



# Army Science & Technology



**NDIA**  
**10th Annual Science & Engineering  
Technology Conference**

*Empowering Soldiers  
through High Technology*

*21 April 2009*



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for Research and Technology/  
Chief Scientist**



# Overview

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- ***Army Science and Technology (S&T) strategy***
- ***Army S&T Priorities***
- ***Science for Disruptive Technology***



# Strategy—what is Army S&T working to achieve

**Foster innovation and accelerate/mature technology to enable Future Force capabilities while exploiting opportunities to rapidly transition technology to the Current Force**

## Current Force



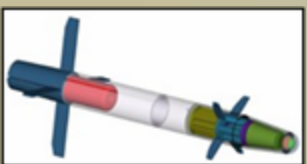
Modular Protective Systems



Add on Armor for Tactical Vehicles



Micro Air Vehicle



120mm Mid-Range Munition

Enabling the Future Force

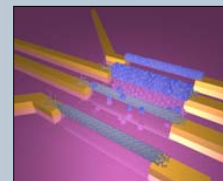


Enhancing the Current Force

## Future Force



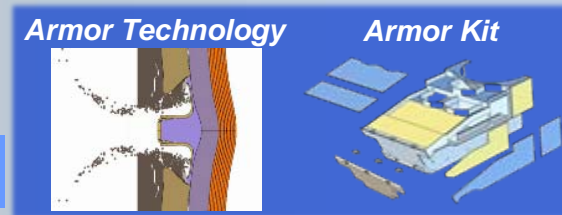
Immersive Training



Virus-based Self-Assembling Electrodes—  
Advanced Batteries



Wearable Flexible Displays

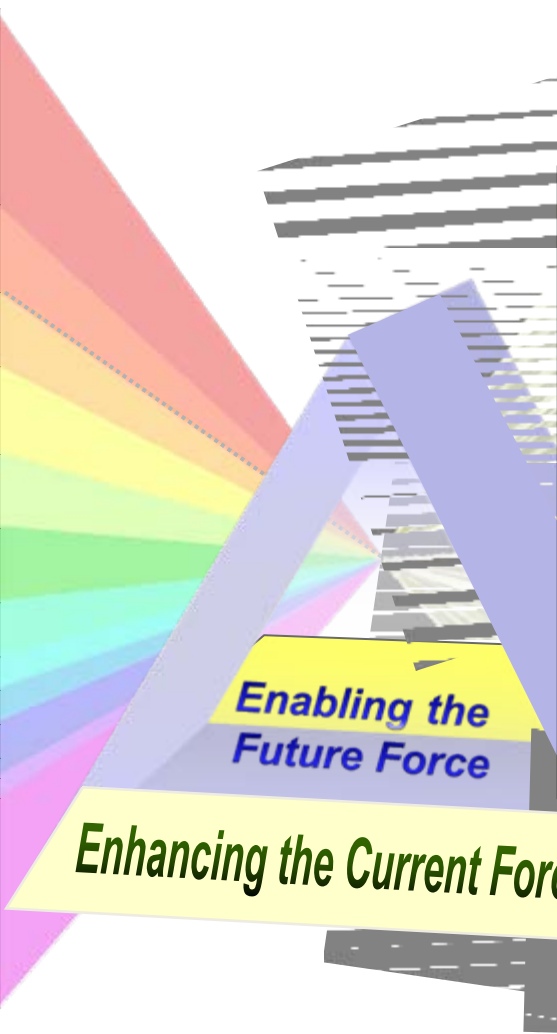
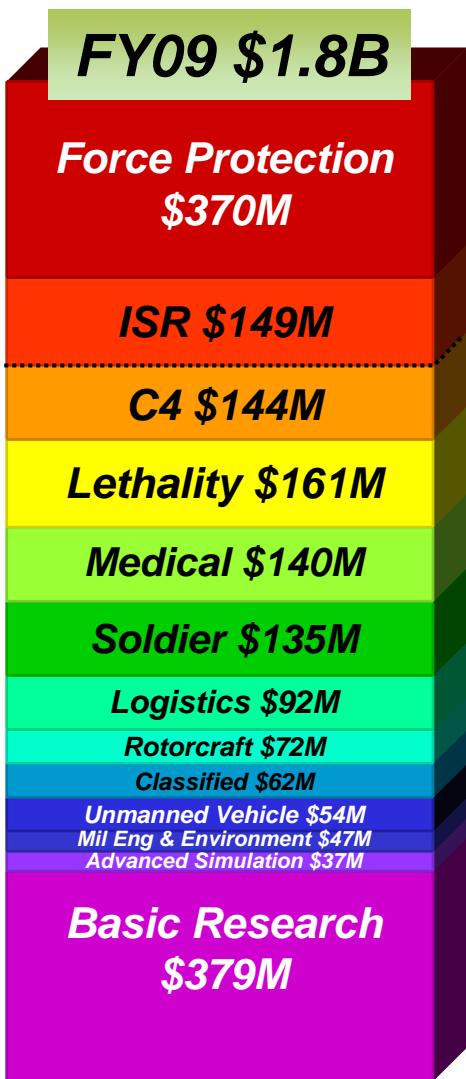


Armor Technology

Armor Kit



# Technology Area Investments



## List of 37 Tier One Warfighter S&T Outcomes (1 of 2)

- Battle Command Network\*
- Counter IED and Mine\*
- Power & Energy\*
- Human Dimension\*
- Training\*

**“Big 5” Integrated Warfighter S&T Outcomes**



## 10 Comprehensive Warfighter Outcomes— includes “Big 5”

- JCA • Battle Command Network
- Counter IED and Mine
- Power and Energy
- Human Dimension
- JCA • Training
- JCA • Force Protection
- JCA • Battlespace Awareness
- JCA • Force Application
- JCA • Logistics
- Unmanned Systems Operations

**Includes all Army Tier I Outcomes—aligned with S&T portfolio**

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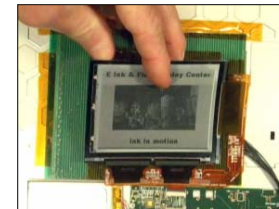
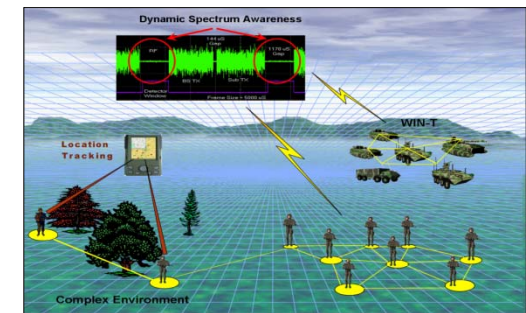
High Technology Army ARMY S&T

- Force Health Protection Initiative
- Increase control of unmanned systems
- Future Force Multi modal Human Computer Interface
- Increase Future Force Soldier Cognitive Functions While Under Stress
- Language and cultural awareness
- Dismounted soldier virtual training environment
- Adaptive training system



# S&T Strategy for Battle Command Network

- **Robust communications systems**
  - *Dynamic spectrum management*
  - *Antennas (e.g., Directional, SATCOM, Multifunctional)*
- **Information assurance**
  - *Network and Data security*
  - *Intrusion detection/mitigation*
- **Timely geospatial awareness**
- **Knowledge Management**
  - *Decision aids*
  - *Intelligent agents that extract data for critical combat functions*



**Enabling Command and Control On-the-Move**

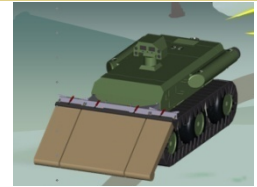


# Technology for Counter-IED

RKG-3 EFP Grenade Trainer

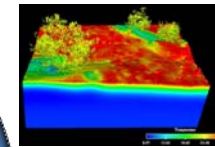


Dynamic Mine Clearing - SBIR Program



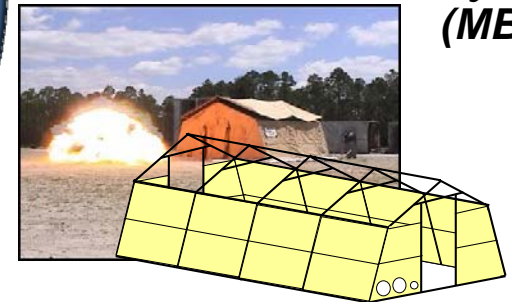
IED/Mine Detection for In Road Threats

Recognition of Combatants - IED



Near-Surface & Countermining Phenomenology

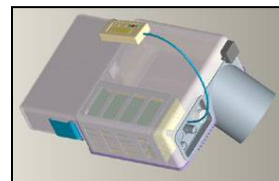
Modular Ballistic Protection System (MBPS)



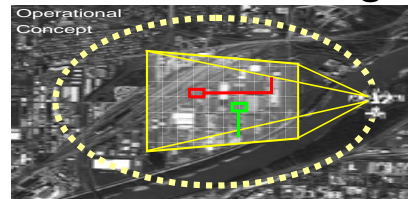
Ghost



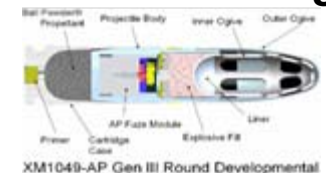
Wizard Dismounted CREW System



Constant Hawk Night



Standoff Mine/IED Defeat Technology



XM1049-AP Gen III Round Developmental

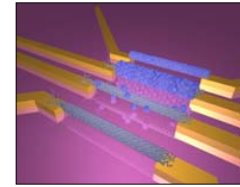


# S&T Strategy for Power and Energy

- **Reduce platform energy consumption**
  - **Lightweight materials**
  - **Lower power electronics**
  - **Unmanned vs. manned platforms**
- **More efficient power sources**
  - **Batteries with higher energy/power density**
  - **Fuel cells**
  - **Hybrid power sources**
- **Smart energy management**
- **Proactive thermal management**
  - **Higher temperature materials**
  - **Harvesting of thermal energy**
- **Provide energy options (e.g., alternative fuels, solar)**



Low Power  
Color Helmet-mounted Display



Virus-based Self-Assembling Electrodes



Direct Methanol  
Soldier Fuel Cell



Vehicle Power Distribution



Vehicle Thermal  
Management

**Reduce Fossil Fuel and Battery Demand**



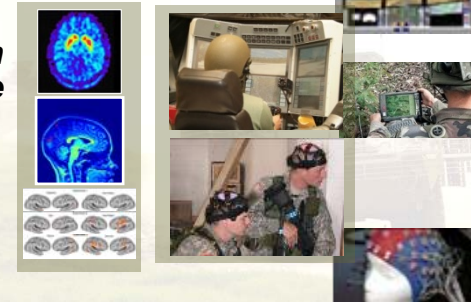
# S&T Strategy for Human Dimension

- **Comprehensive Soldier fitness**
  - **Physiological (e.g., trauma treatments, prediction tools for physical damage assessment, vaccines and diagnostic systems for infectious diseases)**
  - **Psychological (e.g., psychological well-being—Post Traumatic Stress Disorder and mild Traumatic Brain Injury)**
- **Optimize Soldier cognitive functions—under battlefield stress and multitasking environments (e.g., Soldier system interface design – neuro-ergonomics)**
- **Enhance recruitment and retention—develop tools/methods**
- **Develop network-centric automated prediction, reasoning and decision-support tools**



Neuroergonomics designs

MRI Brain Image



Spatial Cognition Experiment

**Enhance Soldier Effectiveness**





# S&T Strategy for Training

- **Accelerate Soldier learning**
  - **Develop innovative tools and methods (e.g., intelligent tutoring/coaching, platform-scalable, culturally realistic, automated performance assessment)**
  - **Tailorable training packages that are easily modified to address current events and mission needs**
- **Embedded training (mounted and dismounted)**
- **Improve leader skills**
  - **Investigate techniques that accelerate the development of skills to enhance decision making, build teams, lead complex organizations**
  - **Identify leader skills, abilities, and effective behaviors in complex environments (e.g., culturally diverse scenarios)**



**Efficient Soldier Need-based Training**



# S&T Strategy for Force Protection

- **Soldier protection**

- **Body armor**

- *Flexible armor for extremities*
- *Advanced helmet designs*
- *Ballistic/blast thoracic protection*

- **Ballistic and laser vision protection**

- **Platform protection**

- **Armor (e.g., composite, reactive, electromagnetic)**

- **Active protection (e.g., counter-munition, EW)**

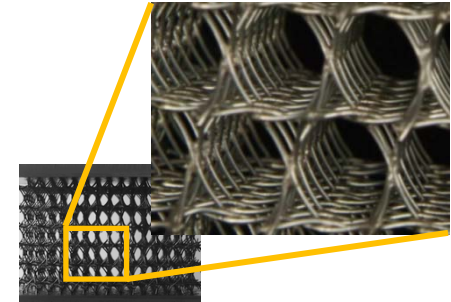
- **Platform design for crew/vehicle survivability (e.g., V-shaped hulls, blast resistant seats)**

- **Facility/area protection**

- **Hardened structures**

- **Entry control point protection**

- **Defense against rockets, artillery, and mortars (RAM), UAVs, and missiles (e.g., high energy laser)**



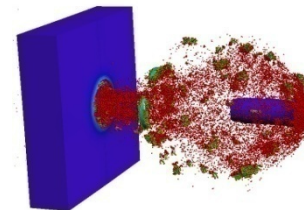
*Bio-Inspired Energy-Dispersive Materials*



**MRAP**



*HMMWV Improvement Program*

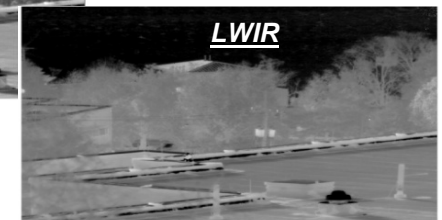


*Macro/Meso-Scale, Mesh-Free Simulations of Protective Materials*



# S&T Strategy for Battlespace Awareness

- **Persistent sensing**
  - Detecting (e.g., Electro-optic/Infrared, acoustic)
  - Tracking (e.g., radars)
  - Identifying (e.g., 3<sup>rd</sup> GEN FLIR)
- **Network exploitation and data fusion**
- **Locate persons/items of interest**
  - Tactical biometrics (e.g., facial recognition)
  - Tag, track, and locate (TTL)
  - Combat Identification
- **Information operations**
  - Security/warfare
- **Signal detection**
  - Mapping and geo-location

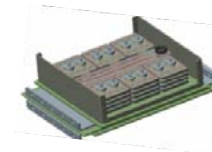


**Reliable, Real-time Knowledge of the Battlespace**



# S&T Strategy for Force Application

- **Multifunction precision lethality**
  - Precision munitions
  - Warheads/energetics/insensitive munitions
  - Scalable lethality
- **Pursue novel mechanisms**
  - Non-lethal weapons (e.g., high-power microwaves, directed energy)
- **Soldier weapons**
  - Lightweight weapon components/ammunition
  - Wall breaching munitions
  - Advanced Soldier targeting/sighting systems

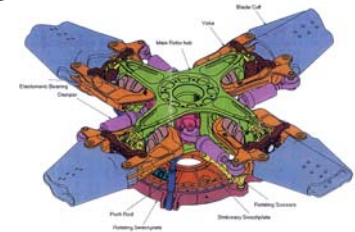
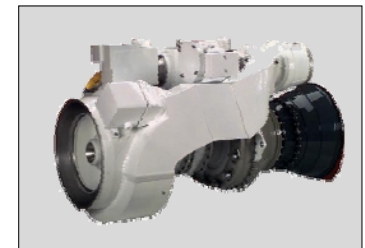
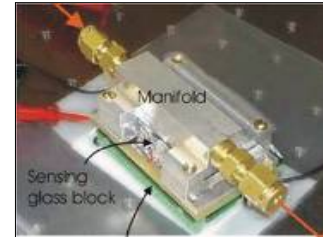


**Scalable Precision Lethality—Minimize Collateral Damage**



# S&T Strategy for Logistics

- **Reduce fuel and water battlefield delivery**
  - **Alternative energy sources**
    - Diesel fuel reforming
    - Waste-to-energy conversion
    - Hybrid power sources
  - **Water generation and purification**
- **Develop efficient turbine, hybrid engines and propulsion systems**
- **Comprehensive condition-based maintenance**
  - **Embedded prognostics/diagnostics**
- **Pursue lightweight materials technologies (e.g., composites, lightweight track)**
- **Improve precision delivery of Soldiers/equipment (e.g., air drop)**



**Reduced Fully Burdened Cost of Logistics**



# S&T Strategy for Unmanned Systems Operations

- **Remove the Soldier from dangerous and “dirty” work through development of autonomous ground and air platforms**
  - **Autonomous perception with high resolution, long range, 360 degree ability to detect and respond appropriately**
  - **Autonomous/near-autonomous maneuvers and tactics in relevant environments and complex terrain (manned-unmanned collaboration)**
- **Micro-autonomous Systems**



MAV



UGV



Packbot



Nanoflyer



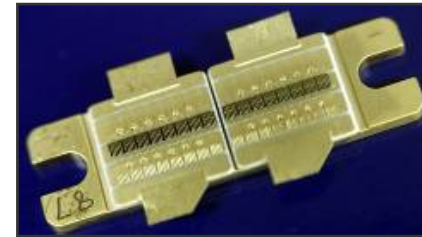
Micro Autonomous Systems  
Technology CTA

**New Capabilities With Reduced Manpower**



# S&T Enabling Affordable Manufacturing

- **Addressing concepts for manufacturing processes in fundamental research on materials—nanotechnology, biotechnology**
- **Integrating technology development with manufacturing processes—flexible displays, MEMS IMU**
- **Designing technology to facilitate affordable production—smaller, lighter, cheaper munition components**
- **Aligning manufacturing technology investments with key technologies for future systems—armor, SiC switch technologies, IR focal plane arrays, batteries and RF electronics for FCS**
- **Addressing manufacturing issues in support of programs of record—PAX-41 (SPIDER Mine), UH-60 composite tailcone**



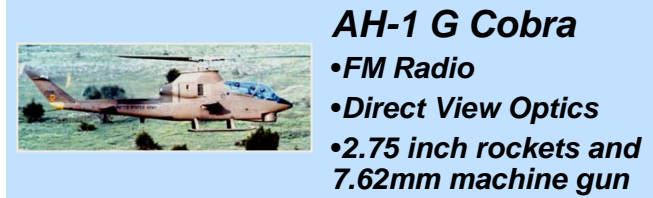


# Complexity Demands Disruptive Technology

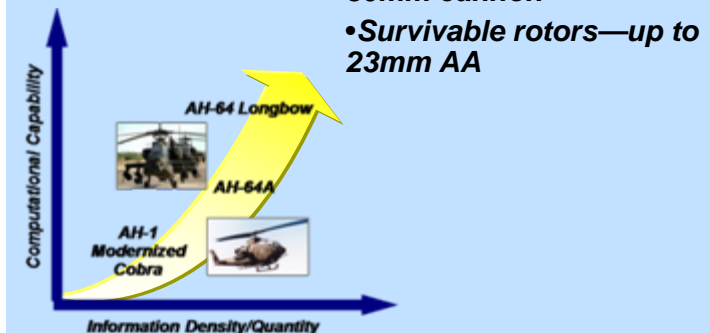
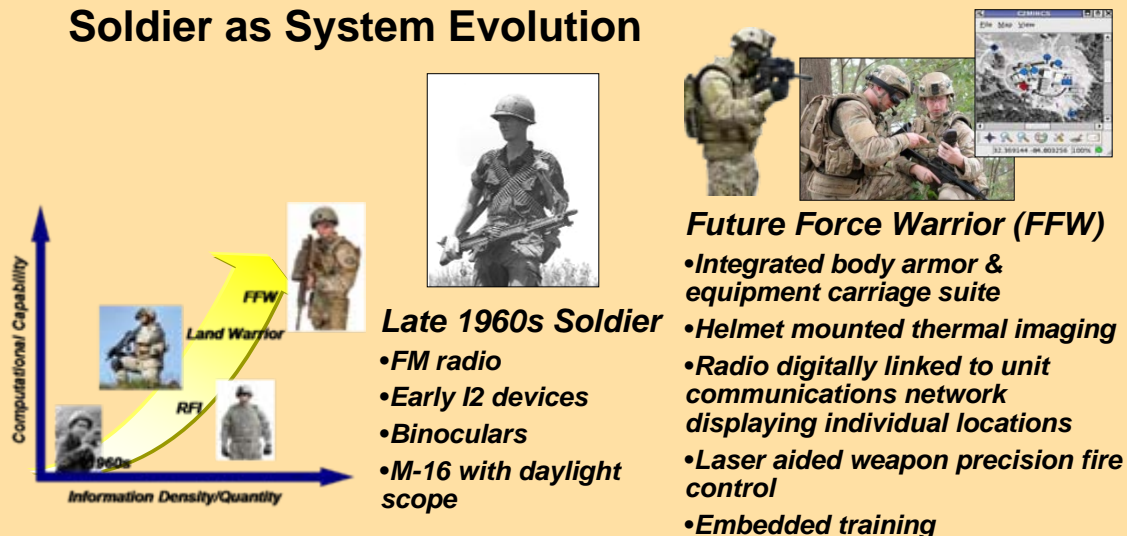
## Ground Combat Vehicle Evolution



## Helicopter Evolution



## Soldier as System Evolution

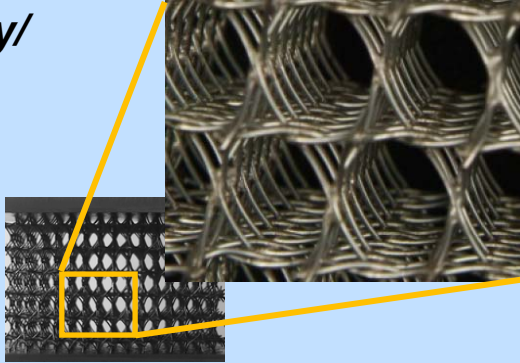
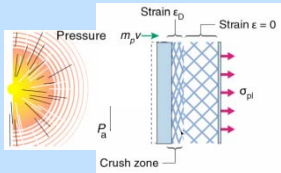




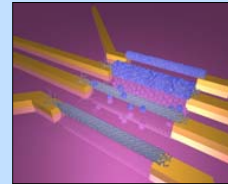


# Science for Disruptive Technology

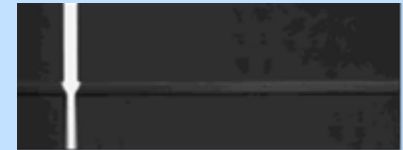
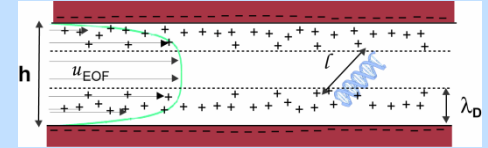
## Nanotechnology/ Biotechnology



Bio-Inspired Energy-Dispersive Materials

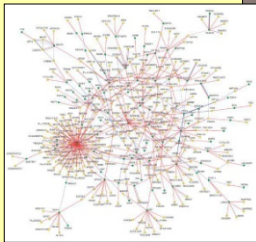


Virus-based Self-Assembling Electrodes



Nanofluidics

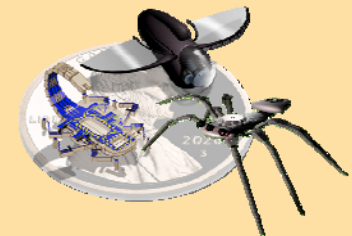
## Network Science



## Autonomous Systems



Nanoflyer

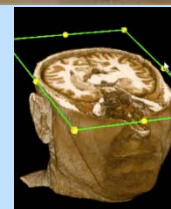
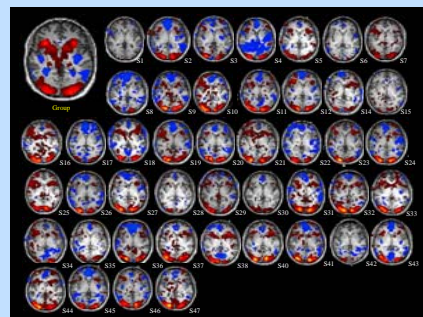
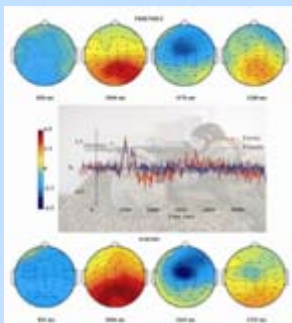


Micro Autonomous Systems  
Technology CTA



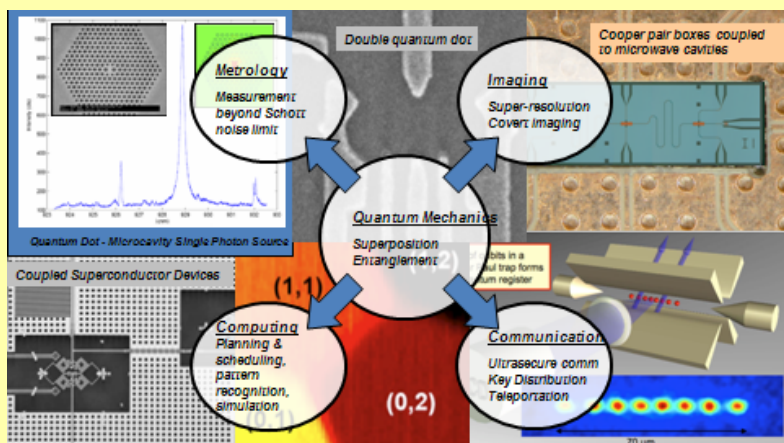
# Science for Disruptive Technology

## Neuroscience



fMRI

## Quantum Information Science



## Immersive Technology





# Basic Research Thrusts

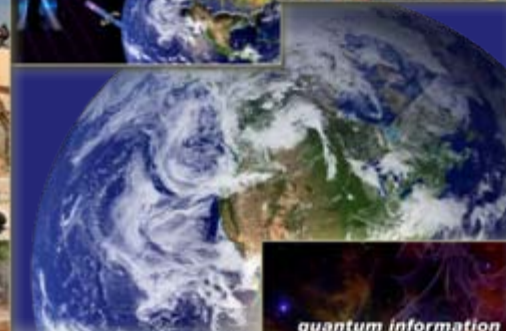
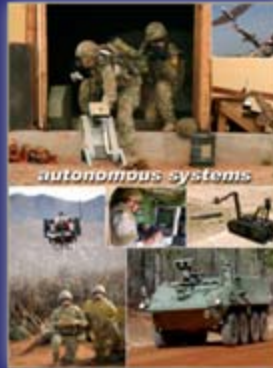
*Research in human engineered and biologically evolved networks to enhance network-centric operations*

*Discover, develop and exploit robotic devices and systems to dramatically enhance Soldier survivability*

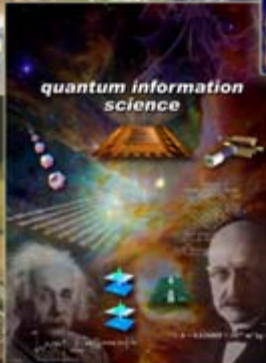
*Revolutionize military training and mission rehearsal through the development of technology and art for simulation experiences and the development of virtual human technology*



*Research in learning, decision models and the functional brain to improve training techniques, human-machine interface design, and to more fully understand the decision-making process*



*Research to understand biological construction of novel materials, structures and processes to develop biologically-derived materials, sensing systems, information processing and power and energy*



*Generate advances in quantum sciences that will enable revolutionary approaches to information processing, cryptography, information assurance, and communication*



# Partnering—leveraging other Services, Agencies, Academia, Industry & International

## Other Services

- Air Force
- Navy/USMC



PTSD treatment

Versatile, Affordable, Advanced Turbine Engine



## Agencies

- DARPA
- DTRA
- DoE labs
- DHS
- NIH
- NASA

Micro Air Vehicle



NLOS-LS

## Academia

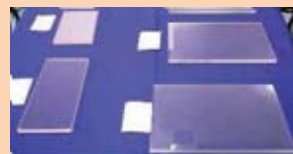
- Georgia Tech
- MIT
- Penn State
- USC
- UMd
- UC System
- Delaware
- Michigan
- Arizona State

⋮

## Industry

- Primarily technology development to create options for PMs
- Small Business Innovation Research—solutions from non-traditional sources
- Army Venture Capital Initiative—dismounted Soldier power

Transparent Armor—Technology Assessment & Transfer, Inc.



## International

- The Technical Cooperation Program (US, UK, CA, AUS, NZ)
- NATO Research & Technology Organization
- Bilateral Agreements (UK, CA, IS, FR, GE...)



Co-investment with UK to advance state-of-the-art in network science





# Fostering Science and Engineering Careers



Students participating in bridge building exercise at George Washington University



Student in bio-suit at Walter Reed Army Institute for Research



**Tomorrow's Technology is in the Minds of Today's Youth**



# Summary

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- ***Investments are aligned to Army needs—emphasis on the future with an “eye” on the present***
- ***S&T funding competes with other Army and DOD priorities***
- ***The Army S&T enterprise includes—Army laboratories, other Services and Agencies academia, industry and international partnerships***
- ***America’s economic survival requires more students to seek science and engineering careers***

***S&T strategic investments provide options for an uncertain future—inventing the possible***



# Army S&T...

# Engine of Transformation



**U.S. ARMY ARMAMENT RESEARCH,  
DEVELOPMENT AND  
ENGINEERING CENTER  
2007 MALCOLM BALDRIGE  
NATIONAL QUALITY AWARD**