



# ***Defense Modeling and Simulation***

***23 May 2000***

**Dr. Delores M. Etter**

**Deputy Under Secretary of Defense (Science & Technology)**

# DoD Science & Technology Mission



*To ensure that the warfighters today and tomorrow have superior and affordable technology to support their missions, and to give them revolutionary war-winning capabilities.*



# Revolutionary Capabilities

*Stealth*



*Adaptive Optics and Lasers*



*Night Vision*



**DoD S&T**

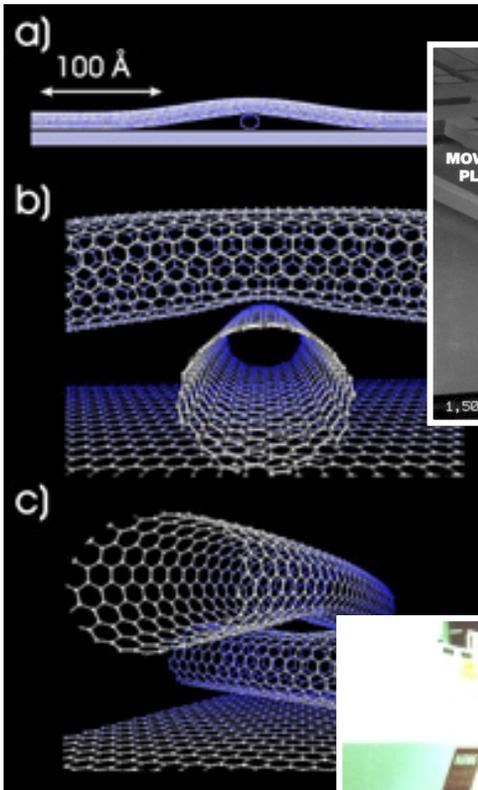
*Phased Array Radar*



*GPS*

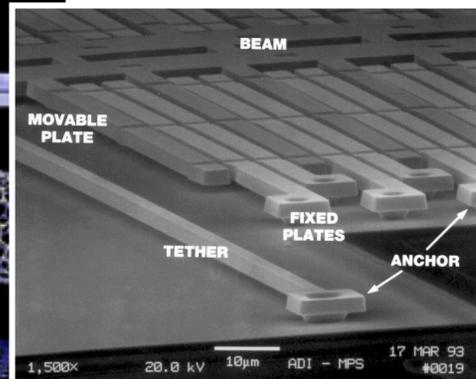


# Current S&T

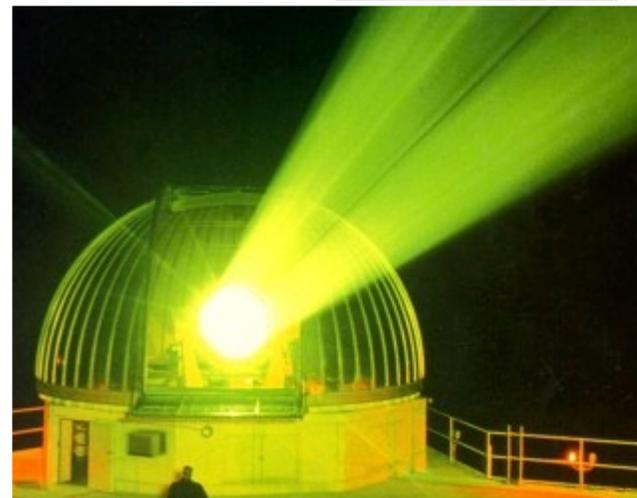


**Nanoscience**

**Biolab**

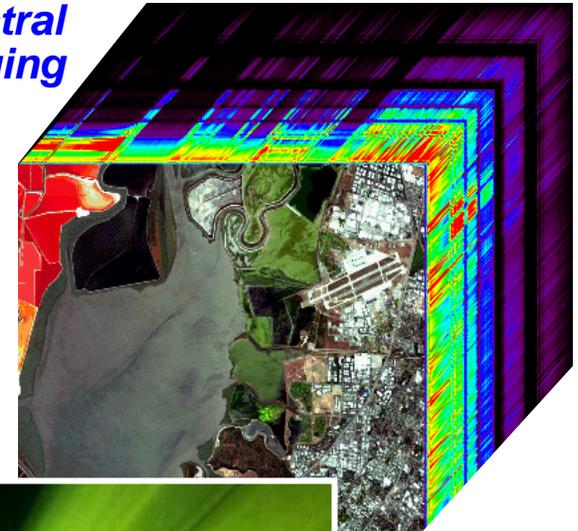


**MEMS**  
microelectromechanical  
systems

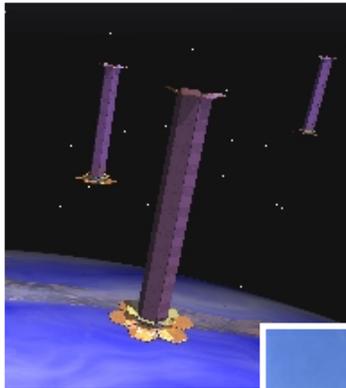


**Starfire**

**Hyperspectral  
Imaging**



# Future Revolutionary Capabilities



**Microsatellites**



**Micro Air Vehicles**



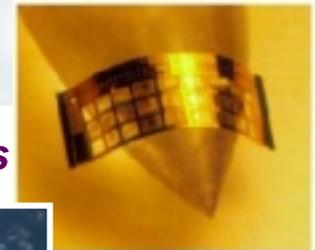
**Micro Robots**



**DD-21**



**Joint Strike Fighter**



**Flexible Sensor Skins**



**Augmented Reality**

**Bio Sensors**



**Embedded Biofluidic Chips**



**Handheld**



# Changing Environments



## Security Threats

States that Threaten International Peace and Security

International Crime Organizations

Transnational Actors/ Terrorists

Weapons of Mass Destruction

## 21st Century

Conflict Increasing

Proliferation of Military and Commercial Technologies

Operations in Urban Environments

Preponderance of Coalitions

Ethnic Strife

## Impact

Greater Range of Solutions

No US Monopoly in all Technologies

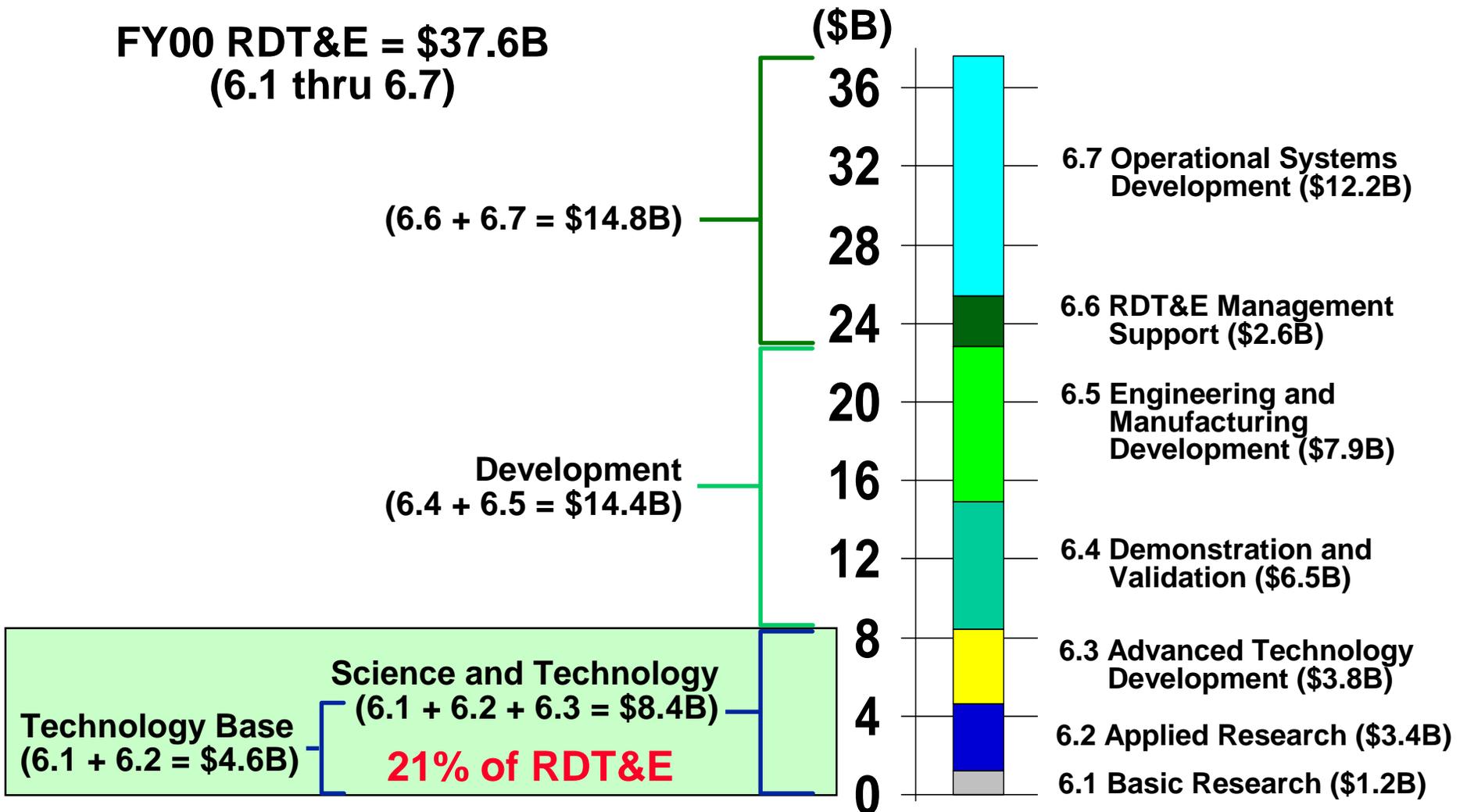
Complex Targets/Terrain

Information Management Critical

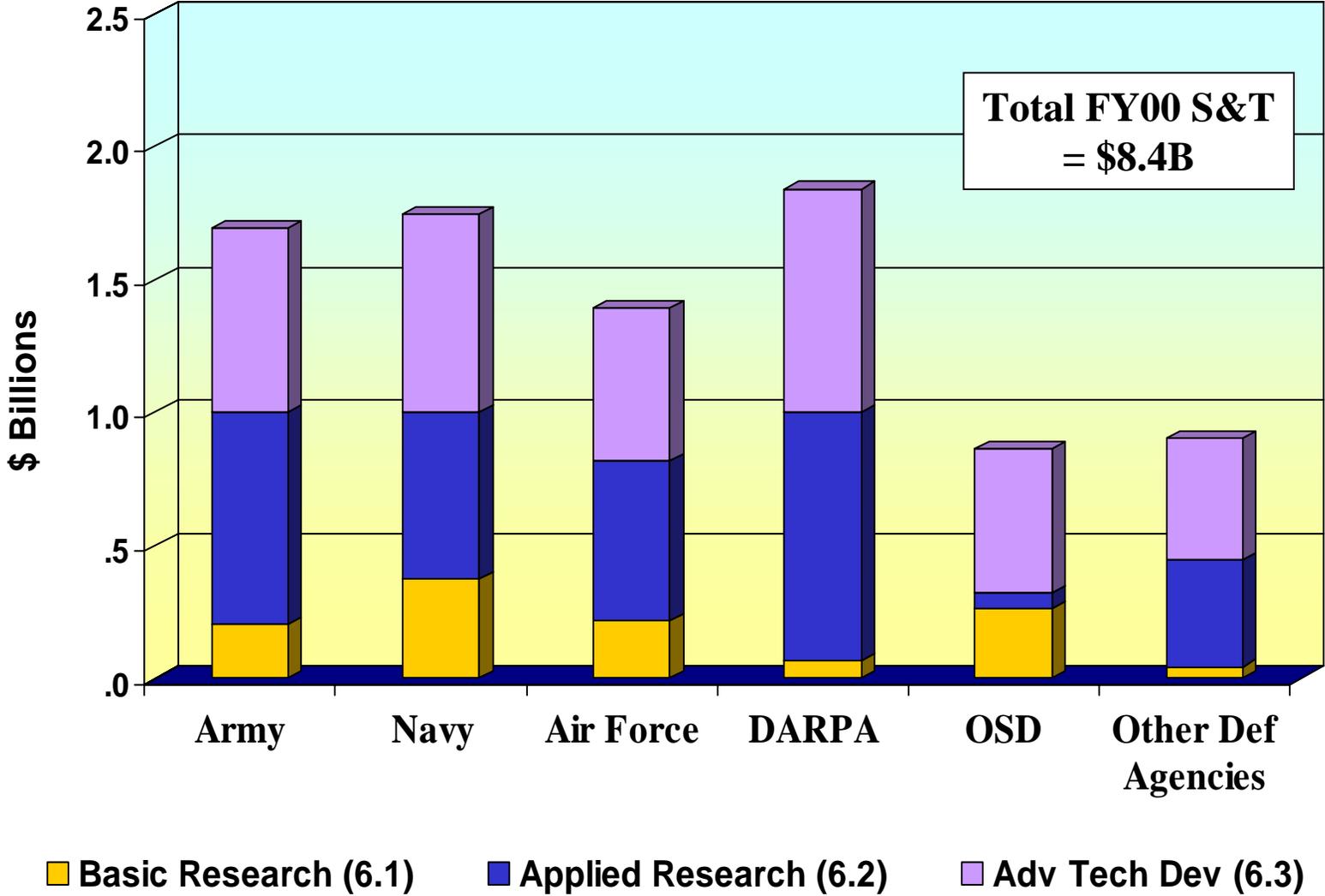
# FY00 RDT&E



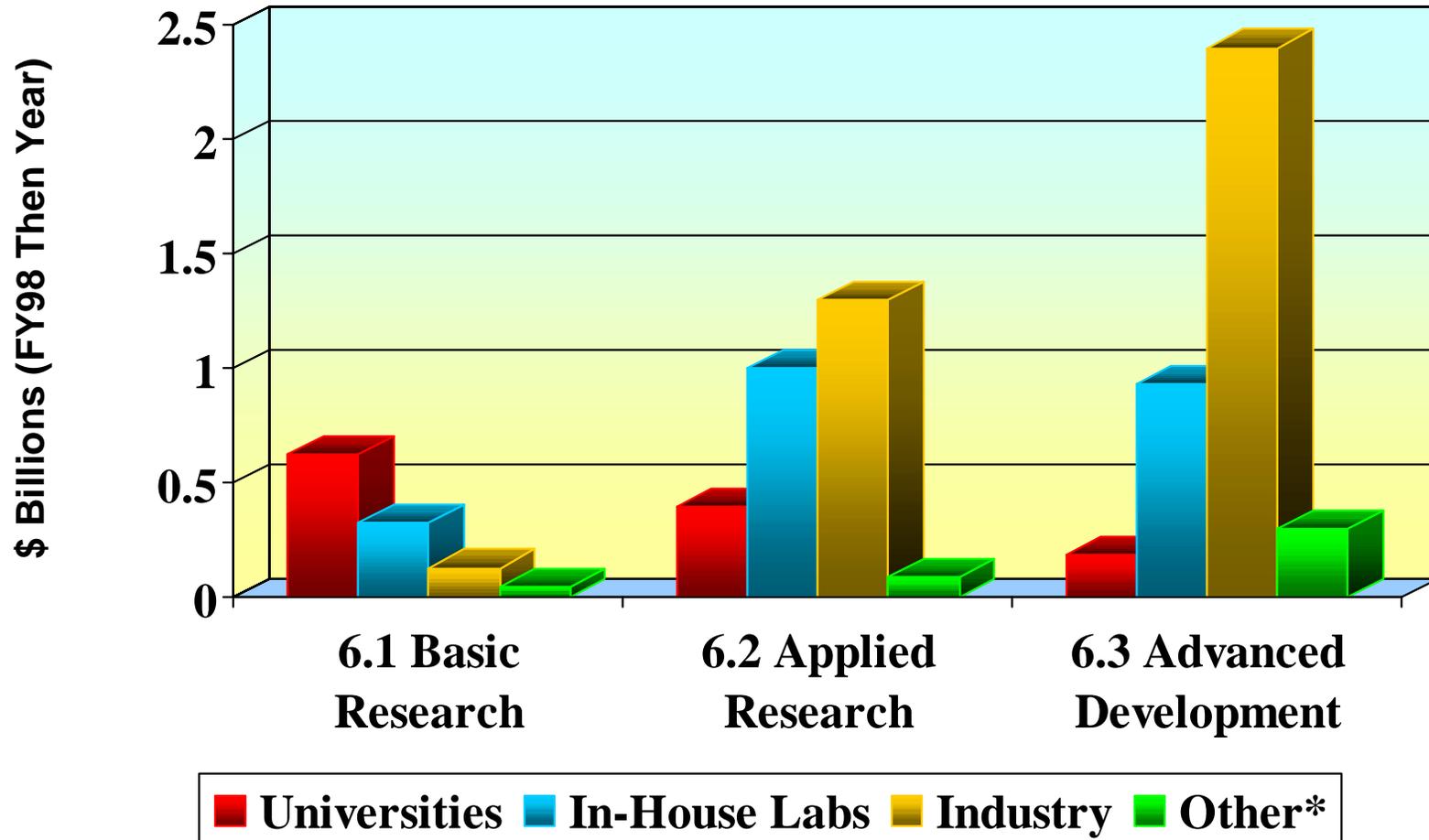
**FY00 RDT&E = \$37.6B**  
(6.1 thru 6.7)



# DoD S&T Investment



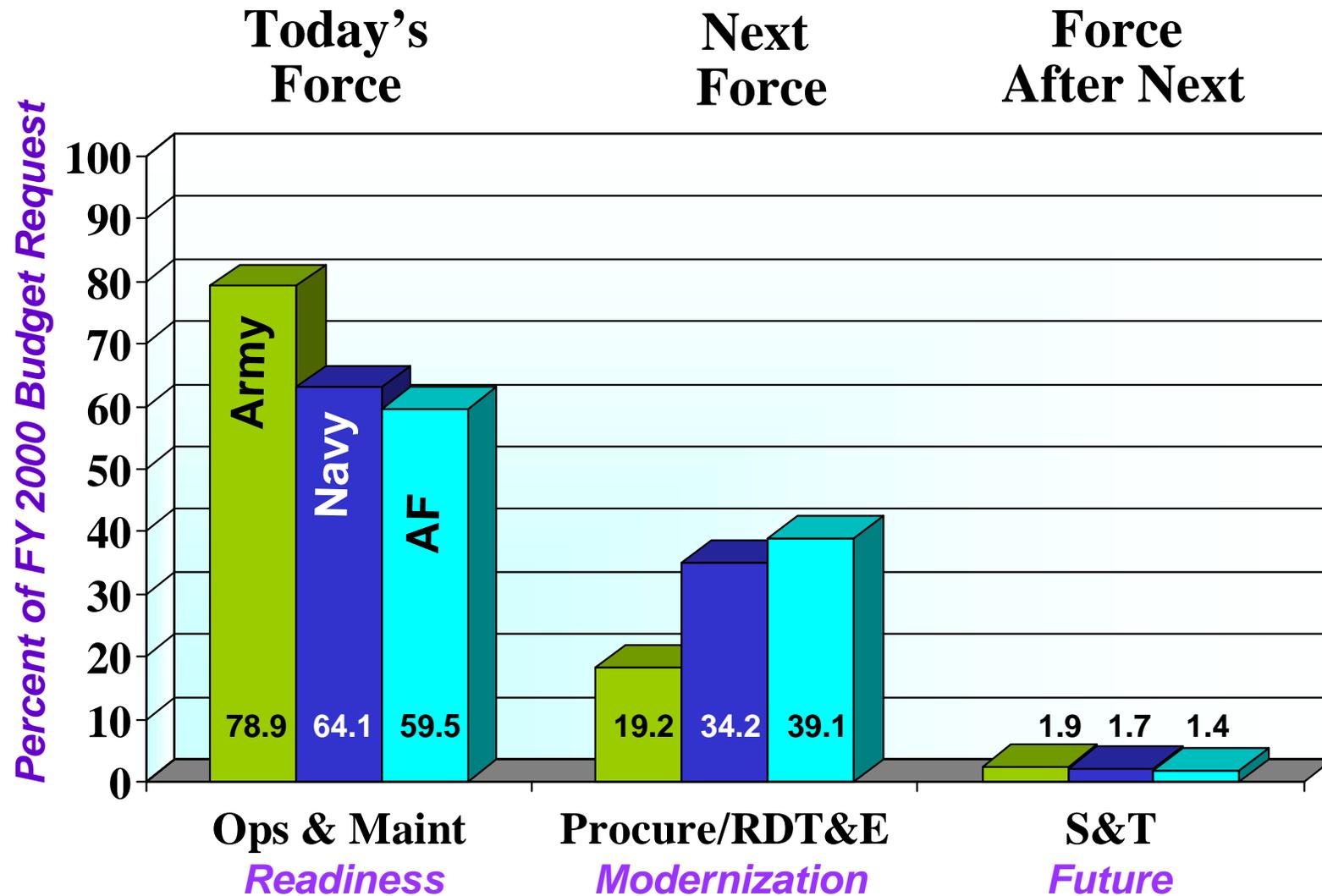
# Recipients of DoD S&T Funds



\*Includes non-profit institutions, State & local govt., & foreign institutions

Source: National Science Foundation Report, NSF 98-332 (FY 1998)

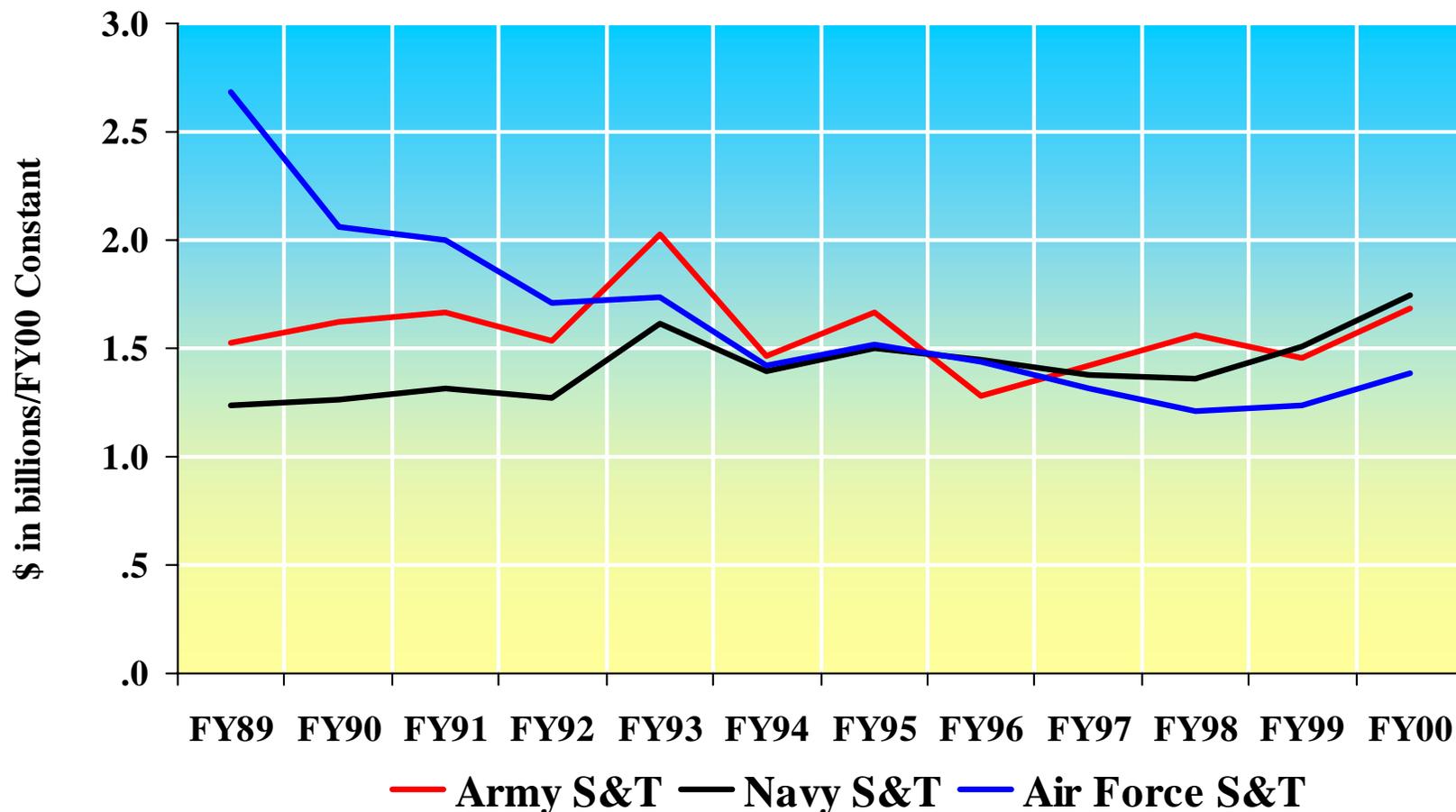
# Technology Perspectives FY00 Appropriated



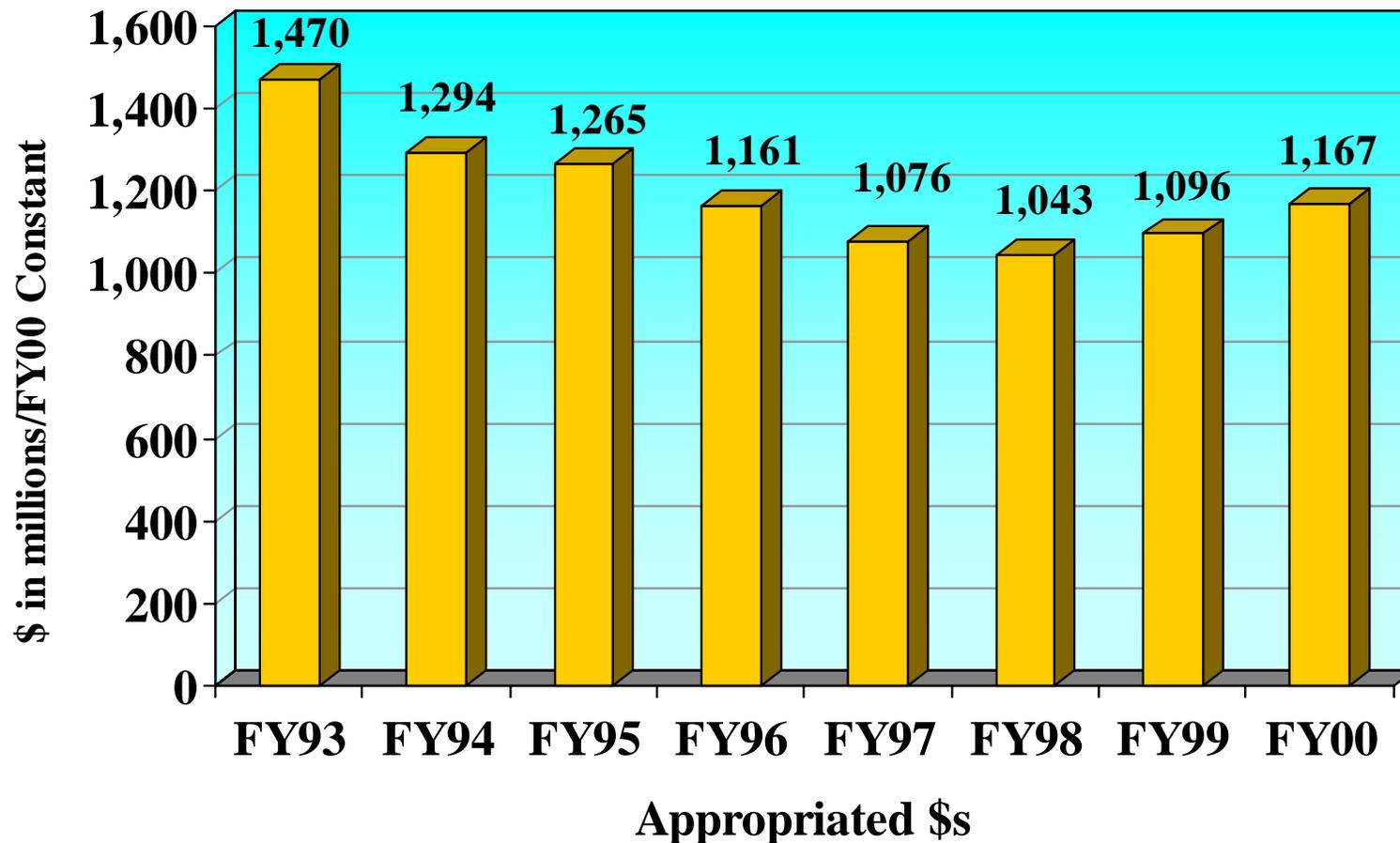
# Service Investment in Science & Technology



## Services Science & Technology (S&T) (6.1, 6.2, 6.3)



# DoD 6.1 Basic Research



**Basic Research funding down over \$300M  
(~21%) in purchasing power since 1993**

# DUSD (S&T) Priorities (2000)

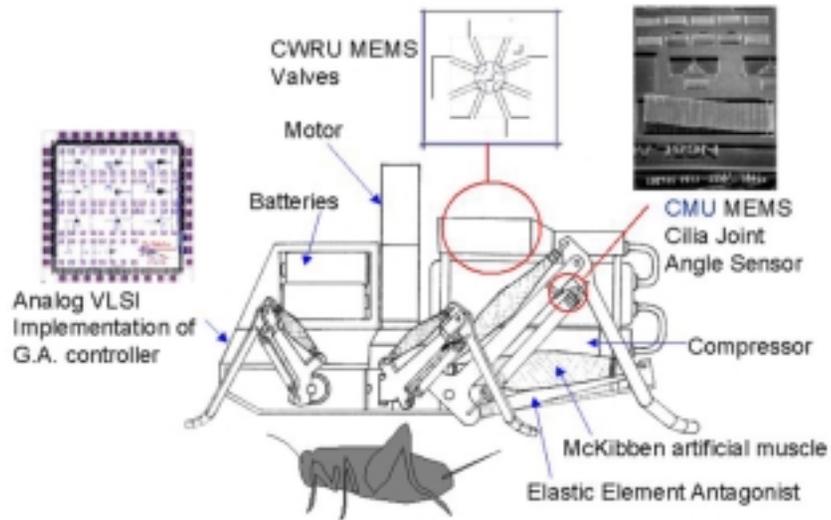


- Basic Research
- Five Focus Areas
  - Chemical & Biological Defense
  - Information Assurance
  - Hardened & Deeply Buried Targets
  - Smart Sensor Web
  - Cognitive Readiness
- Cross Cutting Initiatives
  - Software Intensive Systems
  - High Performance Computing
  - Modeling and Simulation
- Technology Transition Watch/Exposition
- S&T Pilot Laboratory Program

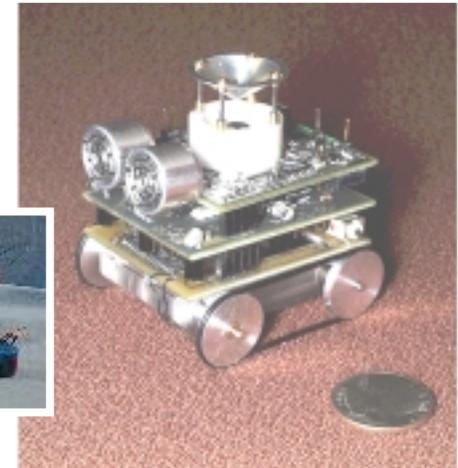
# Microrobotics



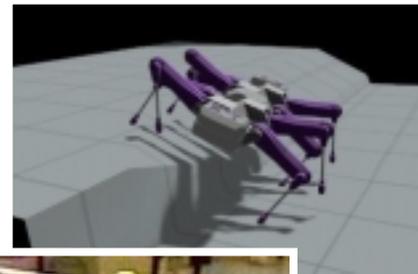
**Cricket Micro-Robot**



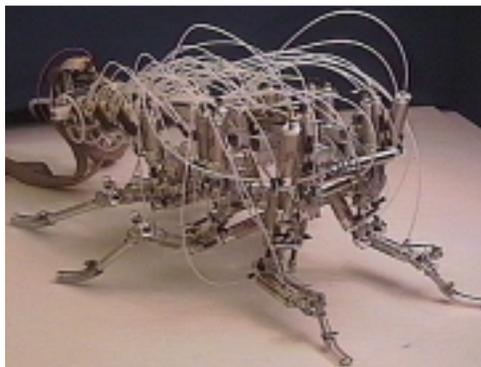
**Millibots**



**Mini Flail**



**Robot III**



**K<sup>2</sup>T**



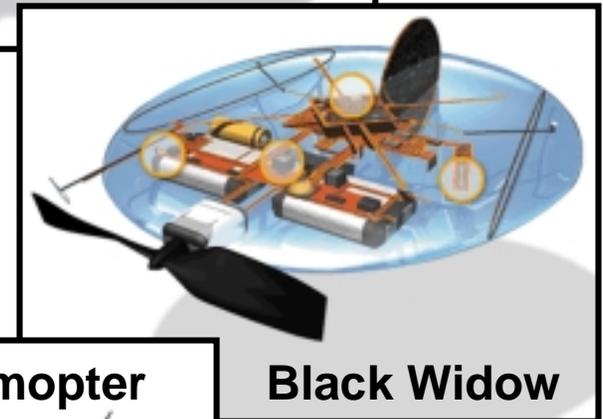
# Basic Research-Micro Air Vehicles



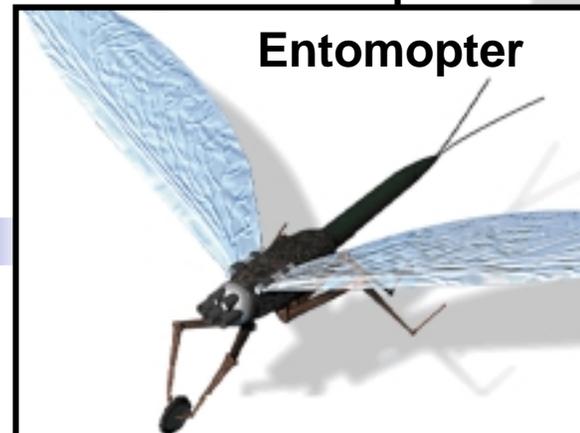
**MAVs**  
(3.5 in. and 6 in. models)



**Micro Bat**



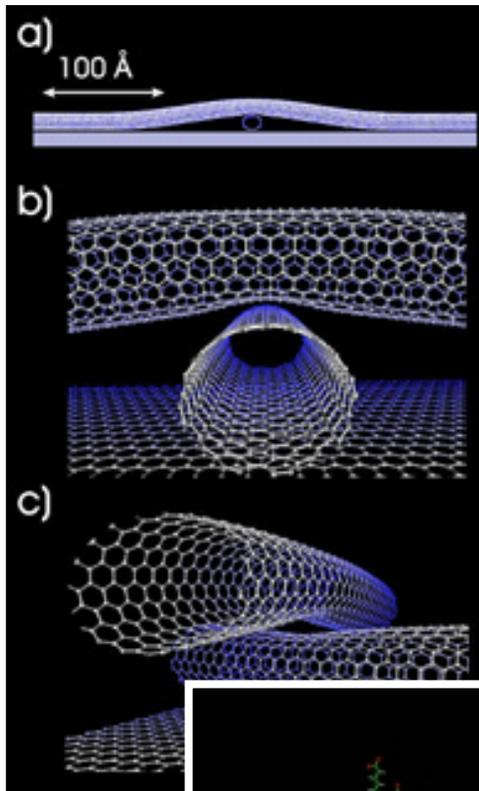
**Black Widow**



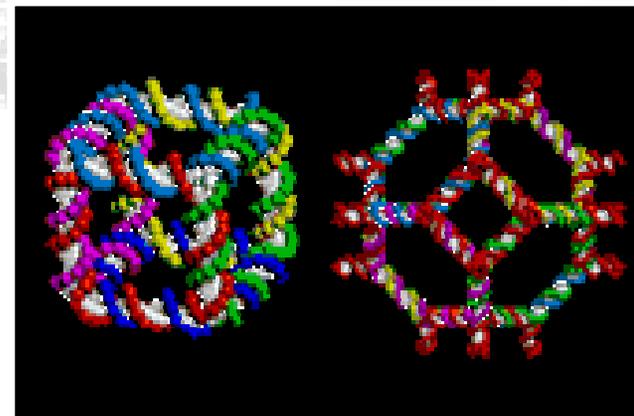
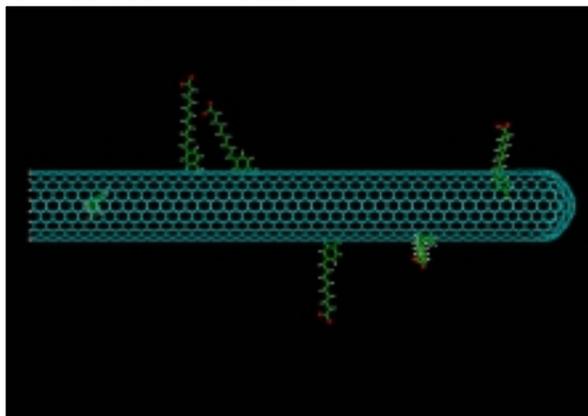
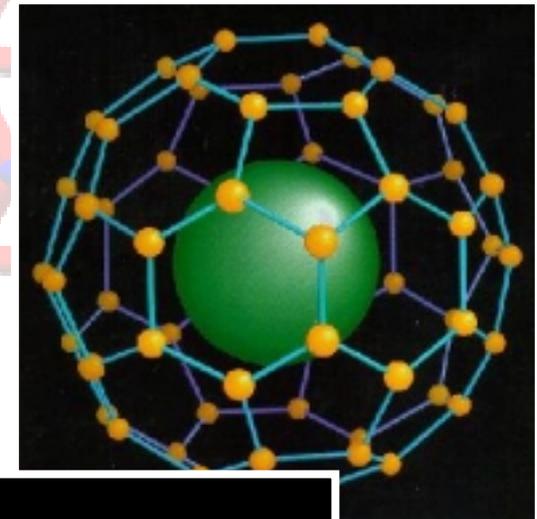
**Entomopter**

- Exoskeletal Chemical Muscle Reaction Chamber
- Exhaust Ports
- Wing Hinges
- Thermoelectric Generator
- Intensity Sensor-Actuated Trinary Steering
- Inflight, widely spread Surface Locomoters provide Anti-Roll Inertia with auxiliary fuel storage (mass) in legs/feet.
- Wing Ribs double as Gas Ducts to Circulation Control Points
- Fuel Storage and Metering is a part of Antenna Structure
- Antennas double as Trim Stabilizers

# Nanoscience



- ***Carbon Computers***
- ***Molecular Engineering***
- ***Nanoscale robots, sensors, machines***
- ***Battery Electrode and Energy Storage***
- ***Vacuum Microelectronics Devices***
- ***Molecular Composites***



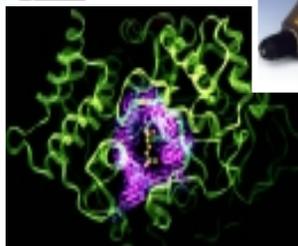
# Chemical & Biological Defense



## *Inexpensive Weapon Proliferation*

*Chemical Agent*  
*Biological Agent*

*Detection*  
*Protection*  
*Decontamination*  
*Agent Dispersal Modeling*



# Information Assurance



## Cyberterrorism

*Hackers*  
*Inside Attacks*  
*Information Warfare*



*Firewalls*  
*Malicious Code Detectors*  
*Encryption*  
*Correlation Technologies*



## DoD Science & Technology

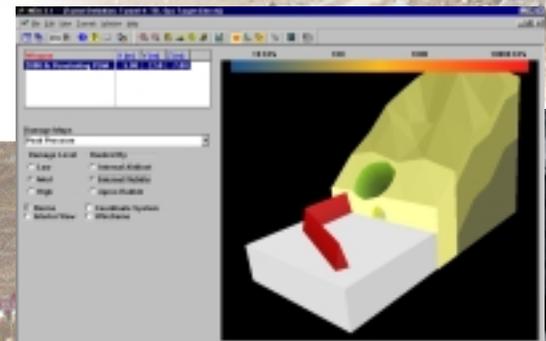
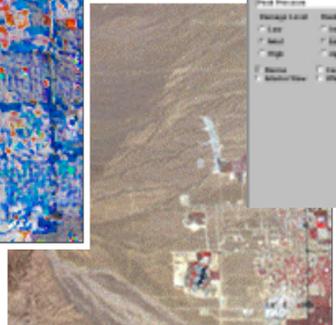
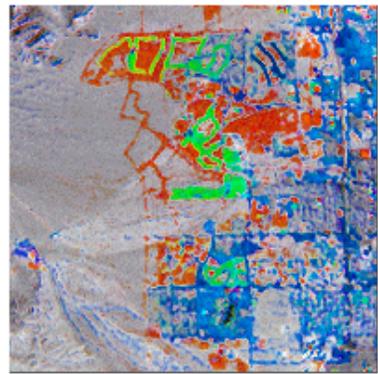
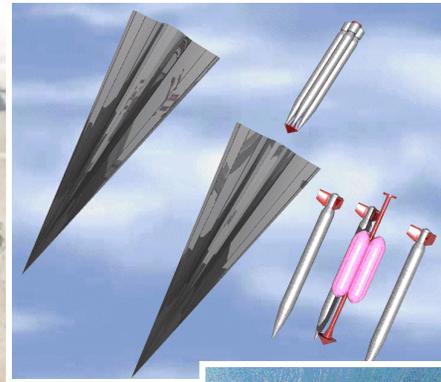
# Hardened and Deeply Buried Targets



## WMD and Missile Concealment

*Detection*  
*Characterization*  
*Neutralization*

*Overhead Imagery*  
*Computational Modeling*  
*Sensors*  
*Delivery Systems*





# Smart SensorWeb

## Complete Situation Awareness

*Real-time Imagery*  
*Micro-Weather*  
*Moving Targets*  
*Integration*

*Physical Models*  
*Dynamic Data Bases*  
*Micro Sensors*  
*Wireless Communications*  
*Next Generation Internet*



## DoD Science & Technology

# Cognitive Readiness



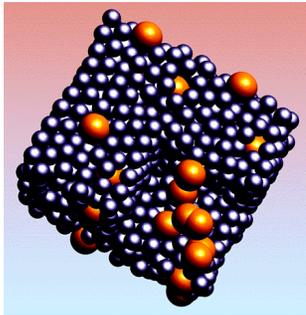
## Human Optimization

*Sustained Operations*  
*Environmental Ambiguity*  
*Distributed Learning*  
*Information Overload*

*Physiological Monitoring*  
*Embedded Training*  
*Learner-centric Instruction*  
*Augmented Reality*

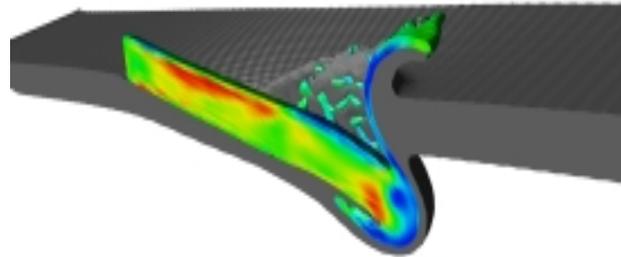


# Impact of Software, HPC and M&S



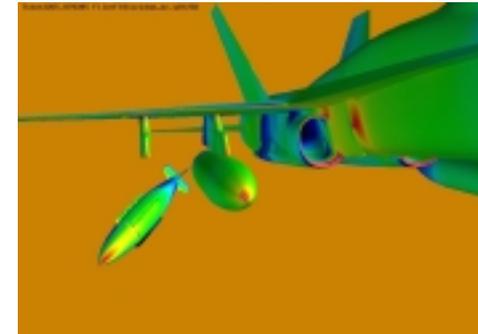
## Basic Research

Simulating High-Energy Density Rocket Fuels



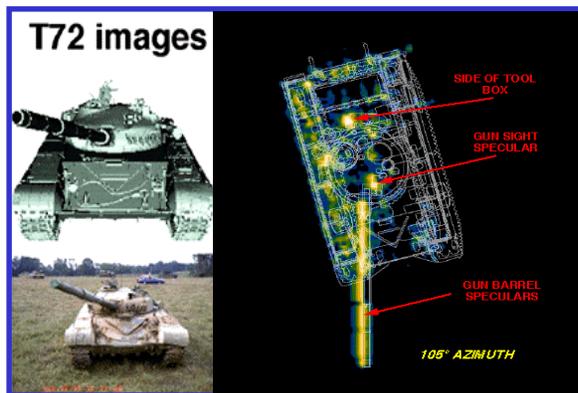
## Advanced Technology

Armor and Projectile Design



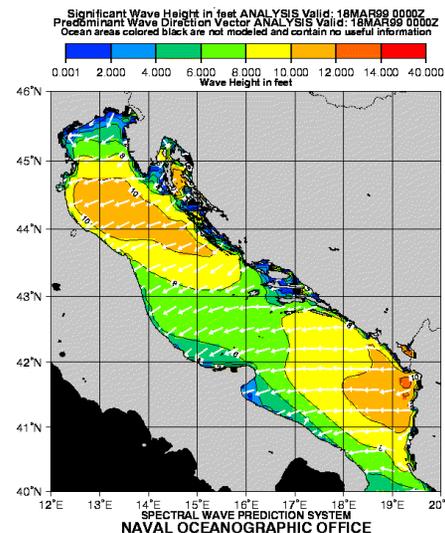
## Developmental T&E

Support of Aircraft-Store Compatibility and Weapons Integration



## Intelligence

Radar Cross-Sections Predictions



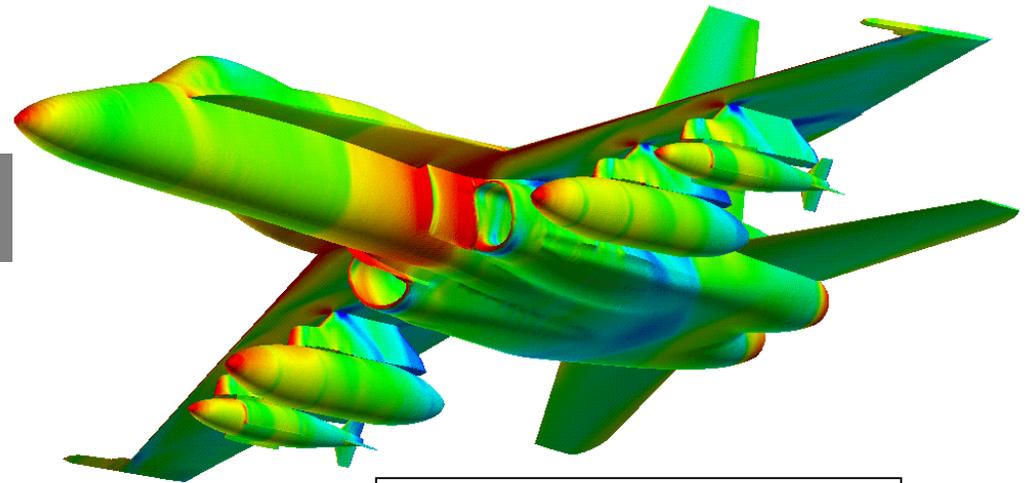
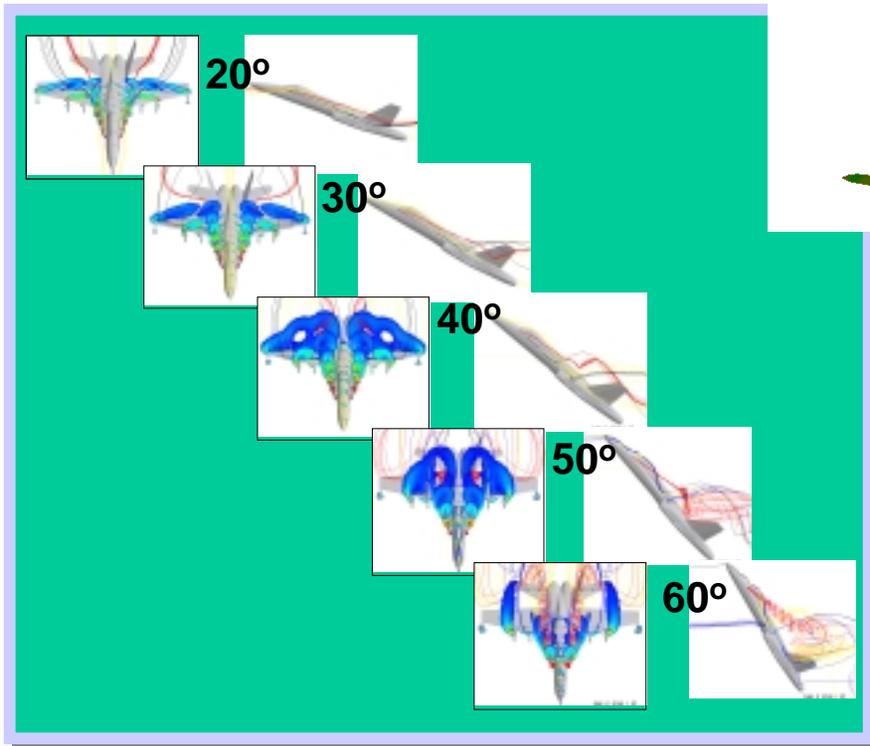
## Operations

Ocean/wave forecasting

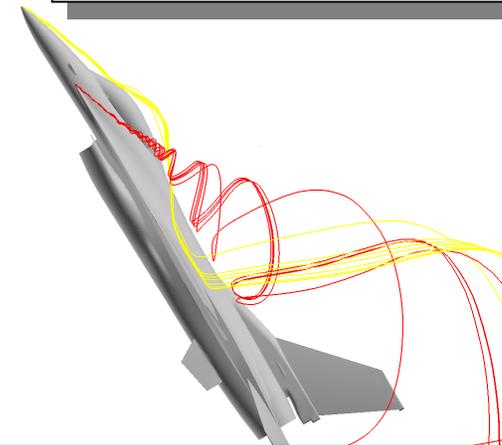
# Contributions to Aircraft Design & Analysis



Unsteady Aerodynamic Analysis



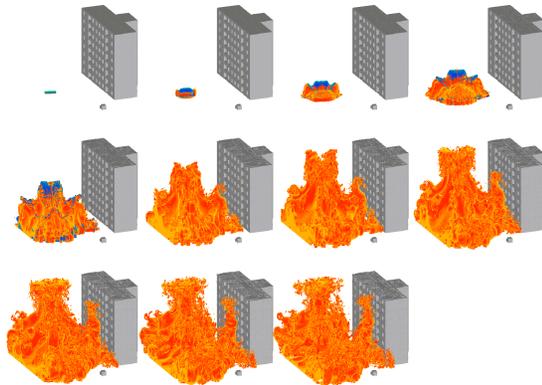
Stores Certification



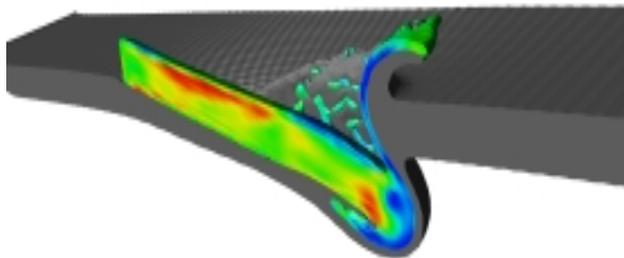
Nose-slice Departure

# Significant to National Security

## CTH – Shock Physics Software



**Objective:** Evaluate blast effects on multi-story building structures



**Objective:** Armor and projectile design

### Application Software – CTH:

- Developed at DOE/SANDIA
- Investment: +100 labor-years
- Size: 250,000 lines of code

Codes are classified or ITAR restricted; Data frequently classified

### Middleware:

- Operating system (Unix)
- Compilers (FORTRAN 77, C)
- Message passing library (MPI and PVM)

Availability varies from commercial to public domain

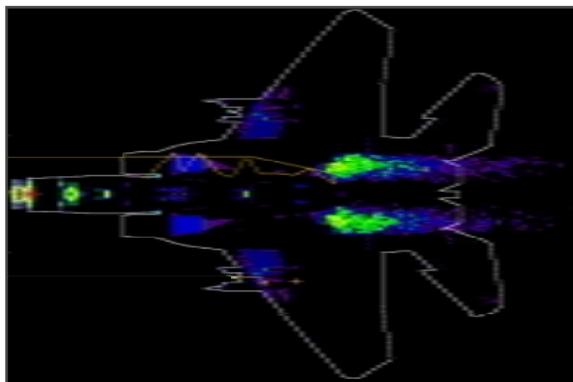
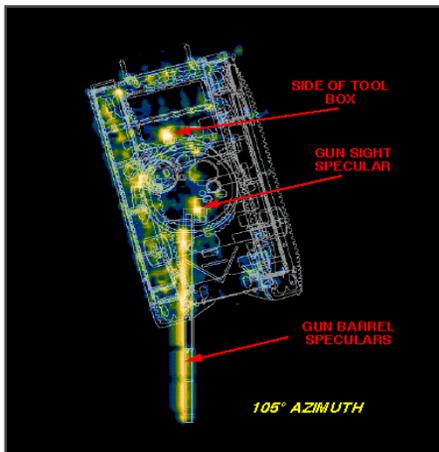
### Computer Hardware:

- Systems: IBM SP, Cray T3E, SGI Origin 2000
- CTH simulations utilize up to 256 processors

Commercial

# Significant to National Security

## Xpatch – Radar Signature Software



**Objective:** Prediction of radar cross section (RCS) for tanks and aircraft

### Application Software – Xpatch:

- Developed via Air Force R&D contracts
- Investment: 150 labor-years
- Size: 1.5 million lines of code

Codes are classified or ITAR restricted; Data frequently classified

### Middleware:

- Operating system (Unix)
- Compilers (FORTRAN 90, C, C++)
- Message passing library (MPI)

Availability varies from commercial to public domain

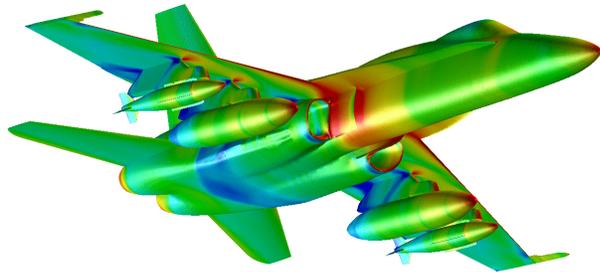
### Computer Hardware:

- Systems: IBM SP, SGI Origin 2000
- Xpatch simulations utilize up to 64 processors

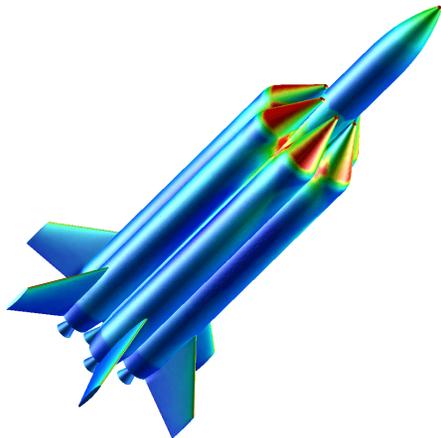
Commercial

# Significant to National Security

## Cobalt – Computational Fluid Dynamics Software



*Objective:* Analyze flow over an F-18



*Objective:* Evaluate flight conditions for future low cost launch system

### Application Software – Cobalt:

- Developed at AFRL
- Investment: 15 labor-years
- Size: 30,000 lines of code

Codes are classified or ITAR restricted; Data frequently classified

### Middleware:

- Operating system (Unix)
- Compilers (FORTRAN 90, C)
- Message passing library (MPI)

Availability varies from commercial to public domain

### Computer Hardware:

- Systems: IBM SP, Cray T3E, SGI Origin 2000
- Cobalt simulations utilize up to 200 processors

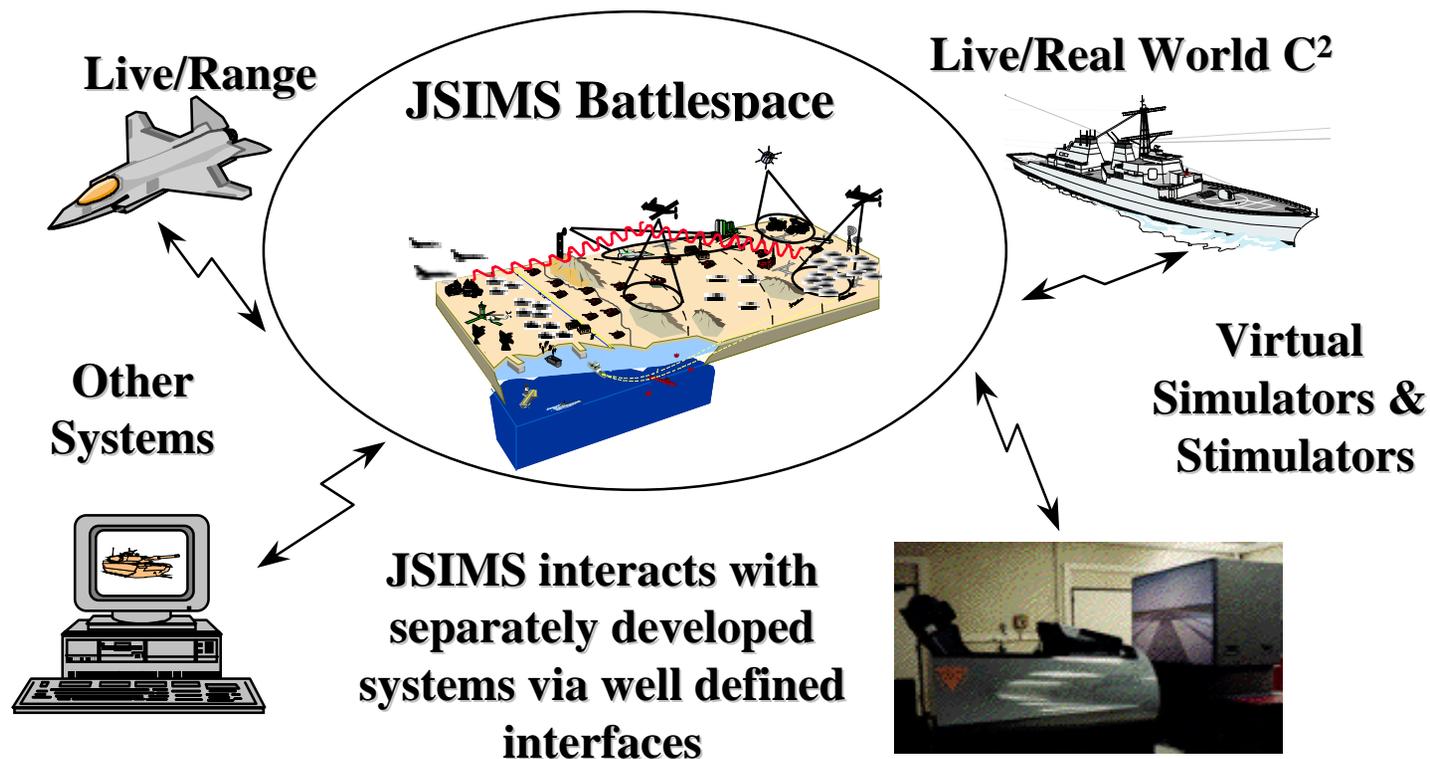
Commercial

# DoD M&S Programs - JSIMS



<http://www.jsims.mil>

JSIMS creates a simulation capability to support Joint or Service training, rehearsal, or education objectives.



# Examples of DMSO Successes

---



- Standards - High Level Architecture
- Framework for Representing Environment - Synthetic Environment Data Representation & Interchange (SEDRIS)
- Repositories for Models
- Modeling and Simulation Information Analysis Center (MSIAC)
- Education and Tutorial Programs

# DMSO “New Vector” For the Future



## Focus on the Warfighter Requirements

- **Lead** M&S in Development of New Revolutionary Capabilities for - Human Behavior, Synthetic Natural Environment
- **Integrate** M&S Activities within Community and Joint Programs - JSIMS, Smart Sensor Web
- **Leverage** Advances to Give Defense M&S New Capabilities - S&T Initiative, Advanced Training

# DoD S&T is a Partnership

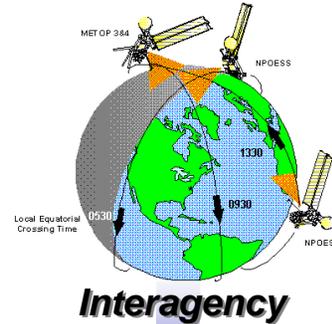


**Stable, Long Term Investment**

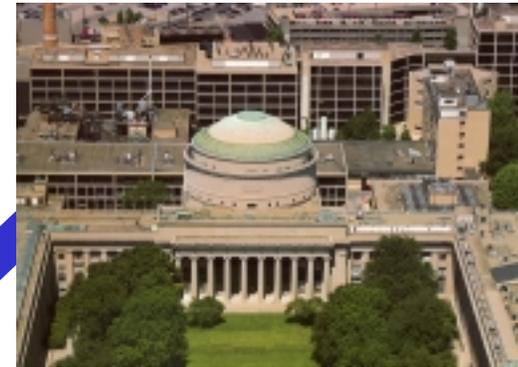


*Service Labs*

**Expanded Resource Base**



**New Ideas, Knowledge**

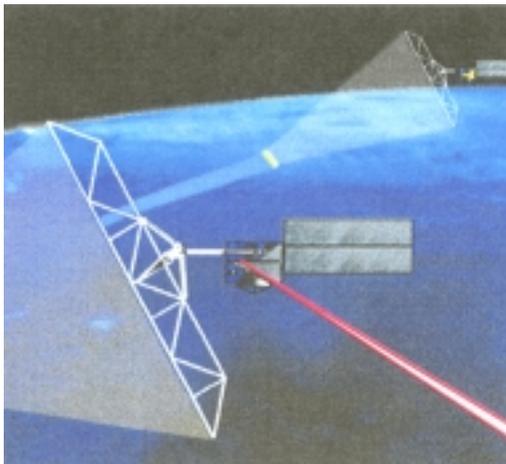


*Universities*

*Industries*

**Maximum National Security Payoff**

**DARPA**



**High Risk, High Payoff**

**International**



**Coalition Capability**



**Innovation, Transition**

*Technical Superiority is  
Critical for National Security.*

*In peace, it provides deterrence;  
In crisis, it provides options;  
In war, it provides an edge.*

