
• UGV/UAS teaming to extend Brigade Combat Team Autonomous Ground Resupply operations

Products:
• Unmanned Systems capable of effectively maneuvering and operating as parts of a manned/unmanned team
• C3 suitable to enable effective MUM-T operations
• Unmanned/Manned vehicle operation in cyber environment
• Mature UGV/Warfighter-born products (architectures, hardware & software) for transition to programs of record
Air Portfolio
Unmanned &optionally Manned Systems

Near-term Goals:
- Improve autonomous behaviors for manned/unmanned teaming
- Human/machine interface for multi-UAS control
- Improve capabilities of electro-optical/infrared payloads
- Autonomous high speed control of small UAS systems for combined air-ground operations

Mid/Far-term Goals:
- Enable combined mission execution for unmanned and manned system teaming
- Investigate autonomous behaviors, swarm technologies, perception, and human aiding using UAS
- Novel designs, flow control, and kinematics for low Reynold’s number winged micro-UAS
Asymmetric Vision aims to regain situational awareness (SA) through the use of unmanned systems to operate in urban canyons with 3-D threats, and dense and mixed Red/Grey populace.

Example Technology Areas
- Multi-spectral persistent ISR / Unmanned Formations
- Counter Tactical Surveillance and Targeting
- Integrated Visual Ensemble
- Urban Sensing for Dismounted and Mounted Ops.
Active cyber defense supported by algorithms, methods, tools, and techniques to provide Soldiers with the ability to monitor, detect, predict, and prevent attacks; minimize vulnerabilities; and defeat exploitation attempts

Program Will Provide:

- Novel detection methods and advanced analysis tools that provide ability to respond to increasingly complex cyber threats and to minimize their impact on friendly systems
- Intrusion detection systems optimized with anomaly-based techniques

Warfighter Payoff:

- Resilient and secure communications across the battlefield enabled through robust networks
- Rapidly deployable and configurable intrusion detection methods and tools
Decide Faster S&T Concept

Decide Faster focuses on overwhelming an adversary’s C2 and OPTEMPO by leveraging advanced processing, exploitation & dissemination technologies, coupled with intuitive targeting and enhanced assured mobility.

Example Technology Areas:
- Augmented Reality Situational Awareness and Targeting
- Small Unit Leader Precision Targeting
- Integrated Sensor Architecture (ISA)
- 3D Enriched Urban Terrain Visualization
- Advanced Training and Simulation technologies
- Wearable Devices
- Soldier-Optimized Performance
**Purpose:**
Innovations in human-computer interactions supporting collaboration between humans and between human and machines

**Products:**
- Methods and algorithms for robust, individualized interface technologies that enable novel Soldiers Systems that adapt to the changing environment
- Machine learning algorithms that can identify, account for and adapt to individual differences as well as human variability over time and across tasks
- Highly adaptive neural classification algorithms that are robust to changes in underlying human variability
Basic Research

Human System Integration (Cybernetics)

Advance the principles and capabilities needed for next-generation Soldier-system interactions

Program Will Provide:

- Cybernetic models of human-system closed-loop behavior
- Design guidelines and algorithms
- Proof-of-concept systems and test-bed platforms for rapid integration and testing

Warfighter Payoff:

- Improved Soldier-system performance including tighter control, more effective communication, and more decisive action
- Enhanced Soldier-system capabilities to adapt effectively to increasing operational complexity
- Address Army Warfighting Challenges including improving Soldier, leader, and team performance

Decide Faster
Survive and Project Indirect Fires

Enables protection of friendly forces during maneuver operations

Example Technology Areas:
- Precision & Cooperative Weapons in Denied Env.
- Missile Multiple Simultaneous Engagement Tech
- Accurate Rapid Controlled Hybrid Effects Round
- Advanced Energetics & Warheads
Army S&T Enterprise—Research, Development & Engineering Centers (RDEC) & Labs

- 16 Army labs within 5 Army S&T Commands
- Approximately 13,000 Army Civilian Scientists and Engineers
  - 45% Bachelors Degree
  - 40% Masters Degree
  - 15% Doctorate Degree

- ERDC – Army Aeroflight Dynamics Directorate
- ECBC – West Desert Test Center – Life Science Division
- ARL – Aeromedical Research Lab
- ERDC Construction Engineering Research Lab
- ARL – Army Research Office
- Army Research Lab (ARL)
- ERDC Cold Regions Research & Engineering Lab
- Natick Soldier RDEC
- Armament RDEC
- Edgewood Chem Bio Center
- Research Institute of Environmental Medicine
- Research Institute of Infectious Disease
- Walter Reed Army Institute of Research
- ERDC Geospatial Research Laboratory
- ARL – Simulation & Training Technology Center
- Research Institute of Chemical Defense
- Army Research Institute for the Behavioral & Social Sciences
- Communications-Electronics RDEC
- ERDC Geospatial Research Laboratory

U.S. Army Materiel Command
U.S. Army Medical Command
U.S. Army Corps of Engineers
U.S. Army Space and Missile Defense Command
Headquarters, Department of the Army, G-1

S&T Commands

Research Institute of Infectious Disease
ERDC Geospatial Research Laboratory
Arl – Army Research Office
ARL – Simulation & Training Technology Center
Army Research Institute for the Behavioral & Social Sciences
Communications-Electronics RDEC

MAINTAINING A LEADING EDGE IN TECHNOLOGY

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Open Campus Initiative

Past: Current Defense Laboratory Model

Gates and high walls provide 20th century security, but are barriers to 21st century innovation.

Defense laboratories relatively unchanged since inception (NRL 1923)

Present & Future: Open Campus Initiative

Reduction in barriers to facilitate collaboration with academia, industry, and small business.

- Less bureaucracy and paperwork
- Open areas for researchers and access to existing facilities
- Collaboration between ARL and external scientists
- Career path for students and scientists
- Hub and Spoke Model
- Collaborator presence through EUL
- Novel staff opportunities

An enhanced defense research environment that fosters discovery and innovation through collaboration on fundamental research.
Developing a Hub and Spoke S&T Global Network

ARL - Aberdeen Proving Ground
ARL - Adelphi Laboratory Center (Headquarters)
CRA - Cyber Security Research Alliance
ISN - Stanford, CA
CTA - Network Sciences
CTA - Micro Autonomous Systems and Technology (MAST)
CTA - Robotics
CTA - Cognition & Neuroergonomics

ARL South
Austin, TX

ARL Central
Advanced Photon Source
Old Main State College, PA

ARO London

ARO Tokyo

Electronic Materials
Salt Lake City, Utah

ICB - Santa Barbara, CA

Los Angeles, CA
ARL West

White Sands Missile Range

ARL Primary Labs Site
ARL Field Element
Collaborative Alliances
Open Campus Hub
Collaboration Spoke
International Hub

DESIGN • DEVELOP • DELIVER • DOMINATE
SOLDIERS AS THE DECISIVE EDGE

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Collaborative Mechanisms

- Cooperative Research and Development Agreements (CRADAs)
- Patent License Agreements
- Educational Partnerships
- Partnership Intermediary Agreements

International CRADAs

- Three Active
- Six Pending

Australia - University of Wollonong
Bulgaria & Ukraine –
Bulgaria Defense Institute,
Chernihiv National University of Technology,
National Technical University of Ukraine
Singapore - Nanyang Technological University
Australia - Australia National University
Australia - University of Sydney
Budapest - Budapest University of Technology and Economics
Israel - Ben Gurion University
New Zealand - University of Auckland
Norway - University of Oslo

- Over 508 People Into and Out of Laboratory Under OC
- Active Collaborators: 96
- In-Process Collaborators: 80
- International Collaborators: 53 from 20 countries including China, India, Germany, Turkey, South Korea, Iran.
CAMMS: Center for Agile Materials Manufacturing Science

Open to national and DoD labs, universities, and industry

Multidisciplinary Focus:
- Manufacturing and processing
- Process-to-microstructure modeling
- Expeditionary technologies development
- Characterization based-performance using a probabilistic approach
- Rapid, in situ certification of additively manufactured parts

CURRENT PARTNERS:
- 3D Systems
- Orbital ATK
- Johns Hopkins (MEDE CA)
- ECBC
- UTEP

UNIQUE FACILITIES
- Selective laser sintering
- Hybrid additive manufacturing system
- Cold spray systems
- Materials characterization and computational tools
- Nondestructive Evaluation (NDE) Capabilities
- X-ray Computed Tomography suite
- Scanning and transmission electron microscopy

Multi-axes, Hybrid-materials Additive Manufacturing

Additive Manufacturing Suite

CT with In-situ Mechanical Testing

Fiber & Film Processing Lab

Cold Spray Laboratory
Technology Maturation Initiative

Vision: Enabler program to mature key capabilities the Army needs, applied when and where appropriate to “ramp up” technology insertion.

- Program of pre-MS B activities focused on advanced component development and prototyping
- Are collaborative initiatives between the S&T and Acquisition communities
- Warrant Army leadership awareness
Army ManTech Program Overview

Goal: Advance industrial manufacturing capabilities to improve the performance and reduce the lifecycle costs of Army systems.

Manufacturing Technology (ManTech)
- Provide efficient and cost effective manufacturing solutions for Army systems.
- Ensure manufacturability of new technologies for Army system insertion.

Mitigate production risks and reduce manufacturing costs of programs of record.
Army SBIR Lifecycle

Army SBIR
Small Business Innovation Research

Phase I
Product: Feasibility Study
- A short term effort to determine viability of a topic solution
- 6 months, $100K
- 2000-3000 proposals, ~200 PhI awards (10-13%)

Phase I Option
- $50K

Phase II
Product: Prototype
- Creation of a prototype to validate & mature the topic solution
- 2 years, $1.0M
- ~50% PhIs Awarded PhII Contracts (5%)

Transition
- Phase II Enhancements (PhII-E, $500K)

Phase III
- Transition
- Non-SBIR Funds
  - Government
  - Industry

Soldier Critical Needs
- R&D / Innovation / New Capability
- S&T Challenge Areas (STO assist)
- Capability Gaps
- TRADOC TEs, AWC
- PEO Roadmaps/T2 Initiatives

Soldier Solutions
- Increased Operational Capabilities
- Army Program of Record
- MDAPs (ACAT I-IV) Integration

Input from Field

Output to Field
Holistic strategy to enhance STEM capabilities: Broadening the STEM-literate talent pool; Attracting, recruiting and retaining elite STEM candidates; Outreach to diverse array of S&T organizations.
Summary

• Army refocusing investments to technologies enabling mid- and far-term capabilities
• S&T investments are critical for future Army operational capabilities
• Open campus provides strong mechanism for collaborative engagement
Army Science & Technology

Providing Soldiers Technology Enabled Capabilities

MAINTAINING A LEADING EDGE IN TECHNOLOGY