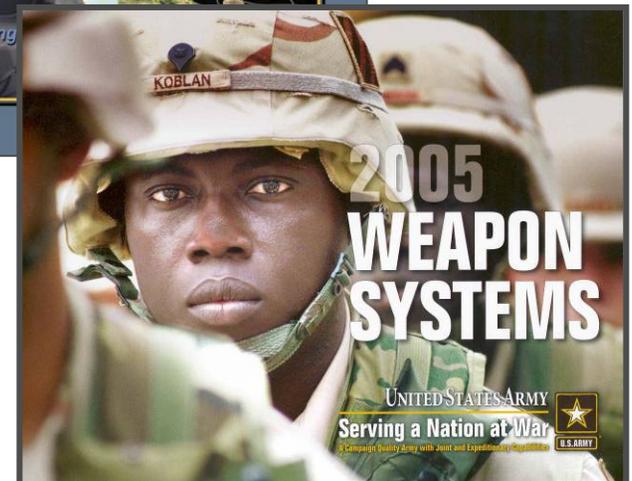
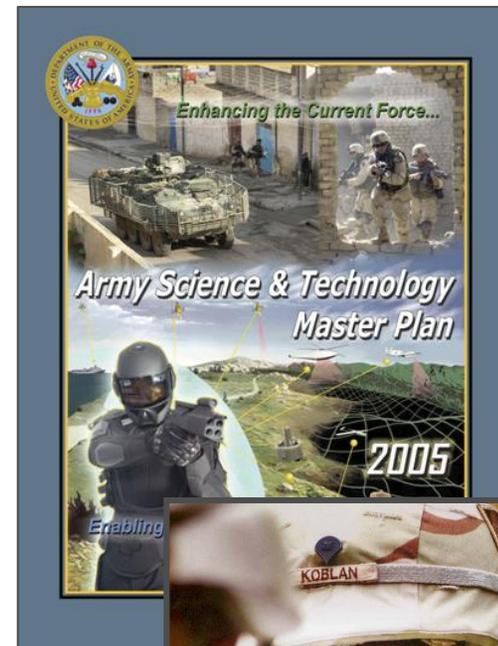




Army Science & Technology

NDIA Next Generation Capabilities: Army Basic Research

19 April 2006



*Mary J. Miller
Director for Technology
Office of the Assistant Secretary
for Research & Technology*



Overview

- ***Basic Research Overview***
- ***Army Basic Research Program Components***
 - *Single Investigator Program*
 - *Paradigm Shifting Capability Centers/University Affiliated Research Centers (UARCs)*
 - *University Research Initiatives*
 - *In-House Research*
 - *University Centers for Enduring Needs/Army Centers of Excellence*
 - *Collaborative Technology Alliances*
- ***New Initiatives***
 - *Network Science*
 - *International Technology Alliance (ITA)*
 - *Army Educational Outreach*



Capabilities for a Joint and Expeditionary Army

Current Force



~100 lb. load



70+ tons



< 10 mph

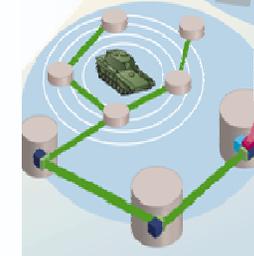
Enabling the Future Force

Science and Technology—
develop and mature
technology to enable
transformational capabilities
for the Future Modular Force
while seeking opportunities
to accelerate technology
directly into the Current
Modular Force

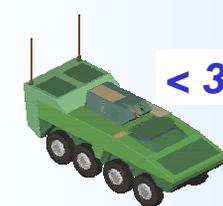
Enhancing the Current Force

Future Force

< 40 lb.
load



Fully networked



< 30 tons



> 40 mph



Army Enduring Need for Basic Research

- Maintain Land Warfare Technological Superiority -

- **Sponsor Army-unique areas of research (e.g., penetration mechanics, insensitive energetic materials, pulse power, etc.)**
- **Focus/tailor research and innovations in other areas to suit Army needs (e.g., compact power for the soldier, smart materials for rotorcraft, new materials for Soldier protection, high density tactical networks)**
- **Purpose:**
 - **Take advantage of new discoveries and mature knowledge to support Army future capabilities**
 - **Enable breakthrough capabilities**
 - **Exploit technological opportunities**
 - **Interpret and tailor progress for Army benefit**

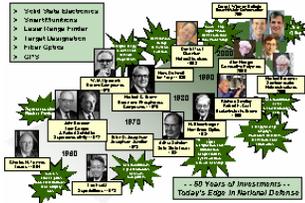




Basic Research

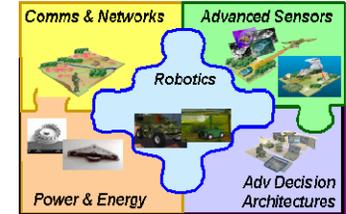
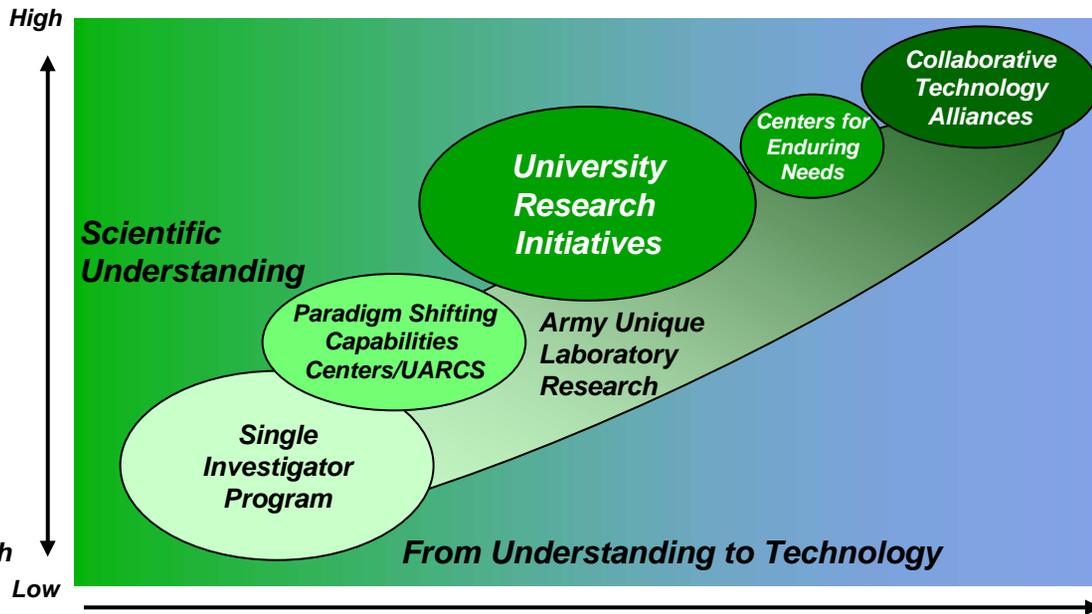
University Single Investor Program

- Solid State Physics
- Structural Mechanics
- Electro-magnetics
- Materials Science
- Innovative Countermeasures



University Research Initiative (Devolved)

- Multidisciplinary Research
- DURIP

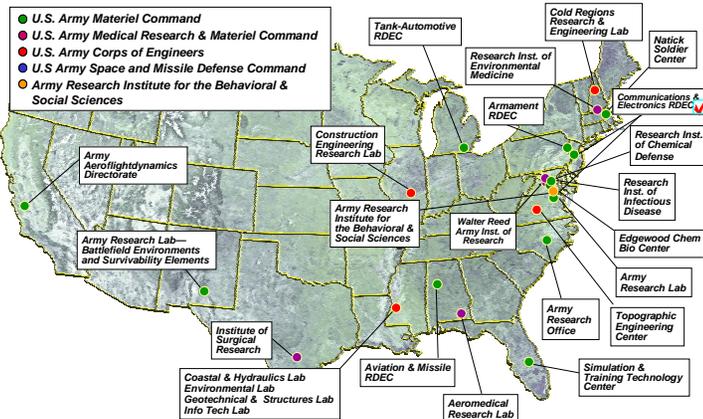


Collaborative Technology Alliances

- Comms & Networks
- Robotics
- Advanced Sensors
- Power & Energy
- Advanced Decision Arch
- Micro-Autonomous Systems & Technologies
- Network & Info Science ITA



In-House Research



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Institute for Advanced Technologies



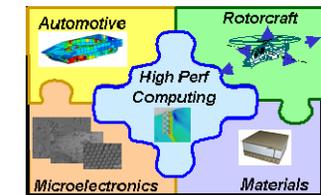
Institute for Collaborative Biotechnologies



Institute for Soldier Nanotechnologies



Institute for Creative Technologies

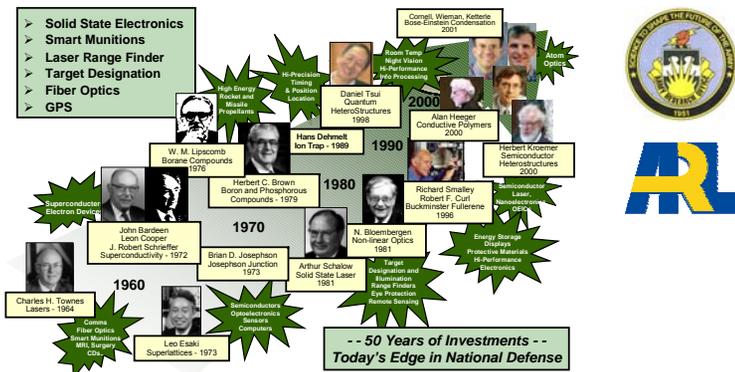


University Centers for Enduring Needs

- Microelectronics Center
- Vertical Lift Center of Excellence
- Materials Center
- Automotive Research Center
- High Perf Computing
- HBCU/MIs with Battle Labs



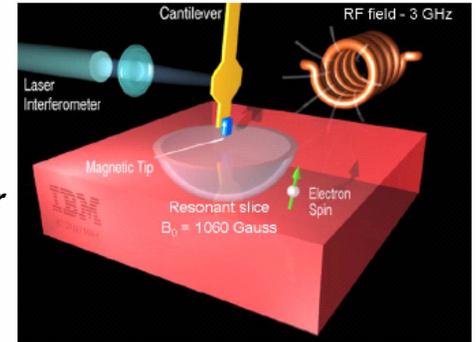
Single Investigator Program



Exploit the innovation and flexibility of academia

Single Electron Spin Detected

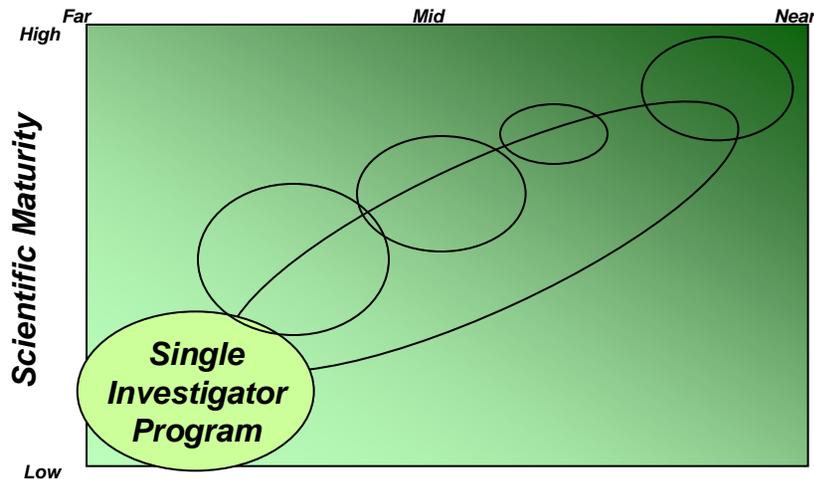
Ultra-high sensitivity coupling the magnetic resonance of atomic spins to the mechanical resonance of an Atomic Force Microscopy cantilever



Potential applications to

- Quantum computing
- Chem/bio defense

Transition to Applied Research



Discoveries and innovations often have unforeseen, widespread impact

- Rapid exploitation of novel science opportunities world-wide
- 45 states and DC
- >200 institutions
- Graduate students supported: ~1400
- ~ 900 university grants, \$80k/yr grant



Paradigm Shifting Capability Centers/ University Affiliated Research Centers (UARCs)



Electromechanics & Hypervelocity Physics



Soldier Survivability

High intensity focus on emerging opportunities



Immersive Environments

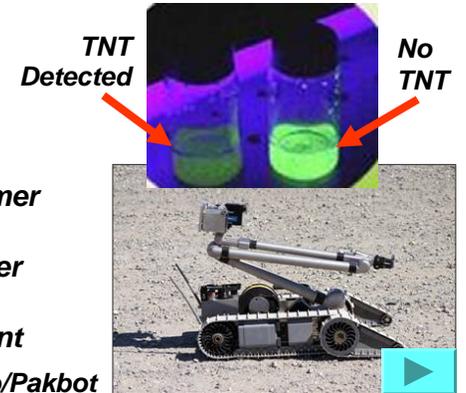


Biotechnology

Institute for Soldier Nanotechnologies

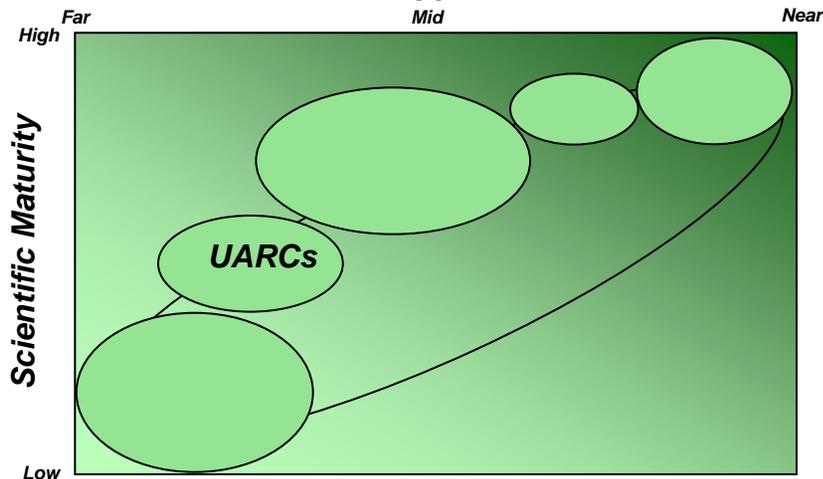
Objective:
Remote IED Detection

Approach:
Amplifying Fluorescent Polymer (AFP) developed by MIT ISN Associate Director Tim Swager normally glows green, but quenches when TNT is present



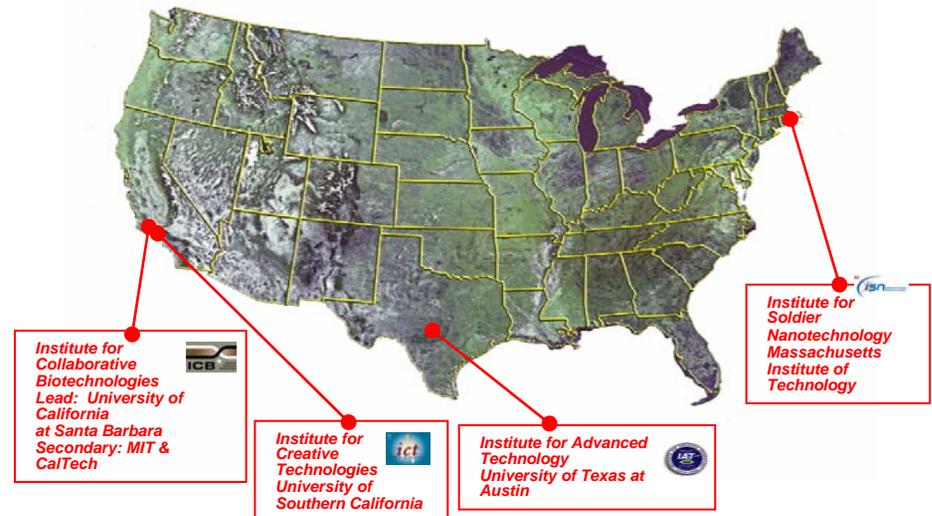
Fido/Pakbot

Transition to Applied Research



Leveraging breakthrough research for revolutionary capabilities

University Affiliated Research Centers





Paradigm Shifting Capability Centers/ University Affiliated Research Centers (UARCs)

Creating a Virtual Human

- ***Incorporate dynamics of human thought process, communication and response***
 - ***Speech recognition***
 - ***Natural language processing***
 - ***Dialogue management***
 - ***Cognition***
 - ***Perception***
 - ***Emotions***
 - ***Animation***
 - ***Cultural attributes***

Institute for Soldier Nanotechnologies



***Grand Challenge:
Develop realistic human performance models***



Multidisciplinary University Research Initiative (MURI)

- *DDR&E provides oversight*
- *Collaboration with Army laboratories*



Adaptive Coordinated Control in the Multi-Agent 3D Dynamic Battlefield

Development of scalable control architecture and algorithms suitable for operation of multiple aerial vehicles in dynamic environments

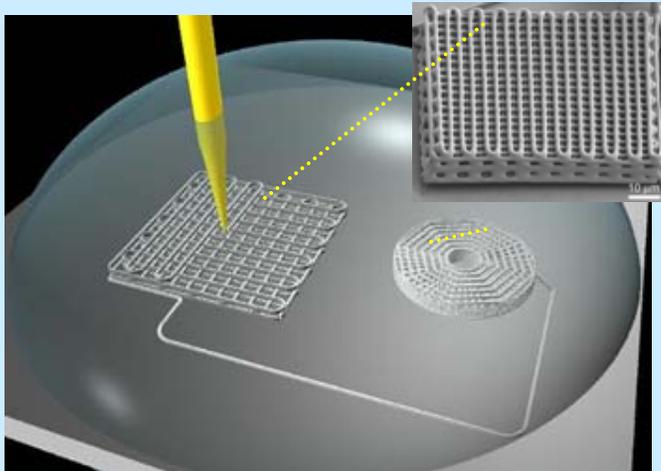
- *Examples of MURI Topics of high relevance to the Army*
 - *Cross-Disciplinary Approach to the Modeling, Analysis, and Control of Wireless Communication Networks*
 - *Develop analytical models and tools to describe, analyze, predict, and control the behavior of mobile ad hoc networks (MANETS)*
 - *Enhance the ability to analyze, design and predict performance of MANETS in a variety of challenging environments*
 - *Material Engineering of Lattice-Mismatched Semiconductor Systems*
 - *Establish the science base and infrastructure needed to commercialize lattice-mismatched electronics*
 - *Provide system designers with options to enable major performance gains in high-speed data processing, improved target detection/recognition, and improved battlefield communications*

Multi-disciplinary research to enable Army transformation



Defense University Research Instrumentation Program (DURIP)

***DURIP provided Research
Instrumentation allows
direct writing of polyelectrolyte ink***



Robotically defined woodpile structure

***Research has applications for future
photonic devices for Army communications
and protection systems***

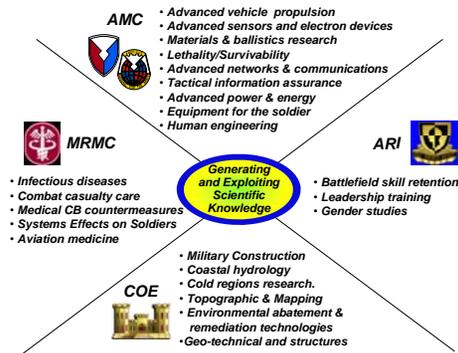
- ***Competitive grants awarded for the acquisition of research instrumentation***
- ***Emphasis on instrumentation vital to the discovery of new science and the advancement of Army transformational technologies***
- ***Allows researchers to take immediate advantage of fast paced instrumentation innovation***

In one year, 210 professors and 920 post-docs and graduate students at top Universities in the U.S. perform research using Army sponsored DURIP equipment



Army Laboratory In-house Research

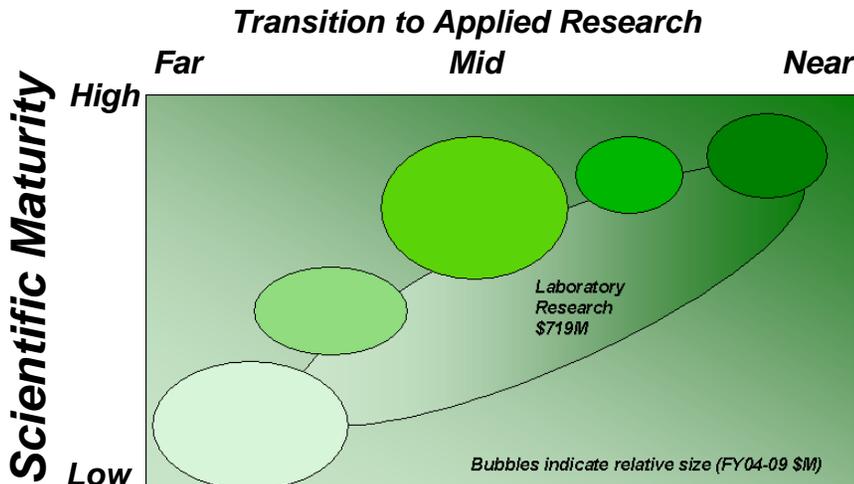
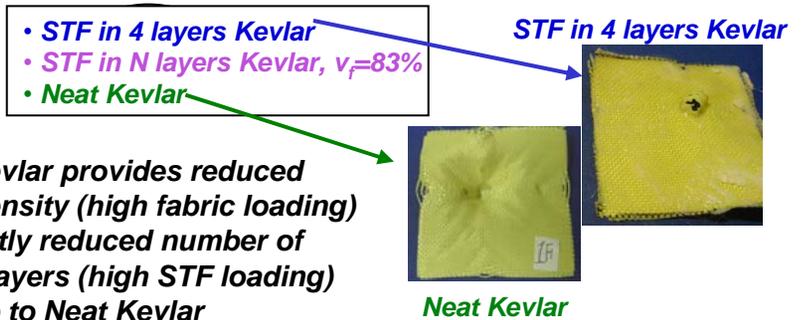
Army-Unique Facilities and Expertise



Insure against technological surprise

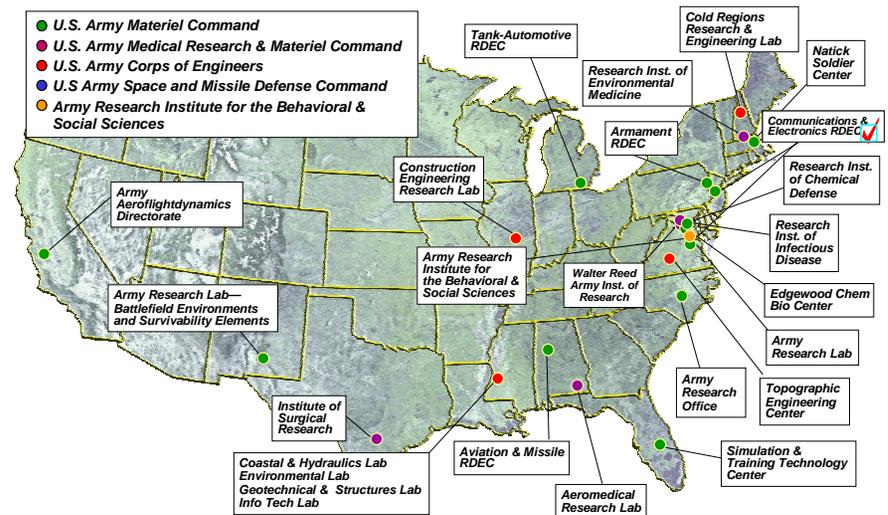
"Liquid Armor" Concept

Objective: Provide a compact, flexible armor material



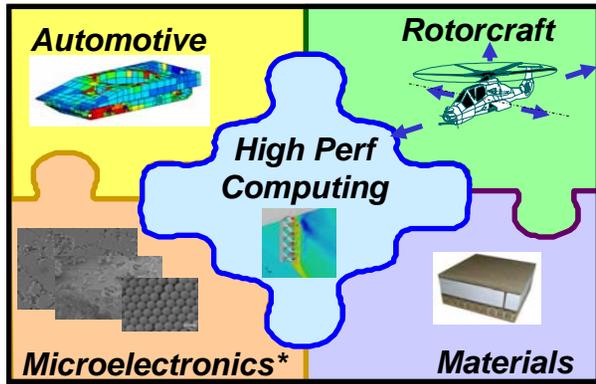
Discover & mature fundamental knowledge underlying Army applications

U.S. Army Laboratories





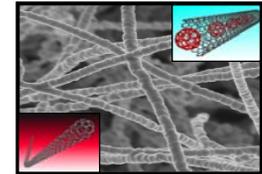
University Centers for Enduring Needs



* Ends in FY07

Objective of this materials research is to protect, conceal, and provide lightweight sustainment for the soldier and equipment.

- **Indestructibility** Integrated self-protection capabilities from weapons, puncture, and blunt trauma
- **Undetectable** by contact search or standard detection devices (metal detectors, radars, etc.).

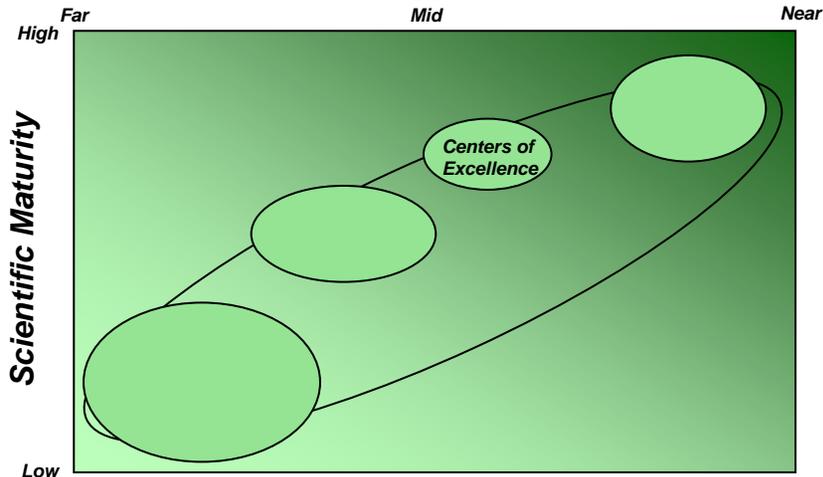


Carbon Nanotube Armor



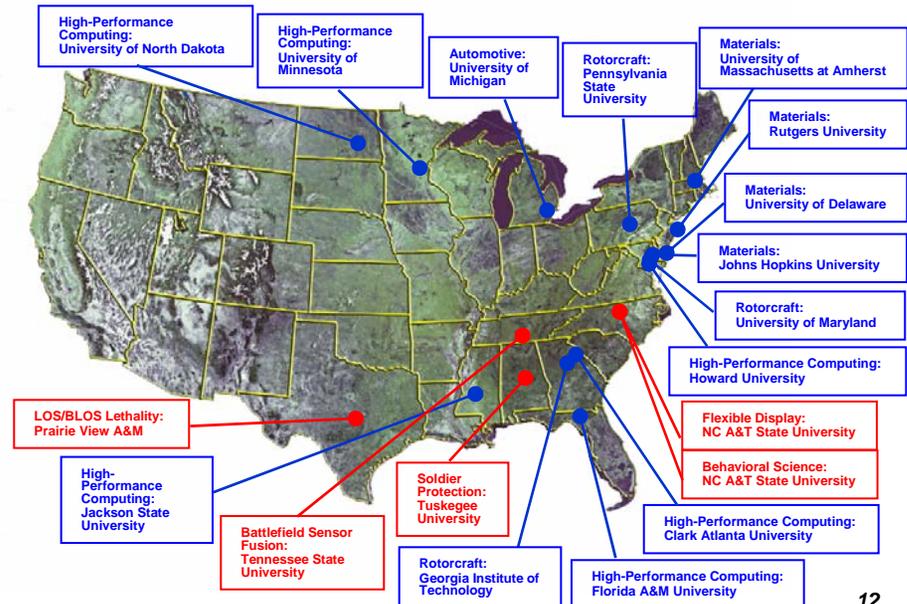
Adaptive Intelligent Laminates

Transition to Applied Research



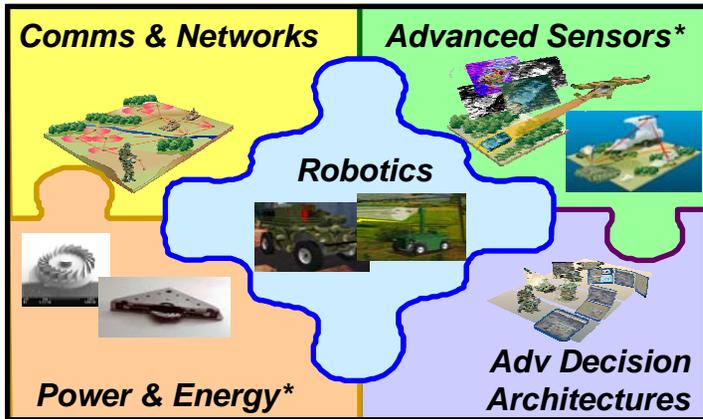
Advance the state-of-the-art for enduring Army needs

University Centers For Enduring Needs





Collaborative Technology Alliances



* Transitions to Micro Autonomous Systems & Tech CTA in FY07

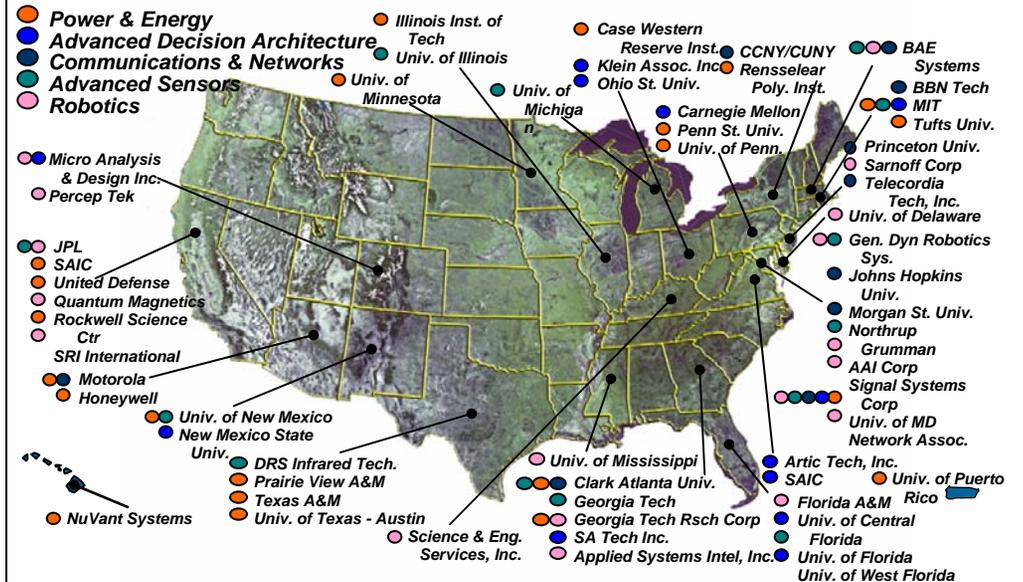
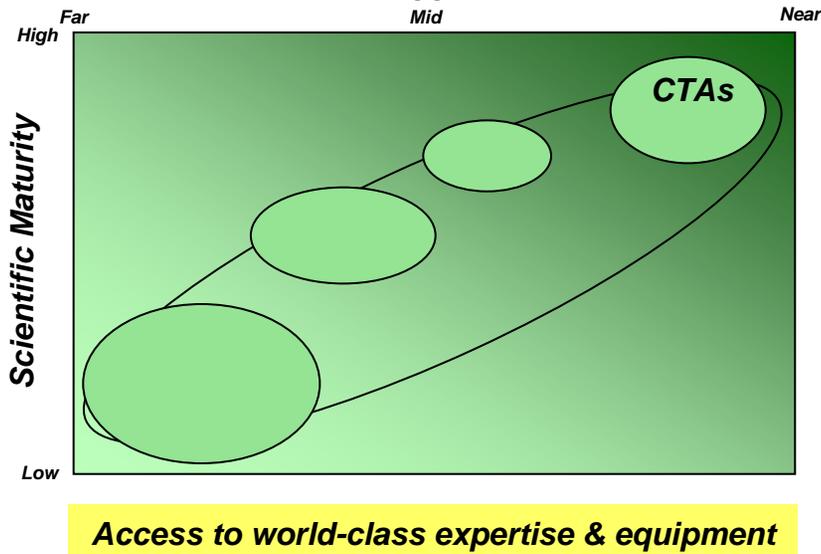
Micro Autonomous Systems and Technologies

Vision: Autonomous networked ensembles of multifunctional microsystems for enhanced battlefield situational awareness for the Soldier

Technical Challenges:

- Sensing, processing, communication, navigation & control
- Materials, devices, integration, & packaging
- Microbionic ambulation & aeromechanics
- Miniature power & energy
- Mobile, Distributed Sentience
- Platform Integration

Transition to Applied Research





New Initiatives

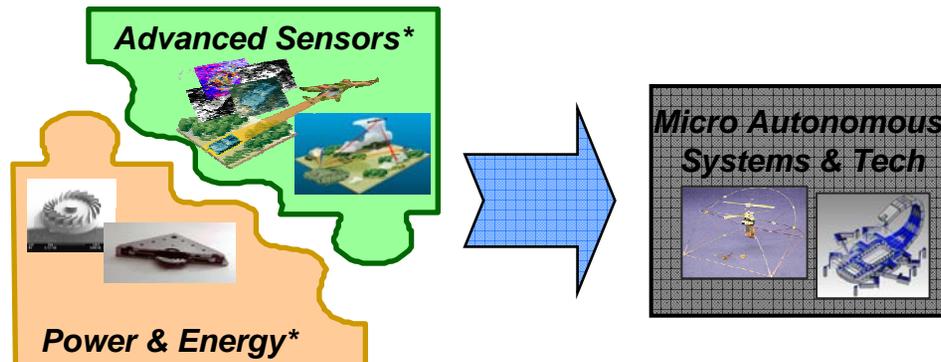


Collaborative Technology Alliances

Industry Led Partnerships with Major Universities and the Army

Micro Autonomous Systems & Technologies (MAST) CTA: Targeted refocusing of Advanced Sensors and Power & Energy CTAs on enabling technologies for next-generation robotic platforms

- **Payload power generation and management for palm-sized platforms**
 - Small size limits mission objective & duration
- **Power generation for mobile palm-sized platform**
 - Small size limits means for generating mobility
- **Bio-inspired and bio-mimetic sensing for navigation & control**
 - Small size requires simple sensors for navigation & control
- **Computational sensing**
 - Extracting information efficiently from data more important than improving sensor performance (e.g., dynamic range, resolution, frame rate)



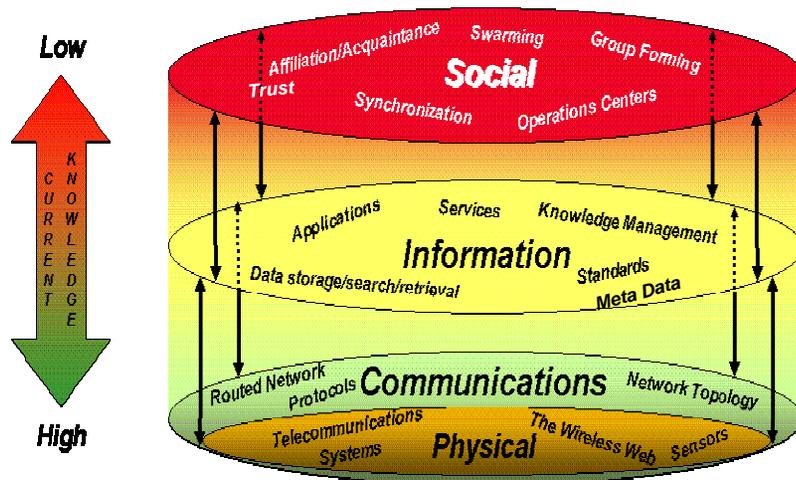


FY06 Initiatives

Network Science

- **Develop mobile ad-hoc networks (MANET) through an integrated research program in Network Science, including cognitive and social domains, comms, mathematical models, biomimetics, ecosystems, sensors, power and coalitions**

Command and Control \rightleftharpoons Collaborate and Connect



Project Provides:

- **Mathematical models of network behavior to predict performance with network size, complexity and environment**
- **Optimized human performance in network-enabled warfare**
- **Networking within ecosystems**
- **Molecular networking of proteins in cells**

Pacing Technologies:

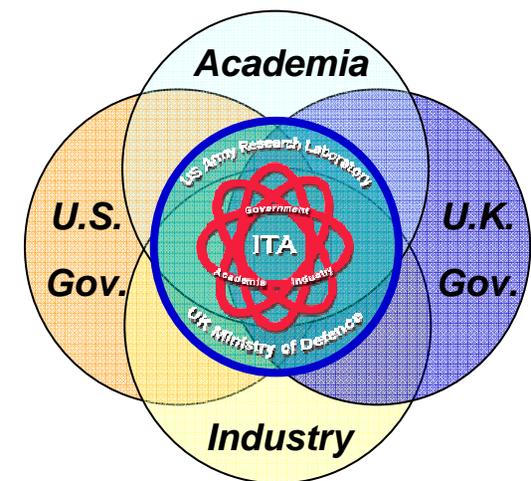
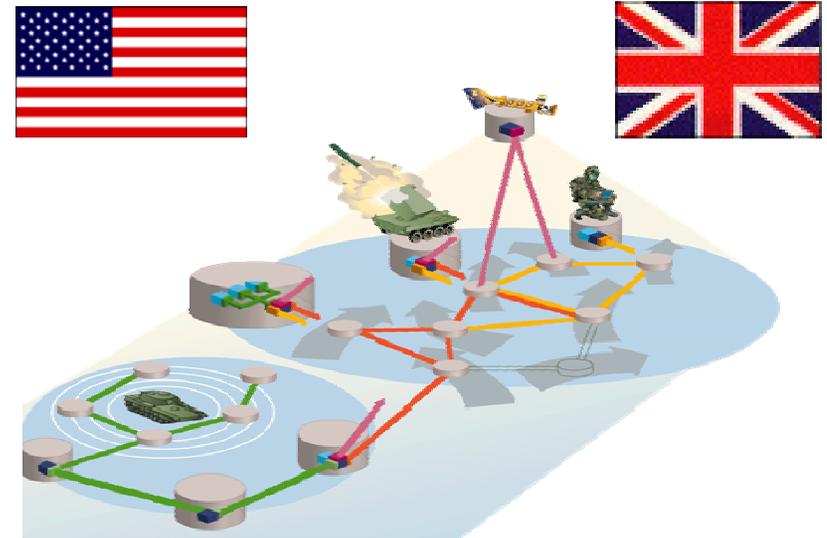
- **Statistical-based and analytic models for understanding MANET performance**
- **Cognitive and social models of individual and unit behavior in information-rich MANET environments**
- **Mathematical models of ecosystems as networks**
- **HPC exploitation of Interactomics**



Network & Information Sciences ITA

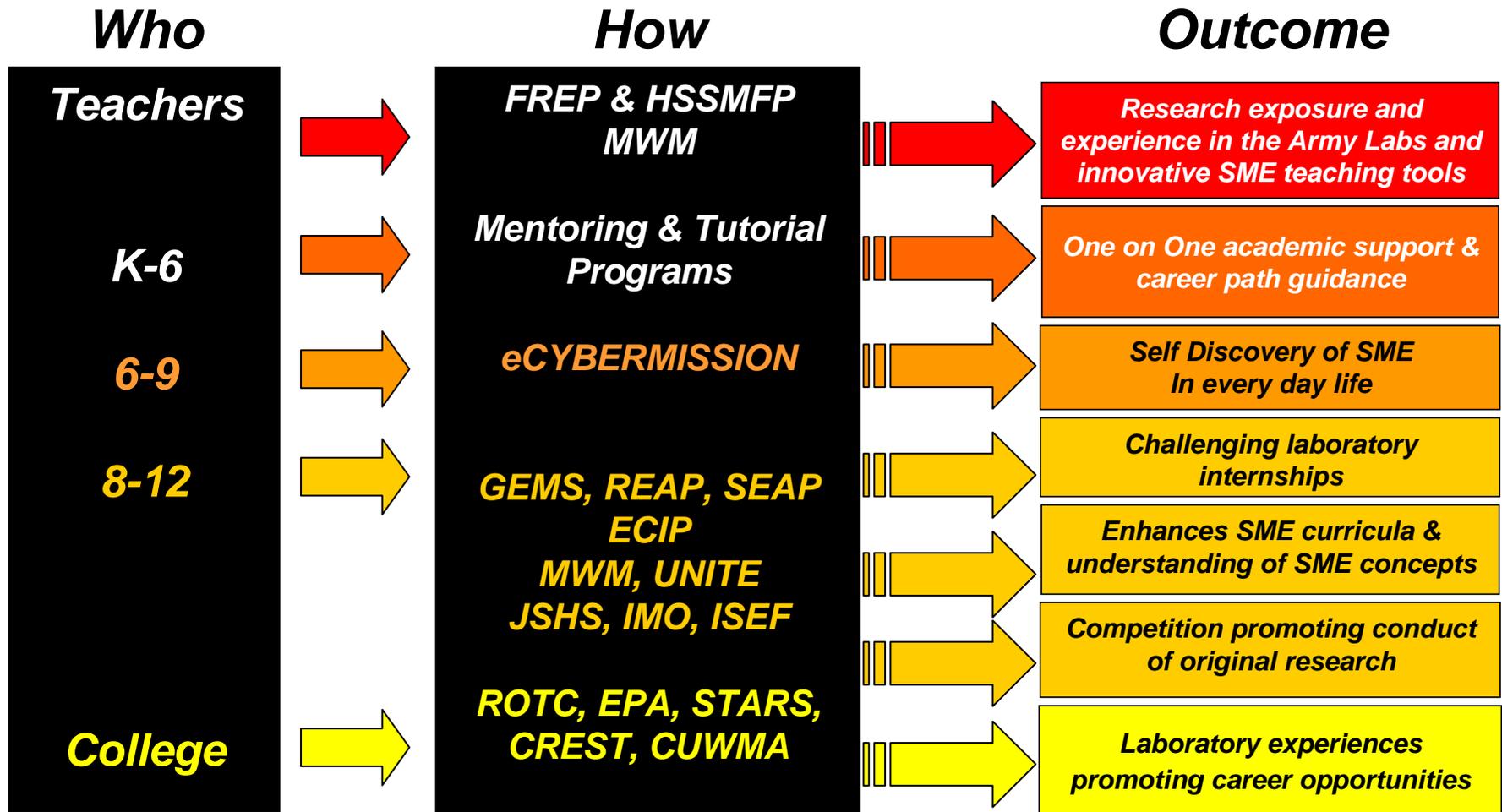
Jointly established research consortium formed from US and UK industrial and academic members for the purpose of conducting research to develop underpinning technology applicable to network centric warfare and to enhance US and UK capability to conduct coalition warfare

- ***Bi-lateral UK MOD—US Army collaboration***
- ***Integrated US/UK industrial/academic consortium***
- ***5-10 year program starting in Spring 2006***
- ***Builds on success of UK Defence Technology Centres and US Collaborative Technology Alliances***





Army Educational Outreach Program



Army S&T is committed to identifying, growing, and developing future generations of the Army's Scientist & Engineering workforce



Summary

- ***Focused on accelerating the pace of Army Transformation to the Future Force while seeking opportunities to enhance the capabilities Current Modular Force***
- ***Exploits innovation through partnerships between Army labs, academia and industry***
- ***Seeks to strike balance between Army unique in-house research and extramural research at various levels of maturity***
- ***Continues to push the boundaries – initiatives in Network Science, Army Educational Outreach and Micro Autonomous Systems and Technologies***



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Transformational Army Science & Technology

— Charting the future of S&T for the Soldier



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