The ability of the future force to establish an “unblinking eye” over the battlespace through persistent surveillance will be key to conducting effective joint operations.

- Quadrennial Defense Review Report (February 6, 2006)
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Quadrennial Defense Review Report (February 6, 2006)
Flexible Displays

Nanoelectronics and MEMS

Advanced Concepts

Photonic Devices

RF Directed Energy

Magnetic & Electric Field Sensing

Lasers / Sources

Power Sources for Soldier Power & Auxiliary Power

Prognostics and Diagnostics

Small Radar

Magnetic & Electric Field Sensing

Power Components for Hybrid Electric Vehicles & Pulse Power

RF Front Ends
Challenges: The Stage

- Urban
- Borders/Perimeters
- Caves
- Riverine
- Jungles/Canopy
Challenges: The Environment

Urban / Cave Warfare Requires Sensors for Detecting the Enemy

Excessive Heat, Humidity, and Dust in the Environment

Riverine – Limited Access Environment

Jungle Canopy – degraded mobility, aerial surveillance, and communications

Non Line of Sight in Urban Environments
Emerging Solutions

Persistent ISR to OIF

Family of UGS

Wearable Sensors

Persistent Threat Detection System to OIF

Microsystems

Unmanned Equipment for Scouting and Detection
Decade of the 1970’s

Structural Imaging

1971 – First Practical X-ray Computed Tomography Image

Artificial Intelligence

1970 – Shakey the robot

Microprocessors

1971 – First 4 Bit Microprocessor in Production

Supercomputing

1975 – Cray I Supercomputer

Nanotechnology

Functional Brain Imaging

Immersive Environments

Robotics

Biotechnology

From March, 2006 presentation by Dr. John Parmentola, Army Director for Research and Laboratory Management

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GOAL: Multifunctional 3-D nanodevice architectures for electronic textiles and networked microsystems for remote sensing applications

OBJECTIVE: Fundamental research on integrated nanoelectronic devices

ARL’s in-house nanoelectronics basic research capability:
- Discrete nanodevice fabrication:
  - Thermal CVD SW-CNT growth
  - Directed nanoscale assembly
  - Nanoscale manipulation
  - 3-D nanoscale architectures
  - Microfluidic channels
- Nanoelectronic device testing:
  - Micro- to nanoscale probing
  - DC to 110 GHz
  - 4.5-475 K
  - fA sensitivity
  - Controlled ambient environments

Research focus:
- Amperometric sensors
- Ultra-high frequency (GHz-THz) communications & sensor devices
- Nanoscale thermal management
- Ensemble effects in nanoelectronic devices
Biologically directed assembly of flexible batteries:
- Use genetically modified viruses to control assembly of cobalt oxide anode
- Polymer electrolyte
- Standard cathodes (metal rod or sheet shown)

Virus fibers for use in multifunctional textiles:
- Virus-assembled barcodes
- Electro-spun virus fibers for sensor & electronics applications

Prof. Angie Belcher, MIT
Dr. Charlene Mello, NSRDEC

Higher Capacity, Faster Reaction Rates

Approved For Public Release
SCIENCE
Amplifying Fluorescing Polymer (AFP) developed by MIT ISN Prof. Swager glows green, but quenches when TNT is present.

MOLECULAR ENGINEERING
design molecules to react specifically

TNT Detected

DETECTION OPPORTUNITY
Hidden explosives give off traces of chemicals, which may be detected.

FIDO Units in Iraq for Evaluation (2005) – Integrated on robot and handheld

Integration of Chemical / Biological Sensing with Electronics.
Networked Fusion & Understanding

Intent “Preventive therapy”

Preventative models → Diagnostic models → Anomaly detector

Feedback to resource management

Physical precursors → Informational precursors

Measure & extract features → Fusion → Actual & Predicted

Databases

Characteristics:
- Scalable
- Adaptive
- Expandable
- Modular

Challenges:
- Network Architecture
- Robust Fusion Engines
- Autonomous Management
- Up-to-date

Data Flow Architecture

Centralized

Distributed

Decentralized
Shaping the Vision: Operational Scenarios

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

Scenario #1: small unit building search
Autonomous navigation in benign indoor environment with human mission control

Scenario #2: small unit cave search or demolished building
Autonomous navigation in complex environment with human mission control

Scenario #3: small unit perimeter defense
Autonomous navigation in complex environment with autonomous mission control
Electronics, Power, and Microsystems
Critical Components for
Emerging Army Applications

We can make a difference to them