Army Science and Technology

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Deputy Assistant Secretary of the Army for Research and Technology

18 April 2017

Army S&T Principles

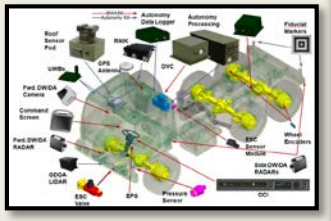
MISSION: ***Identify, develop and demonstrate technology options that inform and enable effective and affordable capabilities for the Soldier***

VISION: ***Providing Soldiers with the technology to Win***

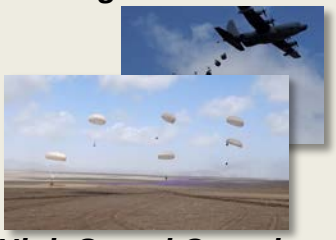
Current Force

Deployable Force Protection Adaptive Red Team

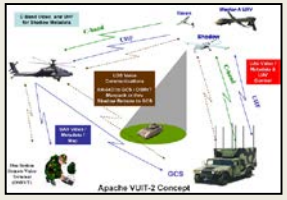
Advanced Rotary Wing Aerial Delivery Sling Load Net



Autonomous Mobility Appliqué System



High Speed Container Delivery System

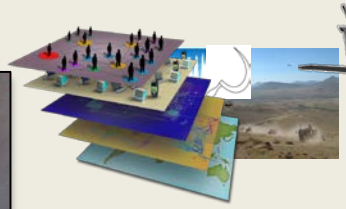


Video from Unmanned Aerial Systems

Enabling the Future Force

Enhancing the Current Force

Future Force



Cyber tools

Next Generation Rotorcraft

Neuroscience

High Energy Lasers

Combat Vehicle Prototyping

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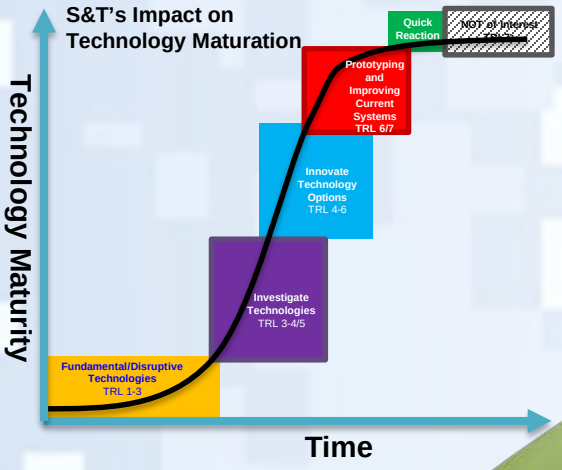
Roles of Science and Technology



DISCOVER

INNOVATE

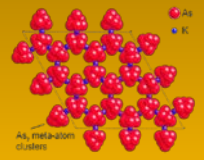
TRANSITION

10-30 years

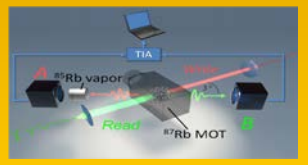
Fundamental Research

Basic and Early Applied Research

NeuroScience



Materials by Design



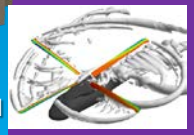
Conceptualized Quantum Memory

6-15 years

Investigate Technology

Applied Research

Disruptive Energetics



Aeromechanics and Computational Methods

Blast Protection for Platforms and Personnel

4-8 years

Innovate Technology Options

Advanced Development Research

Manned-Unmanned Teaming

High Energy Laser – Tactical Vehicle Demonstrator

Joint Multi-Role Technology Demonstrator

2-4 Years

Experimental Prototyping & Improve Current Systems

-Drive Down Technical Risk

-Inform Achievable Requirements

1-2 Years

Quick Reaction

Time Frame	Near	Mid	Far

Army Investments by Portfolio

FY17: $2.4B*

As of PB17

Soldier/Squad

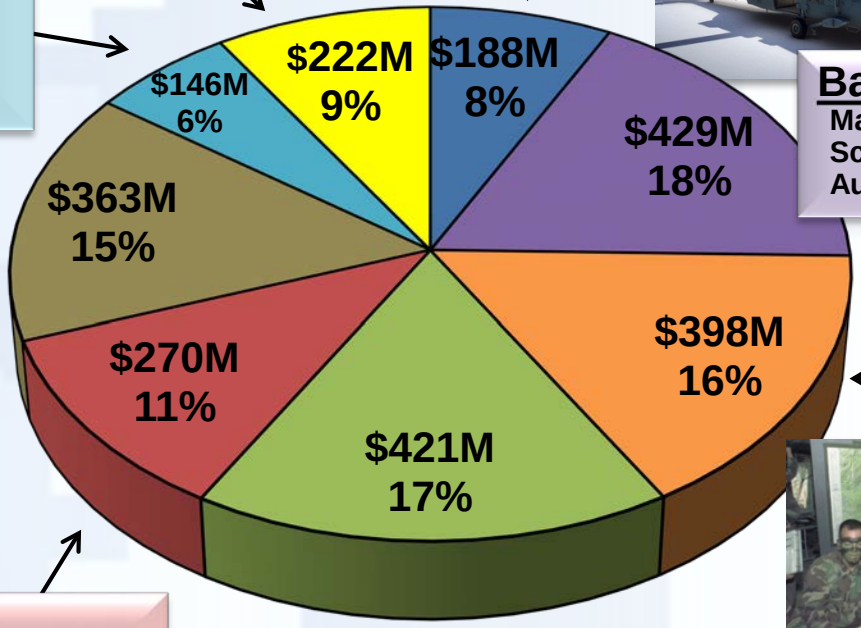
Personnel, Training, Human System Integration, Dismounted mission equipment and power & energy

Air

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

Medical

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

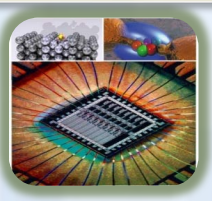


Basic Research

Materials Science; Medical/Life Sciences; Quantum/Info Science; Autonomy; Networks

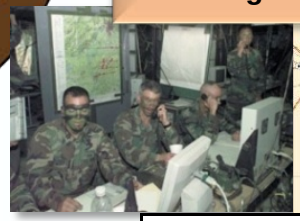
Innovation Enablers

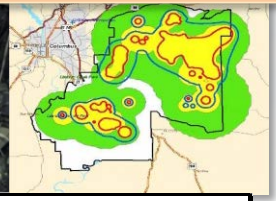
High Performance Computing; Environmental Protection; Base Protection; Studies; Technical Maturation Initiatives; Procurement



C3I

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





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

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

**** Does not include $59M Procurement***

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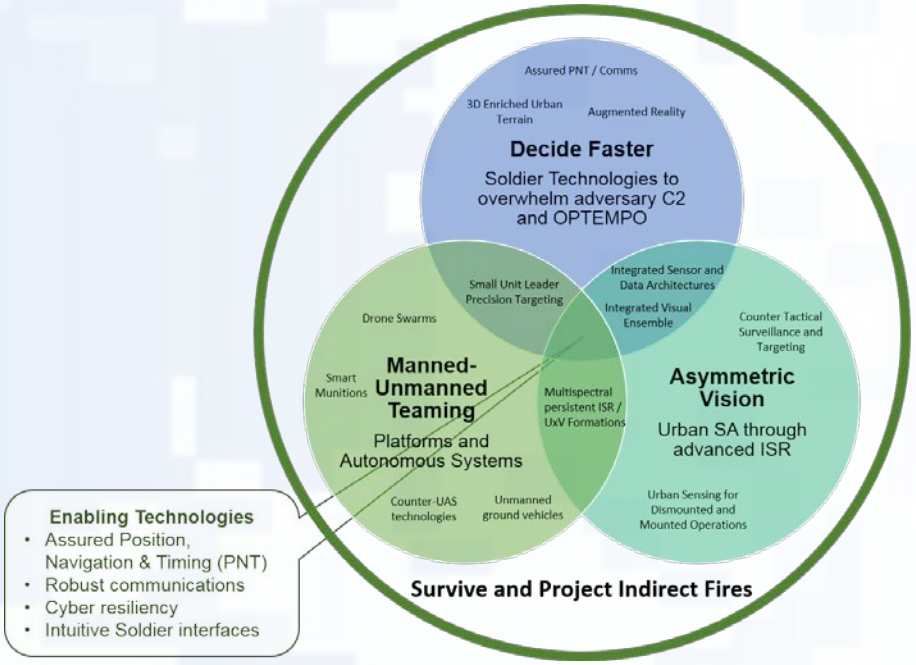
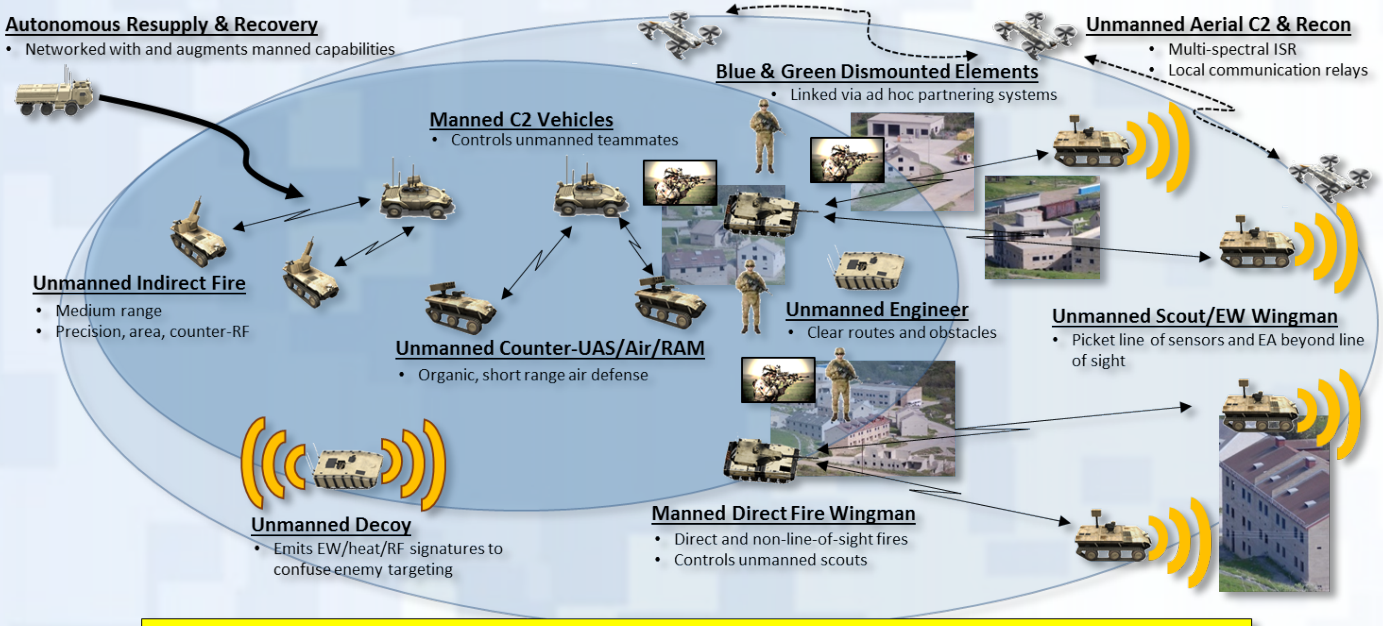
Priority Investment Areas

- ***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



CSA Priorities	
Armor	New Combat Vehicle
Future Vertical Lift	Aviation Protection
Infantry Support Technology	Networks
Autonomy	Artificial Intelligence
Cyber/Electronic Warfare	Additive Manufacturing
Assured PNT	Robotics
Air & Missile Defense	

Future Concept of Operation S&T View



Manned-Unmanned Teaming maximizes U.S. Soldier/Marine advantages in applying creativity and critical decision-making at the point of action, cutting through the fog of war and tyranny of time & distance

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

Manned-Unmanned Teaming S&T Concept

Manned-Unmanned Teaming maximizes U.S. Soldier/Marine advantages in applying creativity and critical decision-making at the point of action, cutting through the fog of war and tyranny of time & distance

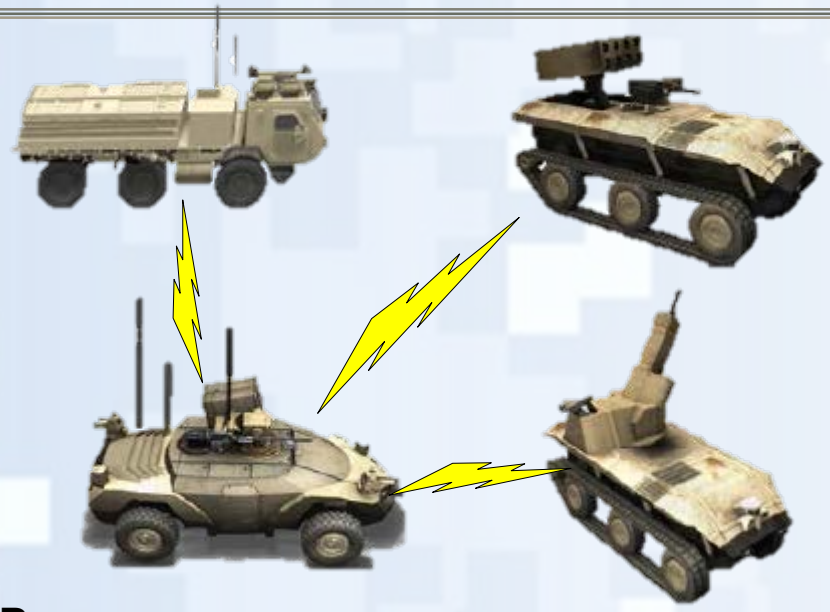
MUM-T focuses on teams of manned and unmanned, autonomous vehicles, working in concert with mounted and dismounted forces

- 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**

Ground Maneuver Portfolio
Manned Unmanned Teaming (MUM-T)



Purpose:

Develop and demonstrate the effectiveness of MUM-T across multiple operational scenarios:

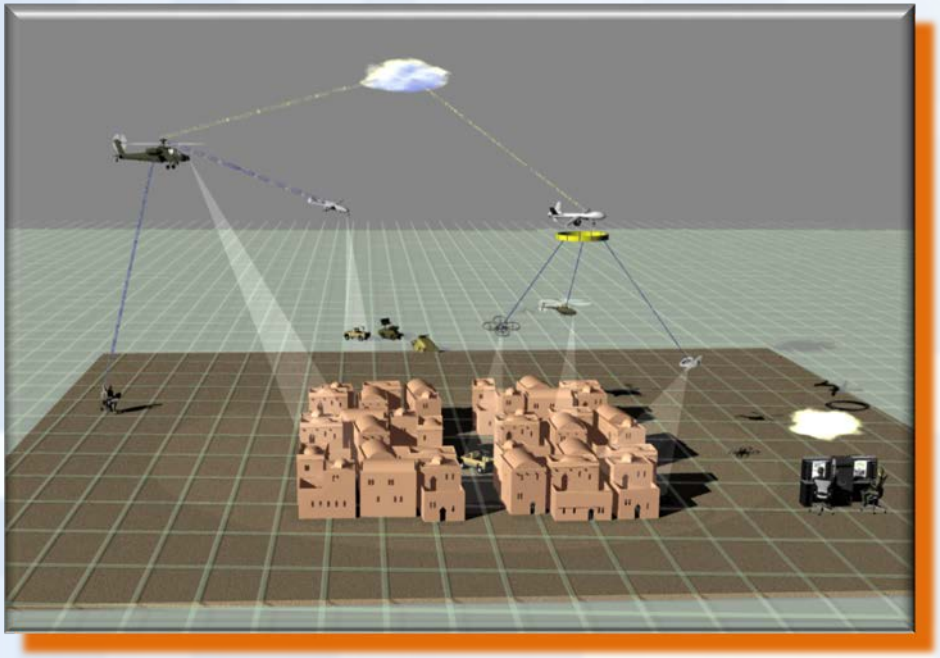
- Soldier use of micro Unmanned Ground Vehicle (UGV) / Unmanned Aerial System (UAS)
- Dismounted maneuver supported by multi-mission UGV
- Armed UGV wingman operating with manned vehicle
- UGV/UAS teaming to extend Brigade Combat Team Autonomous Ground Resupply operations

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

MUM-T

Air Portfolio
Unmanned & Optionally Manned Systems



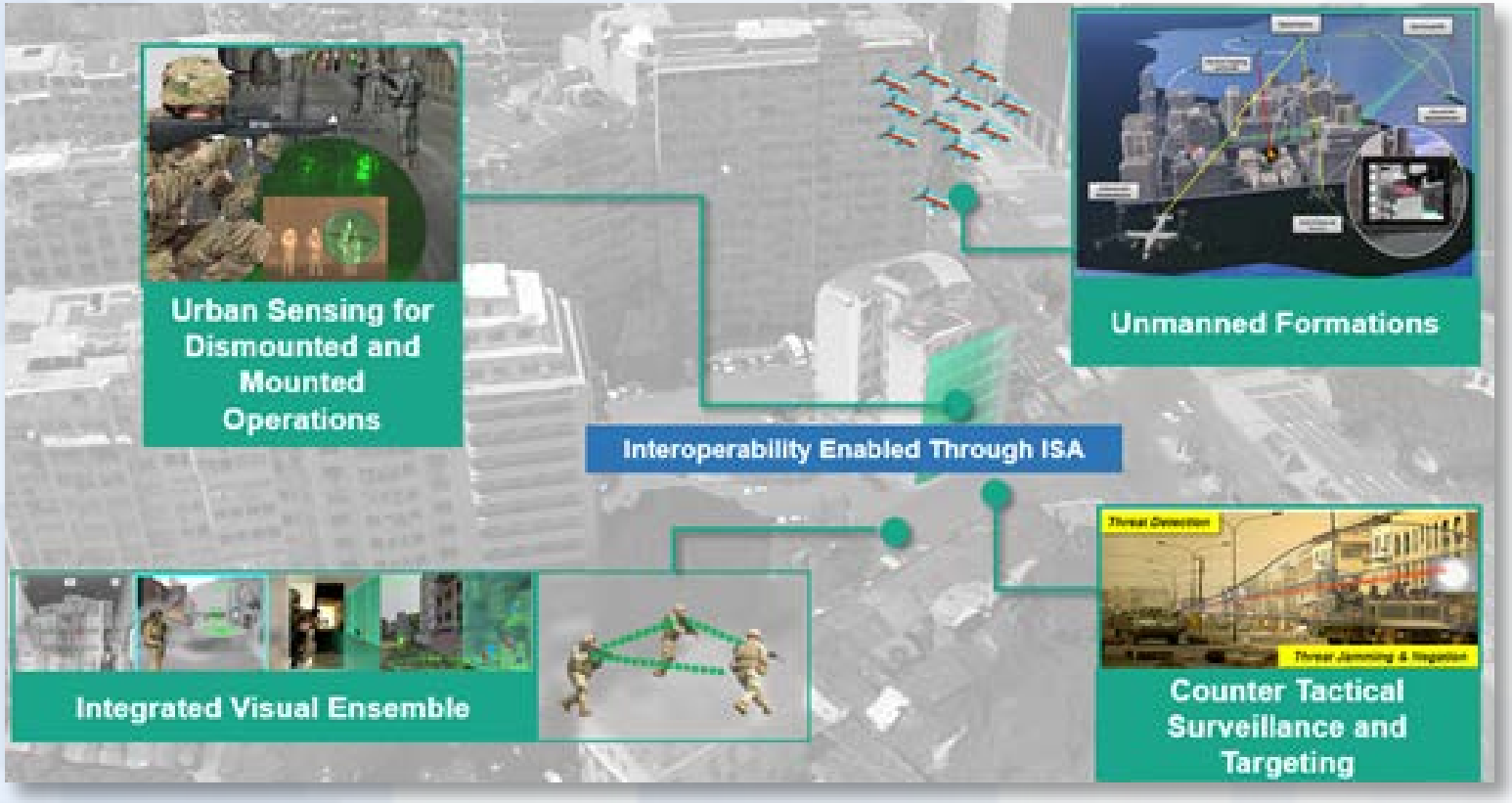
Near-term Goals:

- 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 S&T Concept



<u>Asymmetric Vision</u> 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.

<u>Example Technology Areas</u>

- **Multi-spectral persistent ISR / Unmanned Formations**
- **Counter Tactical Surveillance and Targeting**
- **Integrated Visual Ensemble**
- **Urban Sensing for Dismounted and Mounted Ops.**

Basic Research
Cyber Defense

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

Proactive Network Defense

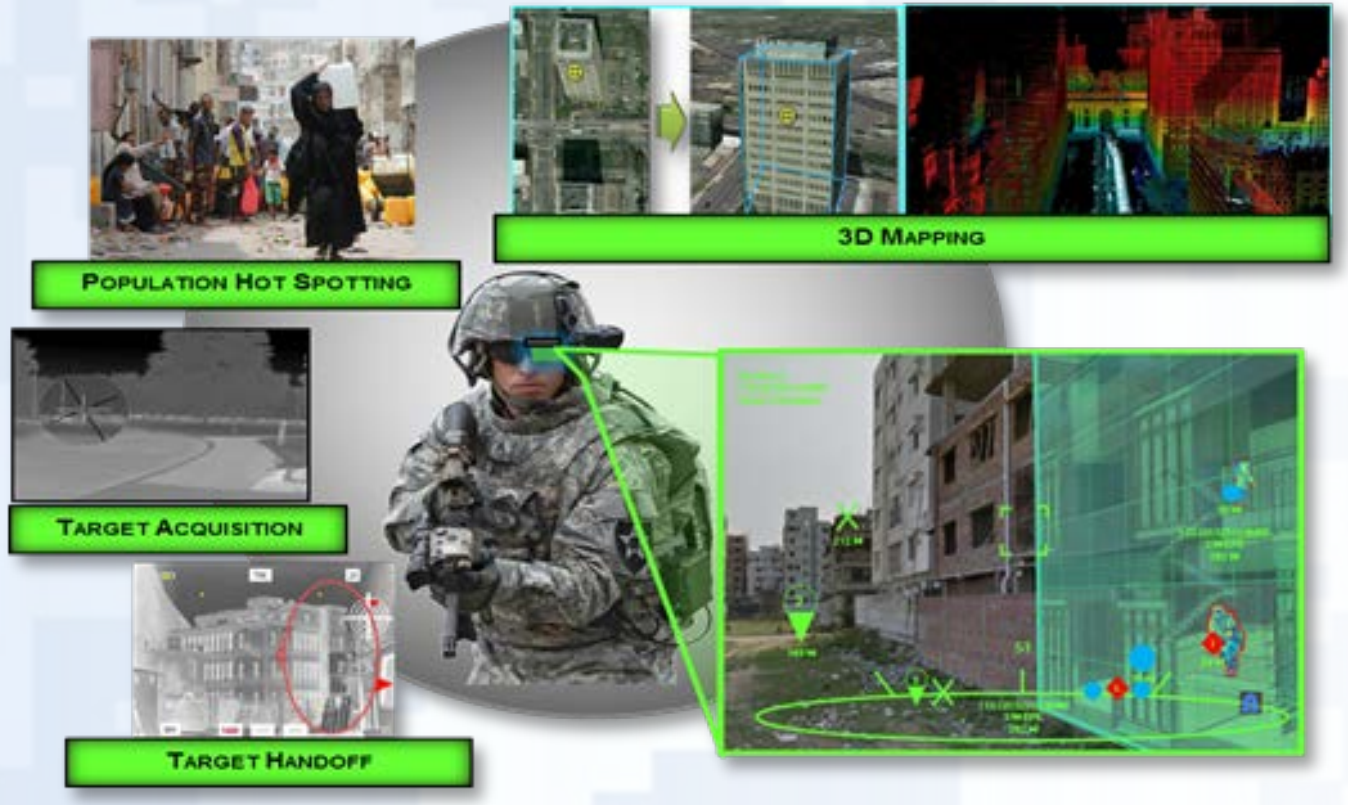
Program Will Provide:

- 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

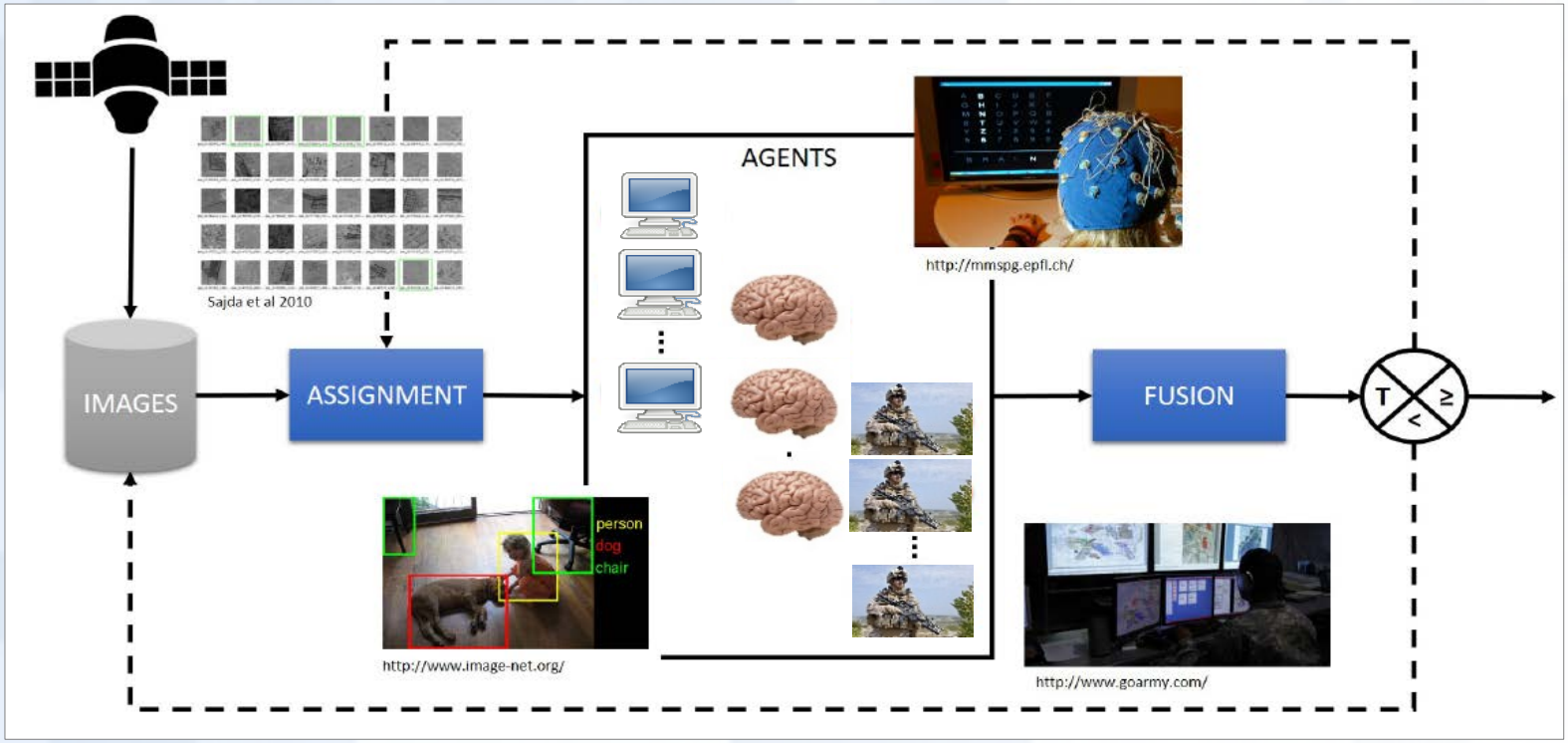


<u>Decide Faster</u> focuses on overwhelming an adversary's C2 and OPTEMPO by leveraging advanced processing, exploitation & dissemination technologies, coupled with intuitive targeting and enhanced assured mobility.

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**

Soldier/Squad Portfolio Man-Machine Interface



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

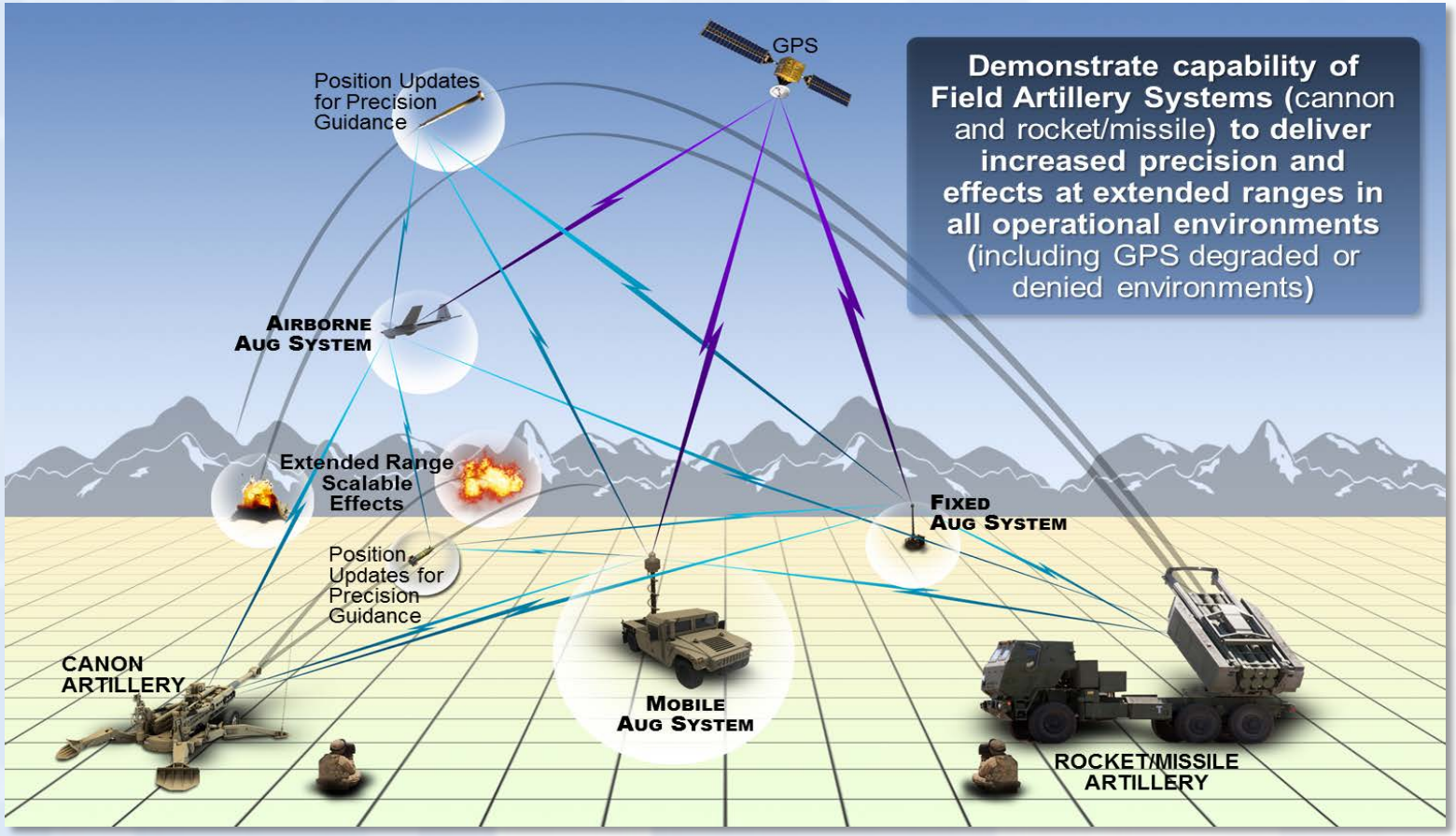
Program Will Provide:

- 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

Survive and Project Indirect Fires



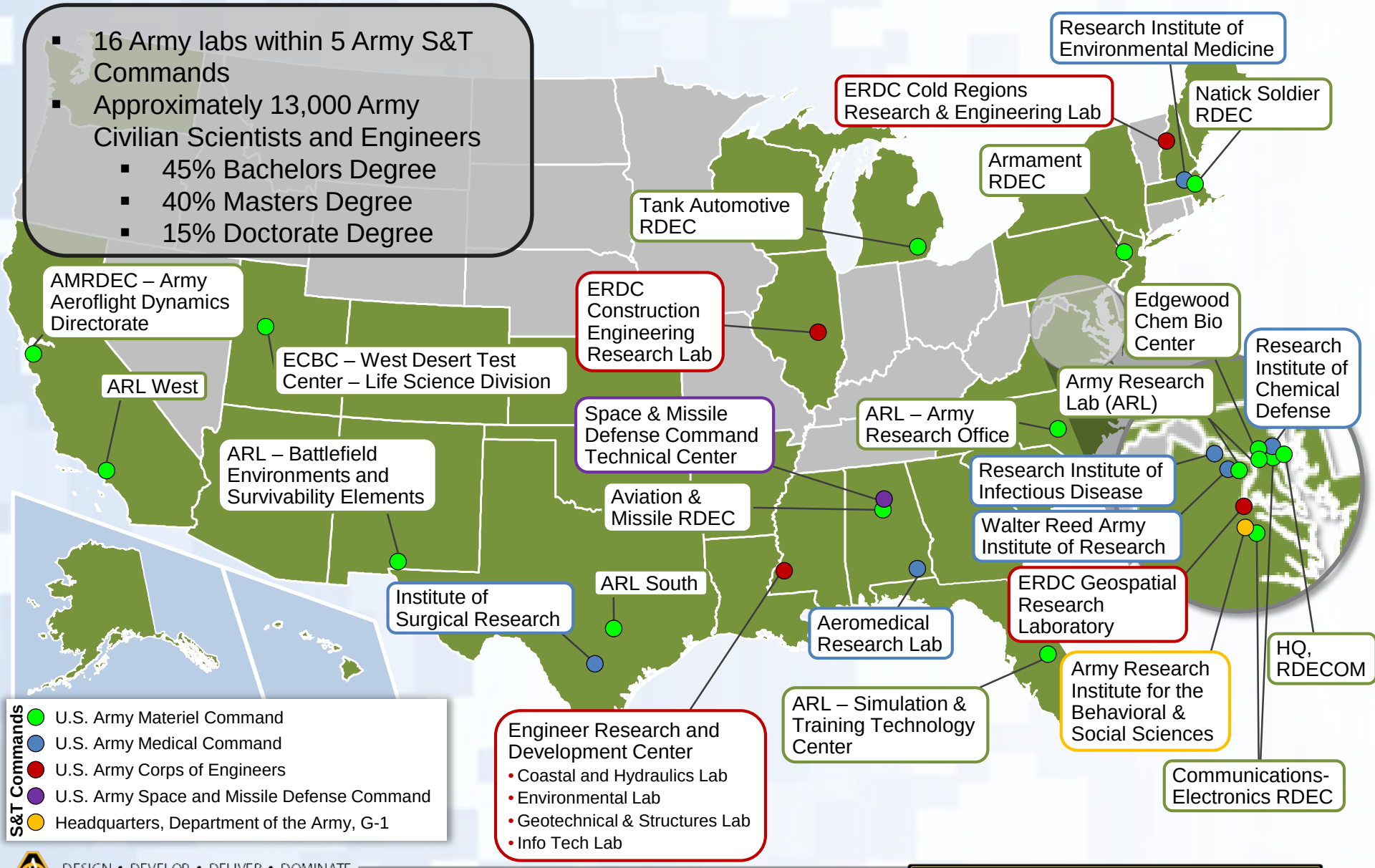
Survive and Project Indirect Fires
Enables protection of friendly forces during maneuver operations

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



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

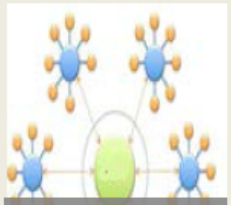
Reduction in barriers to facilitate collaboration with academia, industry, and small business

Less bureaucracy and paperwork

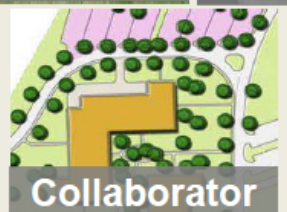
Open areas for researchers and access to existing facilities

Collaboration between ARL and external scientists

Career path for students and scientists



Hub and Spoke Model

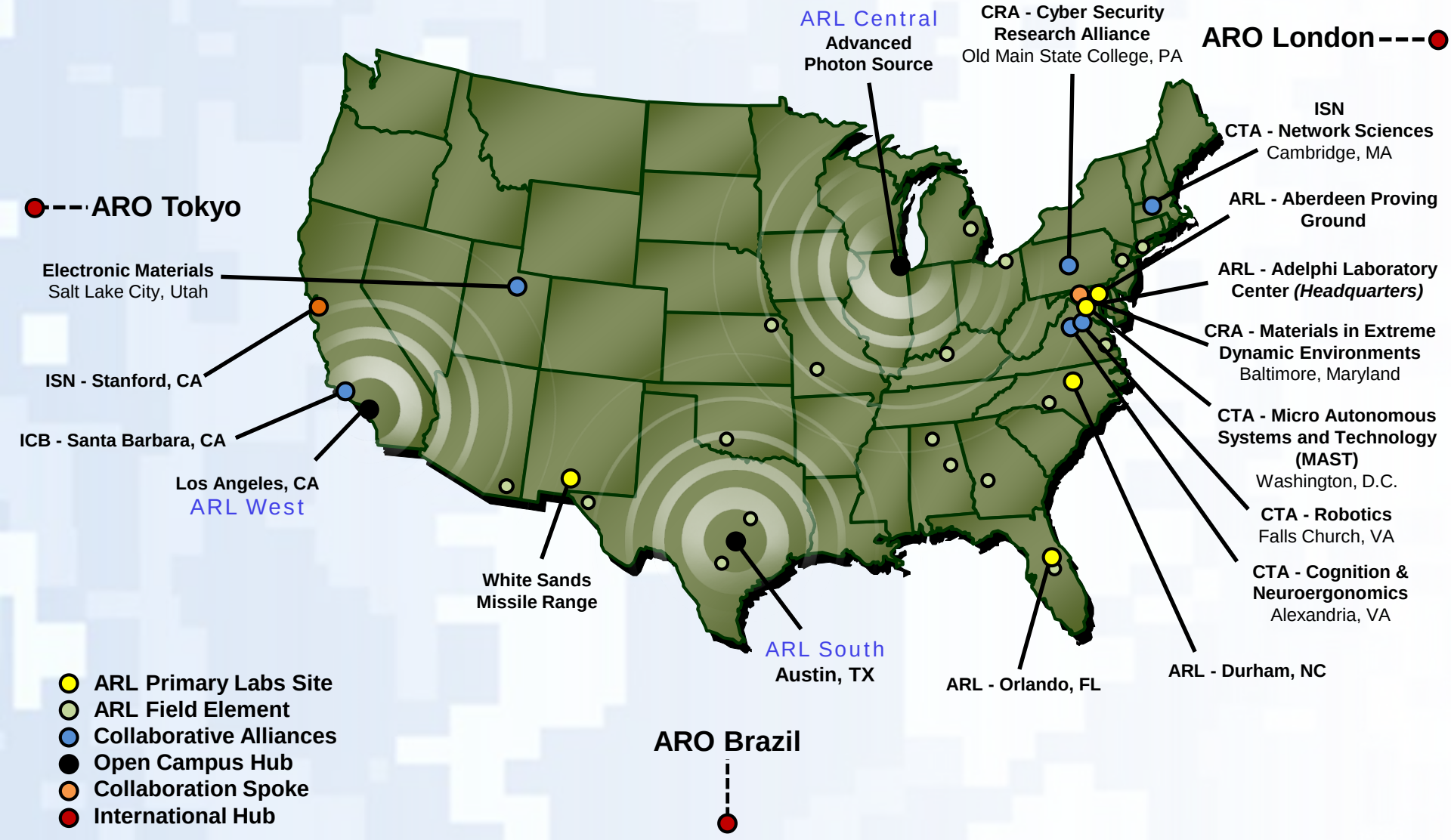


Collaborator presence through EUL

Novel staff opportunities

An enhanced defense research environment that fosters discovery and innovation through collaboration on fundamental research

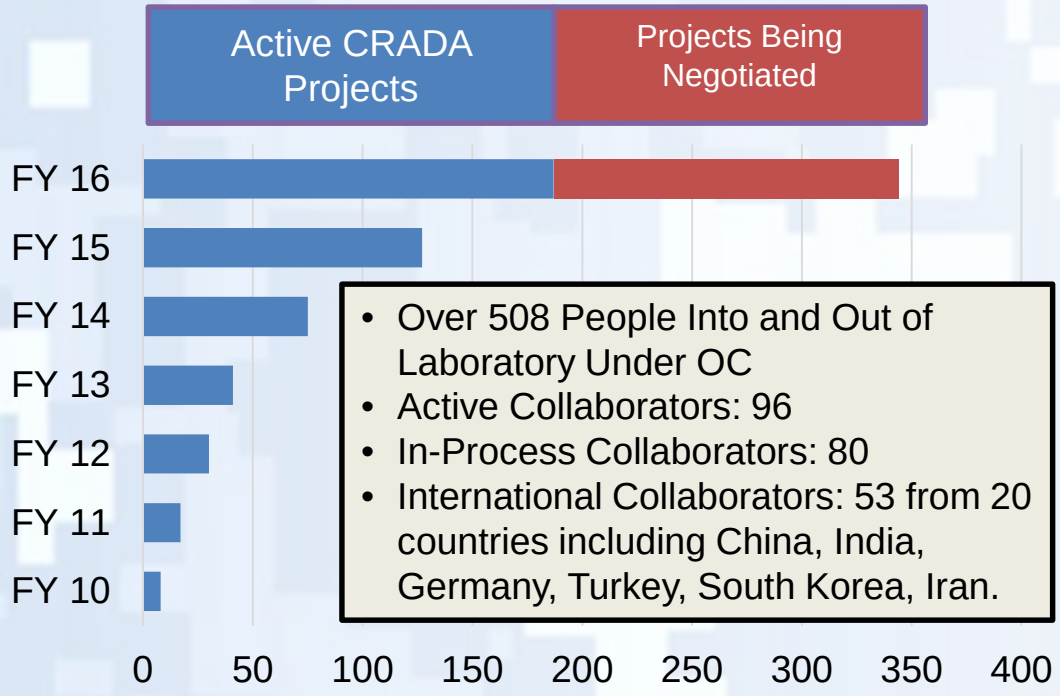
Developing a Hub and Spoke S&T Global Network



Army Research Lab (ARL) Open Campus: Route for Collaboration

Collaborative Mechanisms

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



- 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.

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

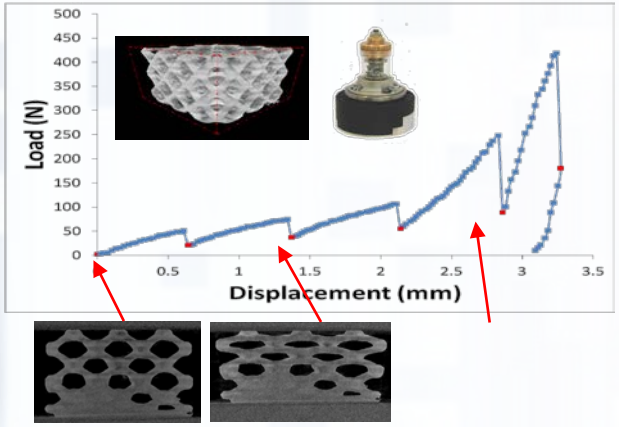
CAMMS: Center for Agile Materials Manufacturing Science

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

Additive Manufacturing Suite



CT with In-situ Mechanical Testing

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

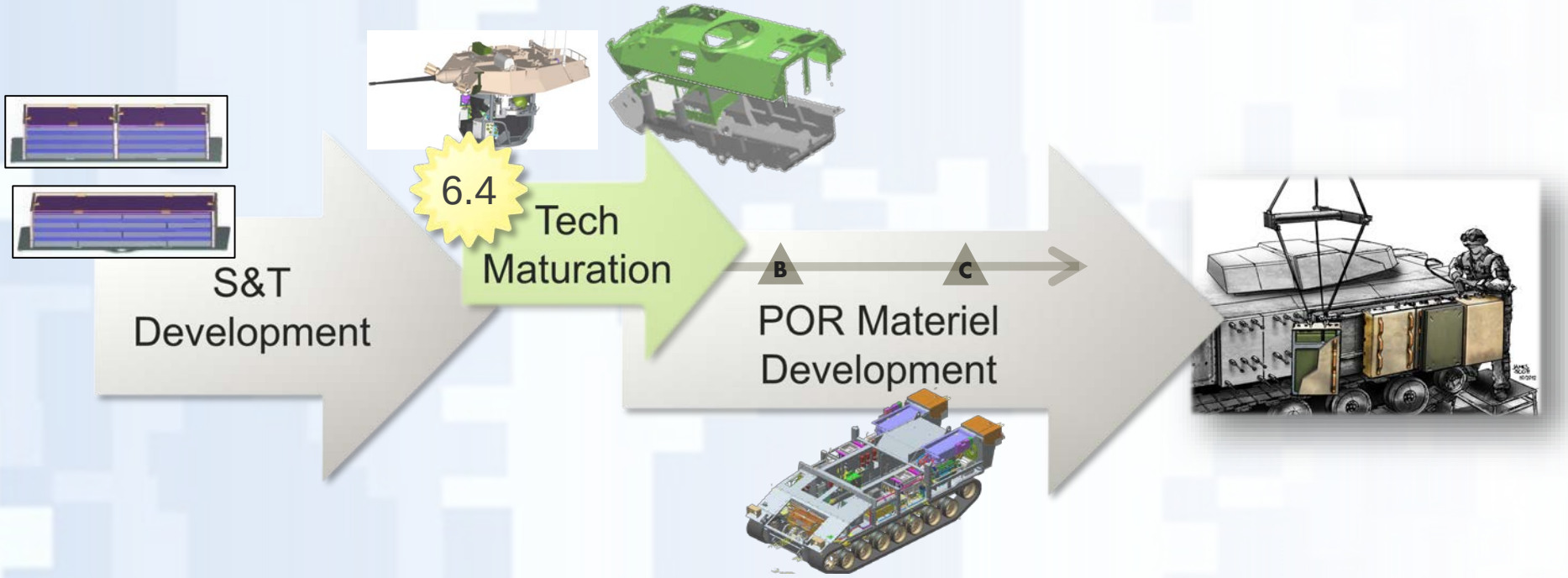

Multi-axes, Hybrid-materials Additive Manufacturing


Fiber & Film Processing Lab


Cold Spray Laboratory

Technology Maturation Initiative

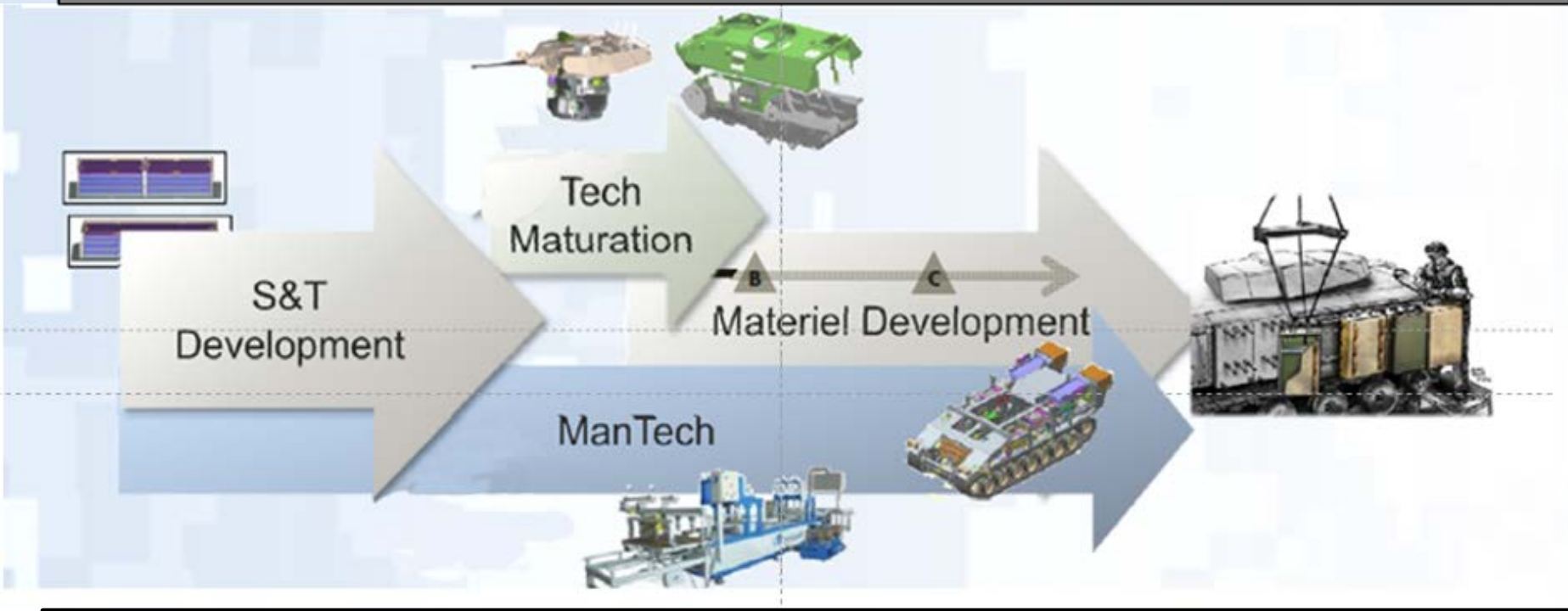
Vision: Enabler program to mature key capabilities the Army needs, applied when and where appropriate to “ramp up” technology insertion.



- **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.

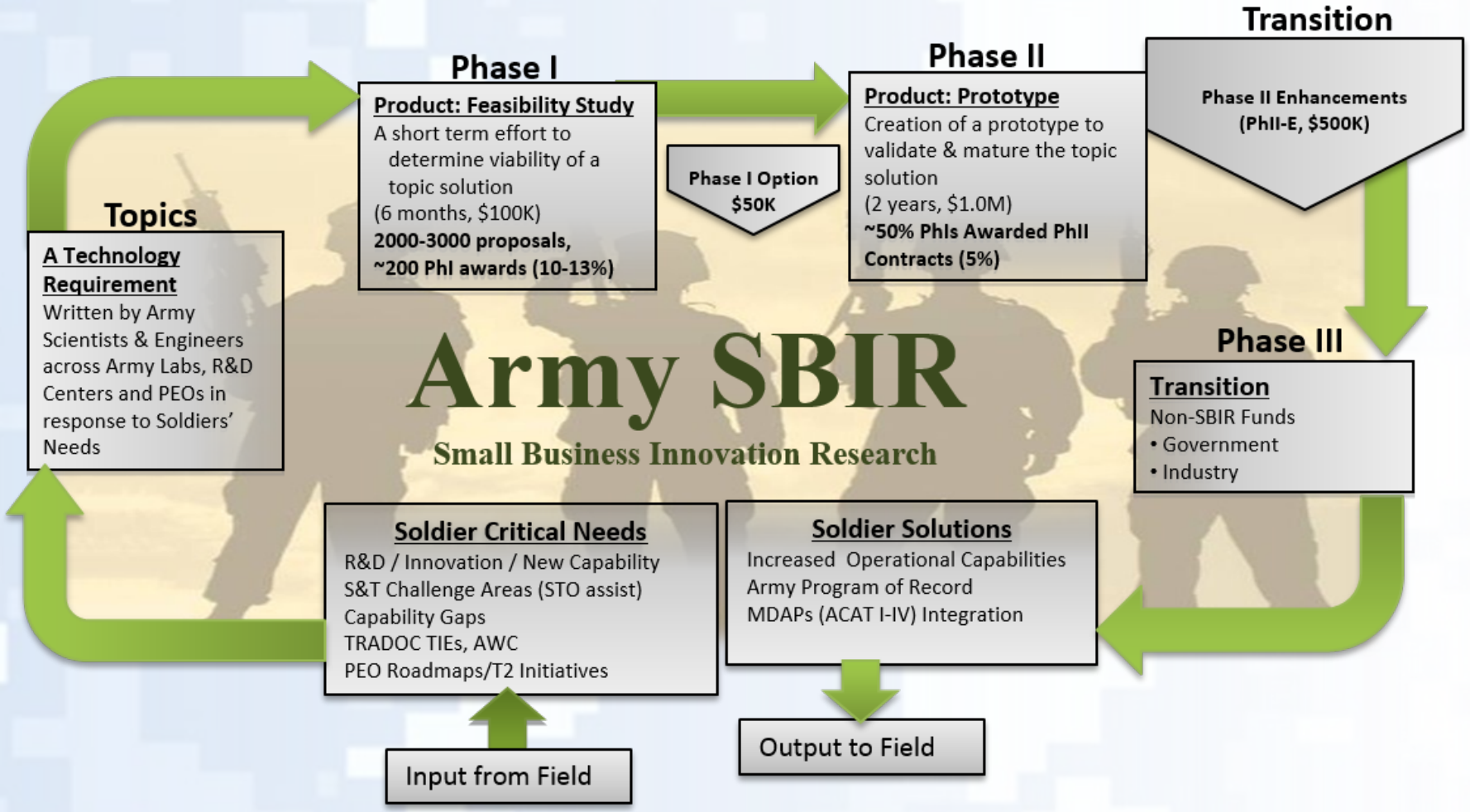


Manufacturing Technology (ManTech)

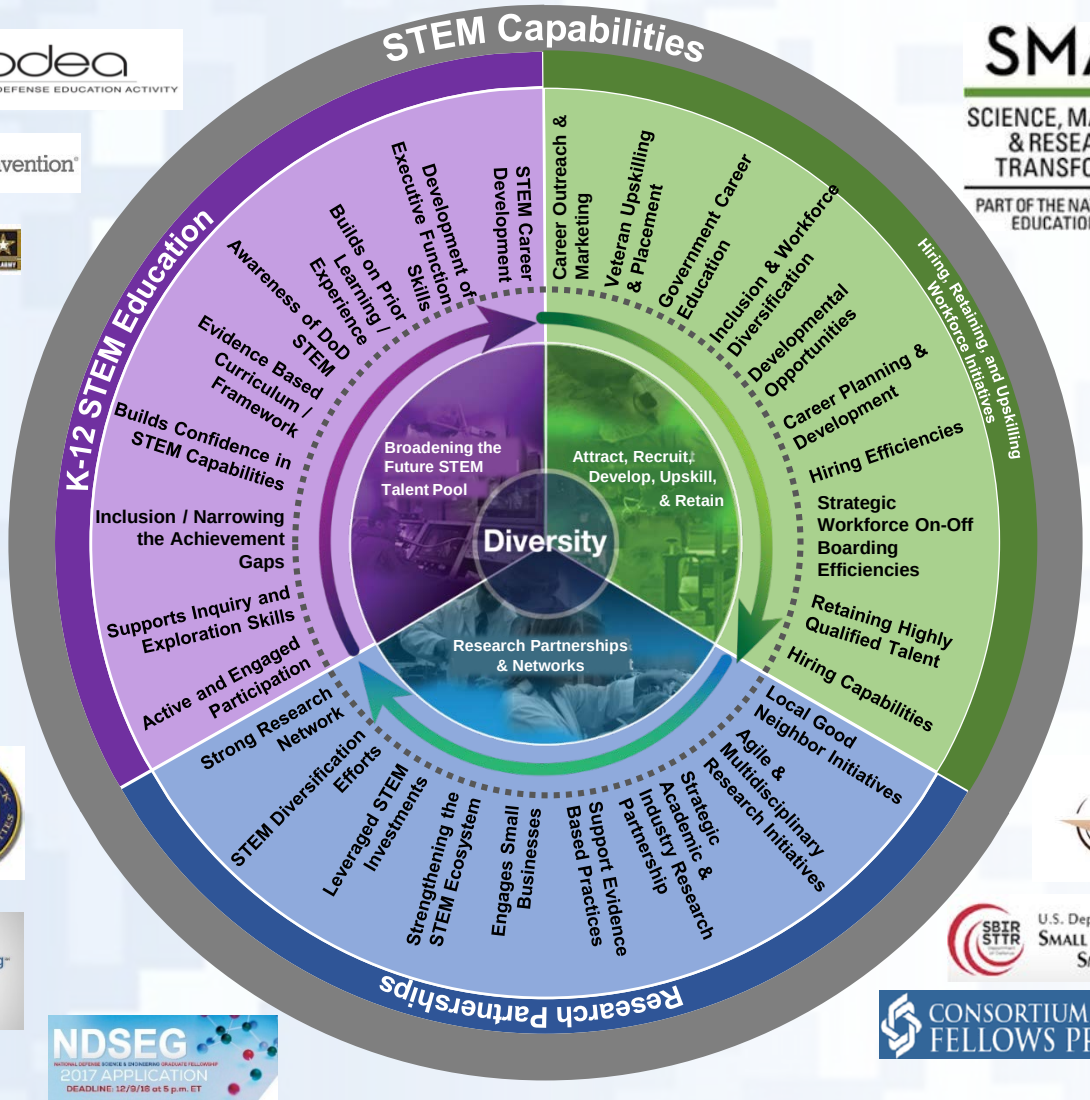
- Provide efficient and cost effective manufacturing solutions for Army systems.
- Ensure manufacturability of new technologies for Army system insertion.

Mitigate production risks and reduce manufacturing costs of programs of record.

Army SBIR Lifecycle



Army's Holistic Approach to STEM Capabilities



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