



Defense Modeling and Simulation

23 May 2000

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Deputy Under Secretary of Defense (Science & Technology)

REPORT DOCUMENTATION PAGE

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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

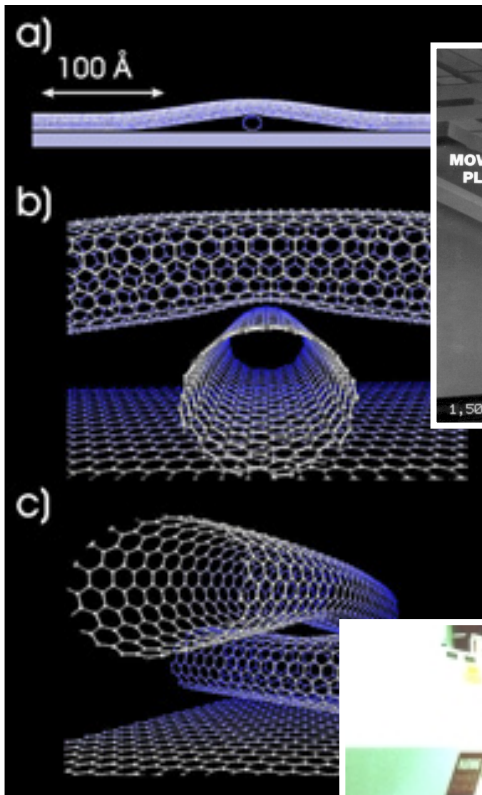
Phased Array Radar



GPS

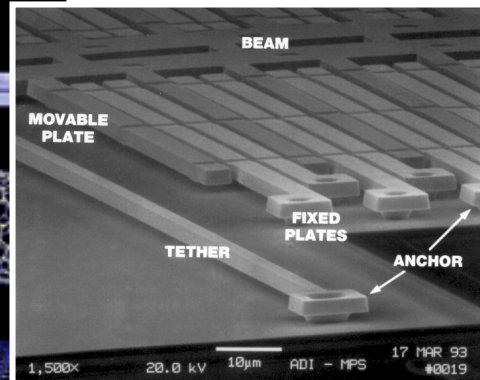


Current S&T

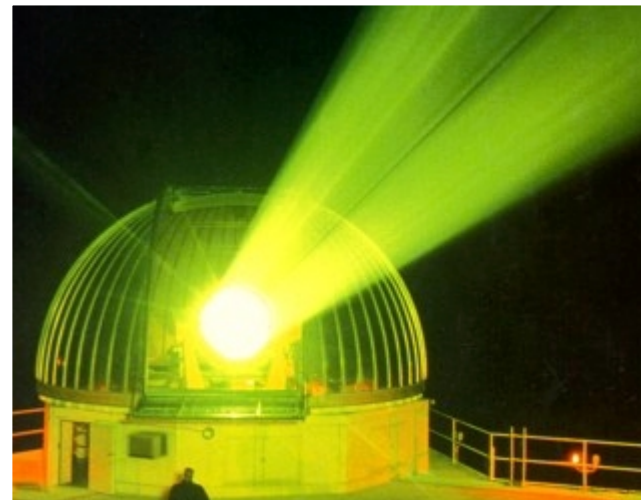


Nanoscience

Biolab

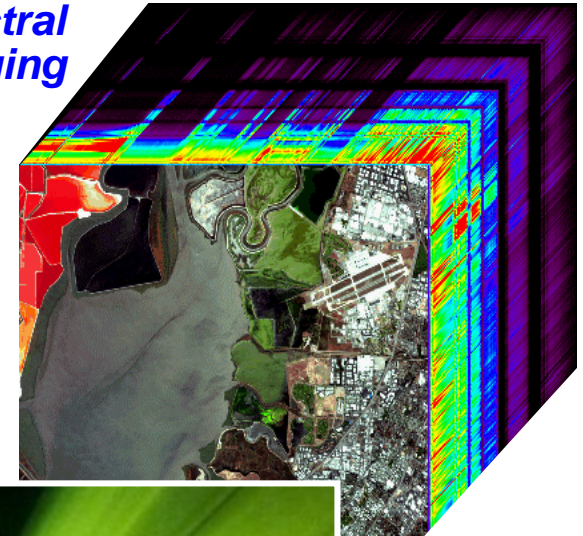


MEMS
microelectromechanical
systems



Starfire

Hyperspectral
Imaging



Future Revolutionary Capabilities



Microsatellites



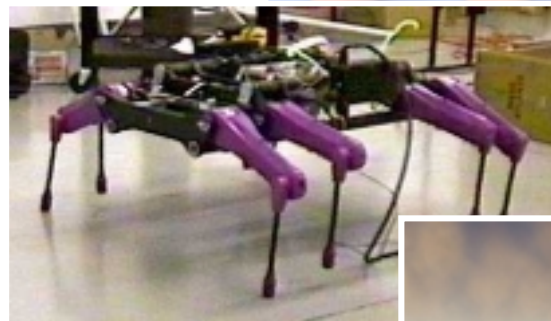
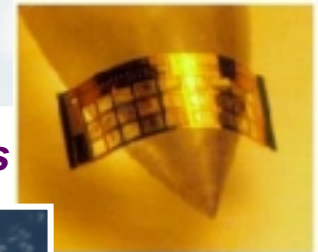
Joint Strike Fighter



Micro Air Vehicles



Flexible Sensor Skins



Micro Robots



Augmented Reality



DD-21

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

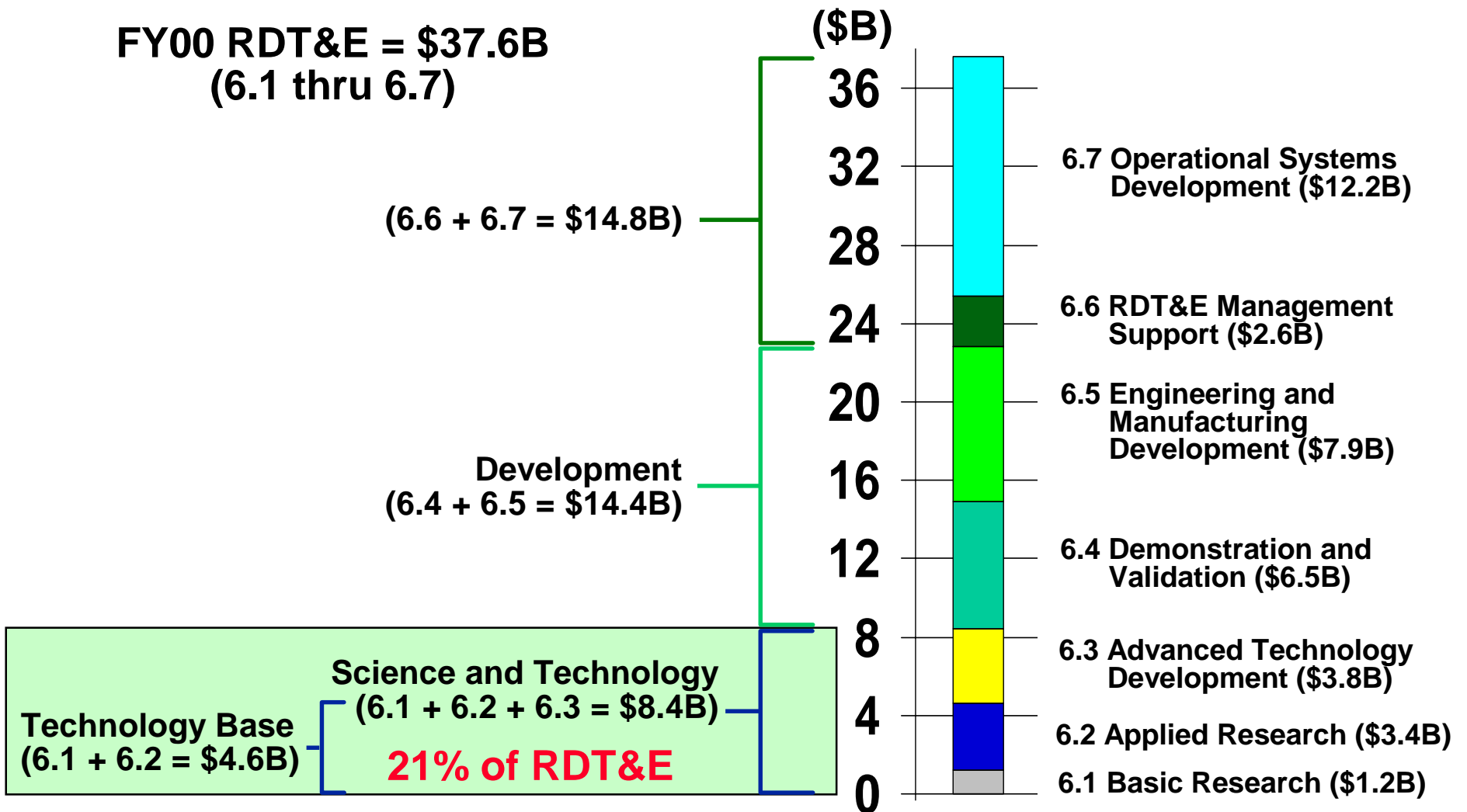
Complex Targets/Terrain

Information Management Critical

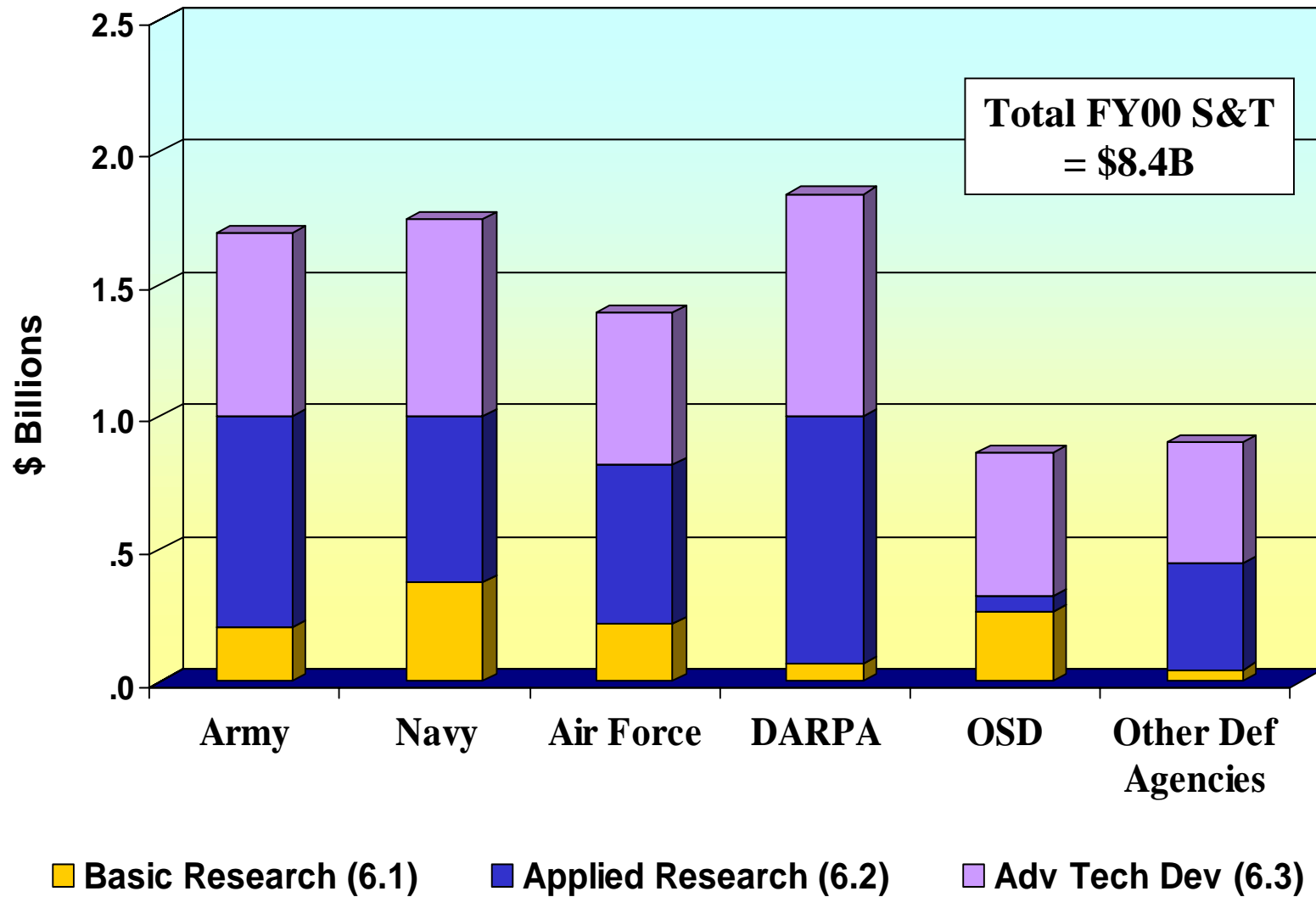
FY00 RDT&E



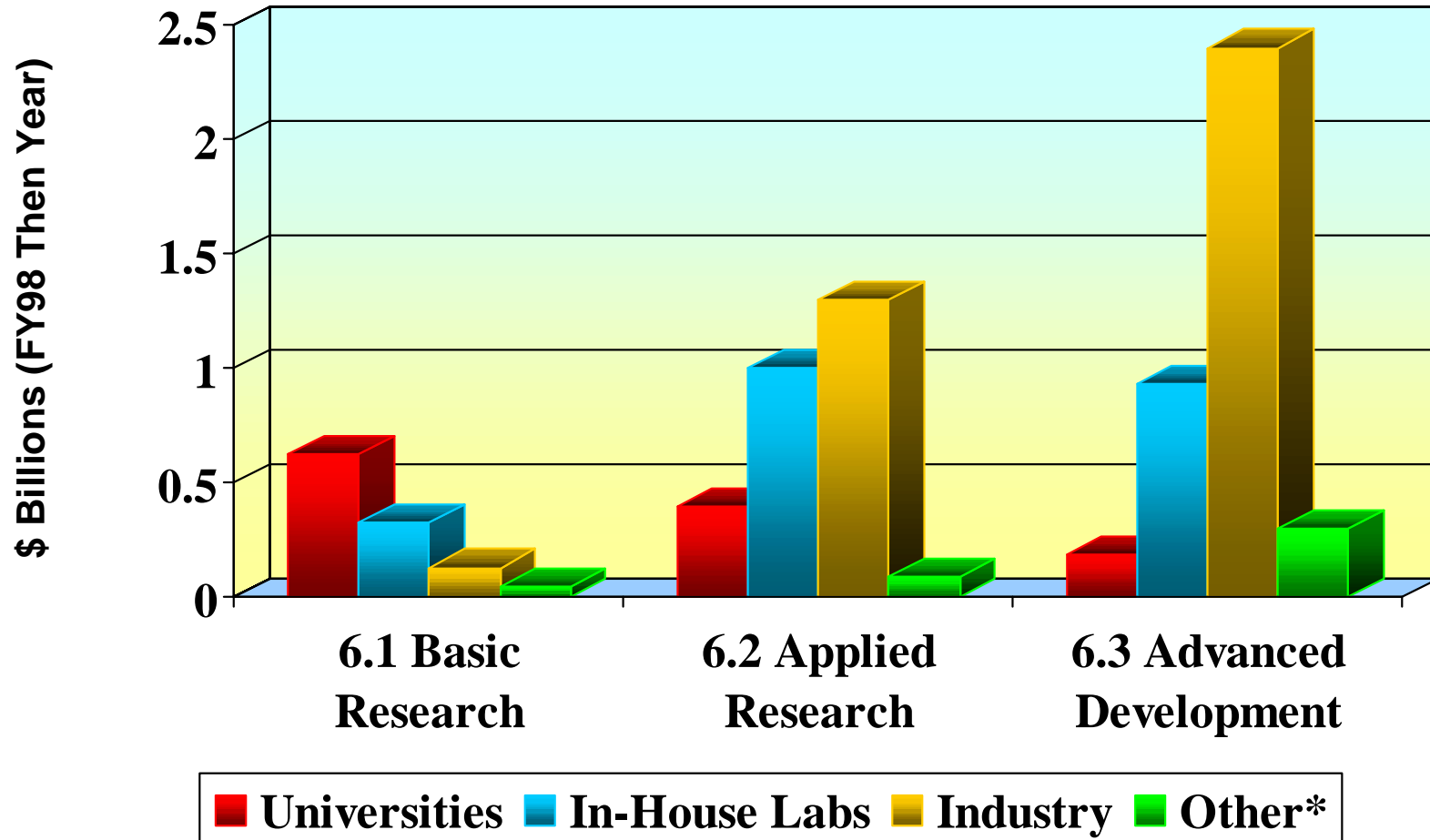
FY00 RDT&E = \$37.6B
(6.1 thru 6.7)



DoD S&T Investment



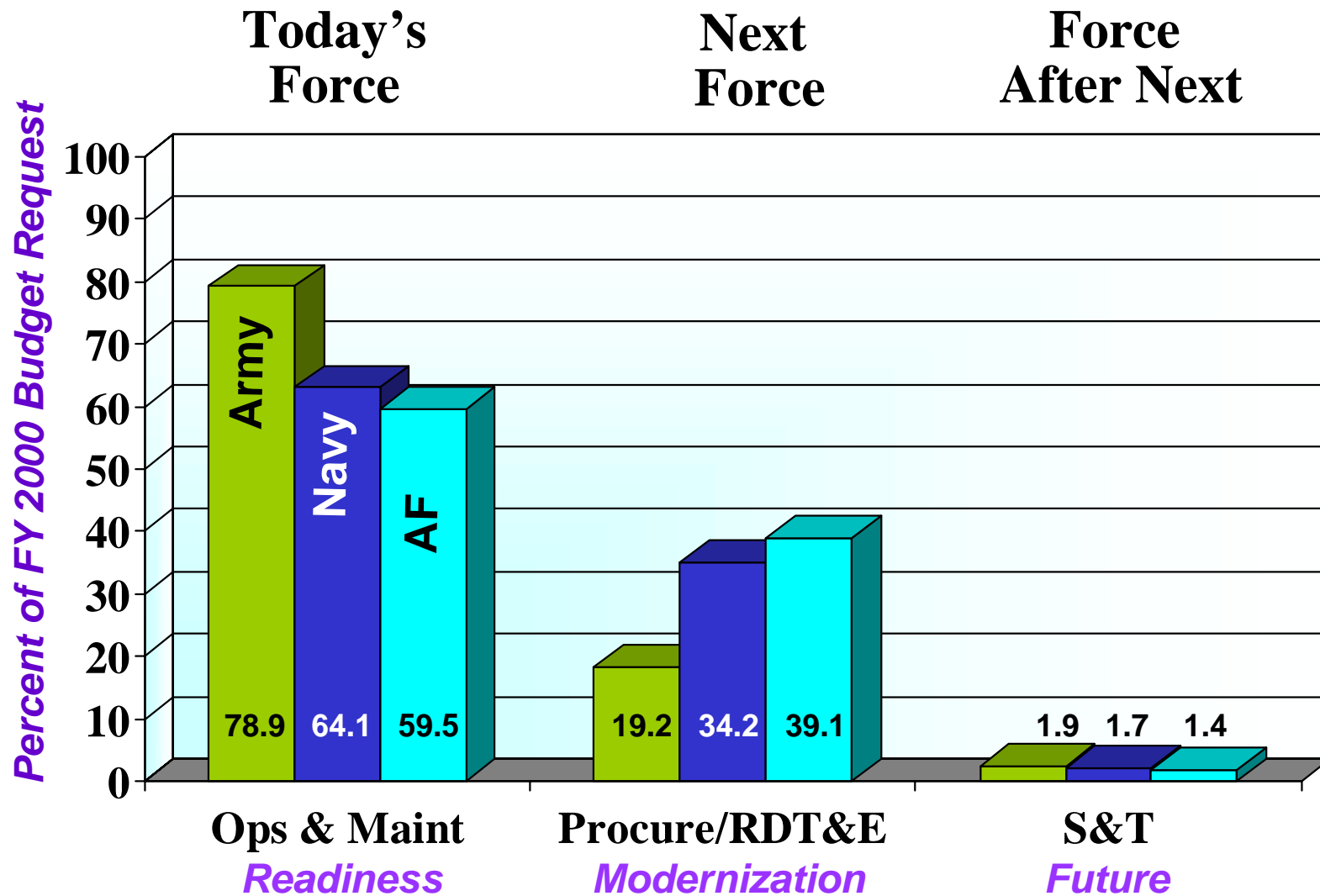
Recipients of DoD S&T Funds



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

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

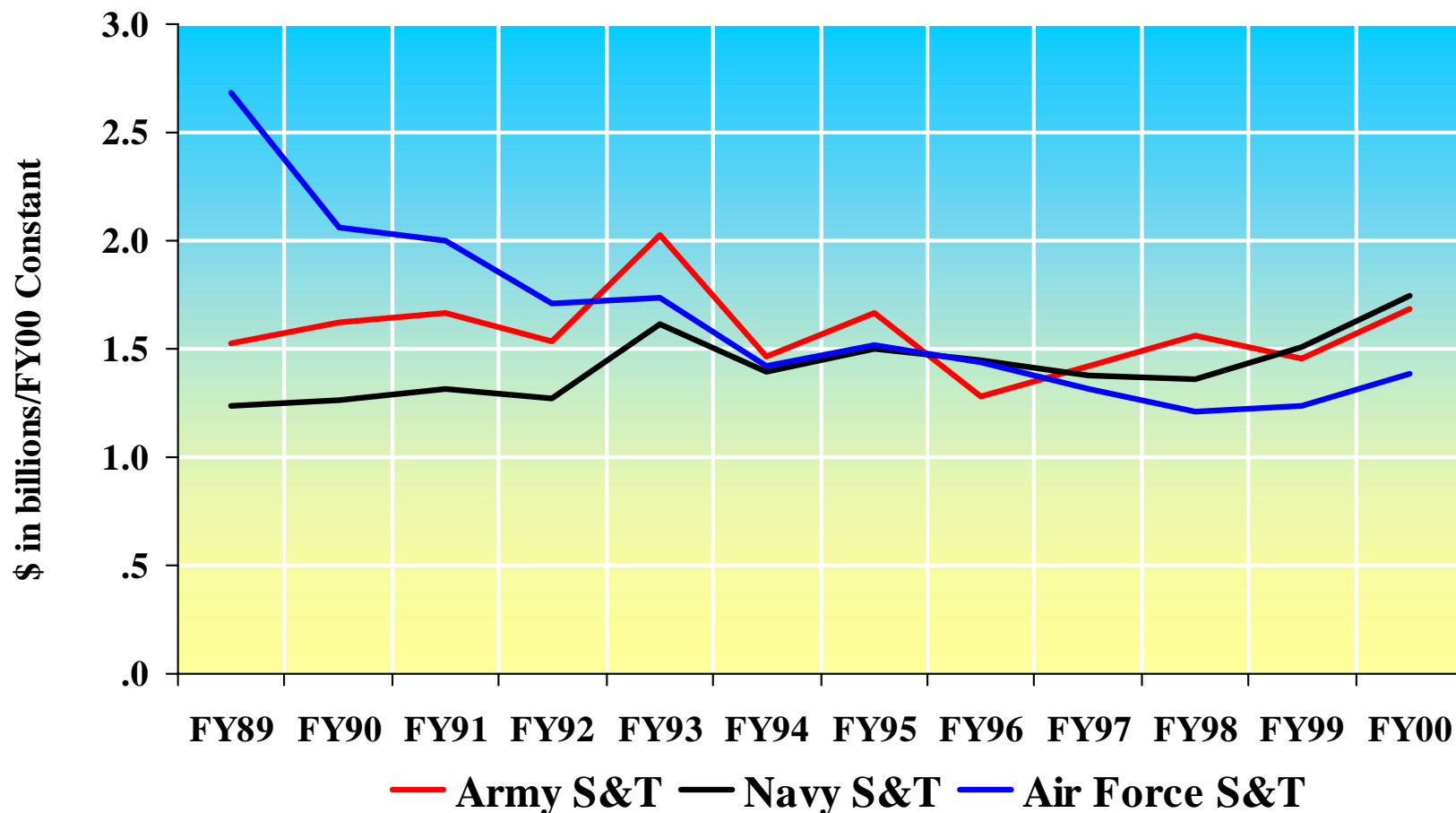
Technology Perspectives FY00 Appropriated



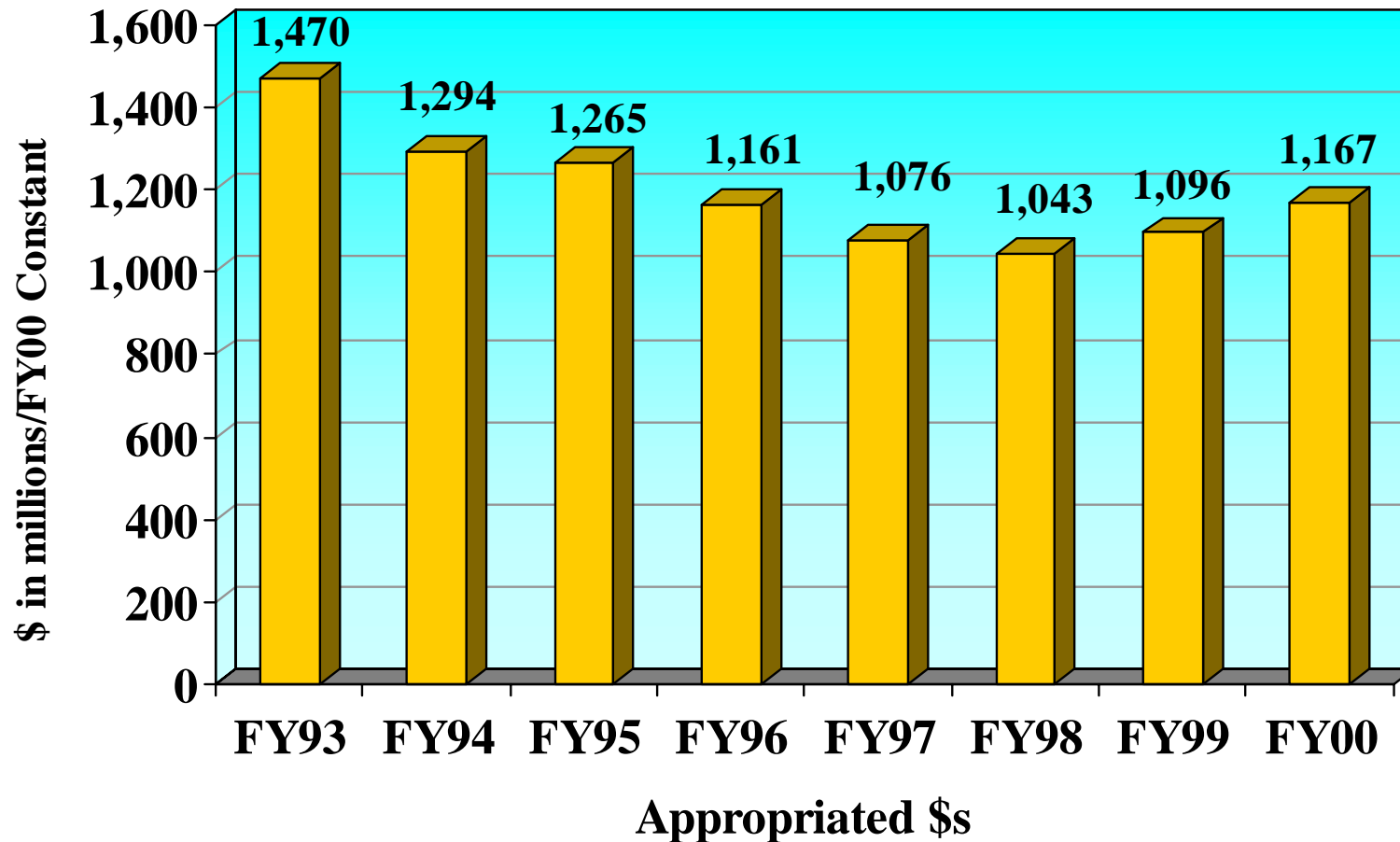
Service Investment in Science & Technology



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)

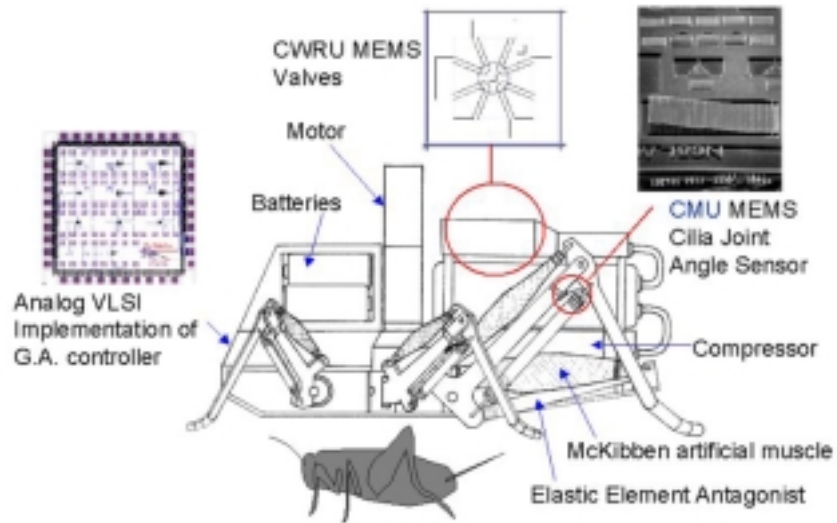


- Basic Research
- Five Focus Areas
 - Chemical & Biological Defense
 - Information Assurance
 - Hardened & Deeply Buried Targets
 - Smart Sensor Web
 - Cognitive Readiness
- Cross Cutting Initiatives
 - Software Intensive Systems
 - High Performance Computing
 - Modeling and Simulation
- Technology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

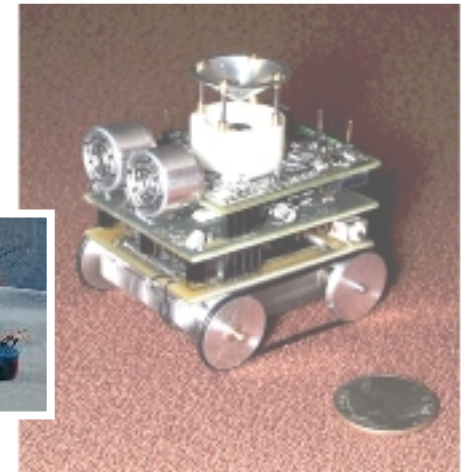
Microrobotics



Cricket Micro-Robot



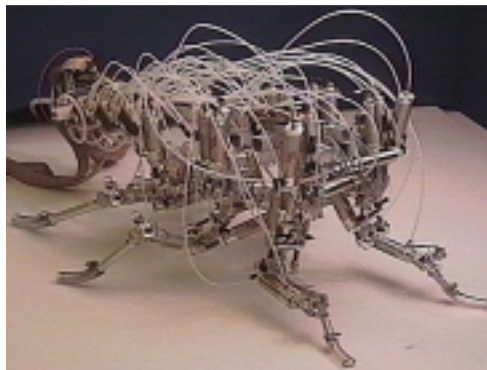
Millibots



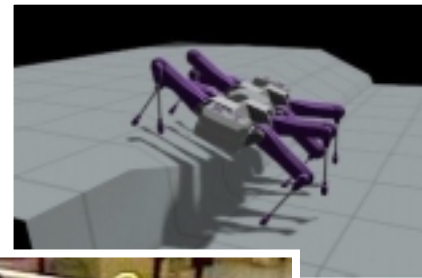
Mini Flail



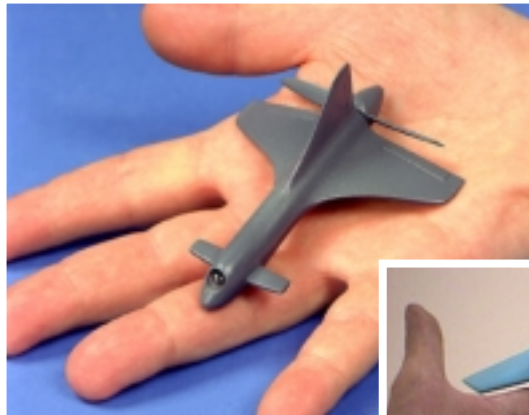
Robot III



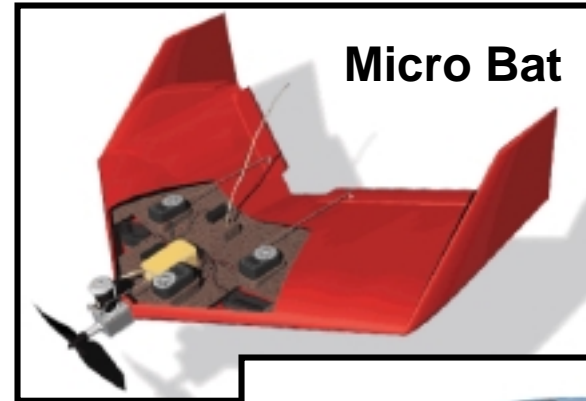
K²T



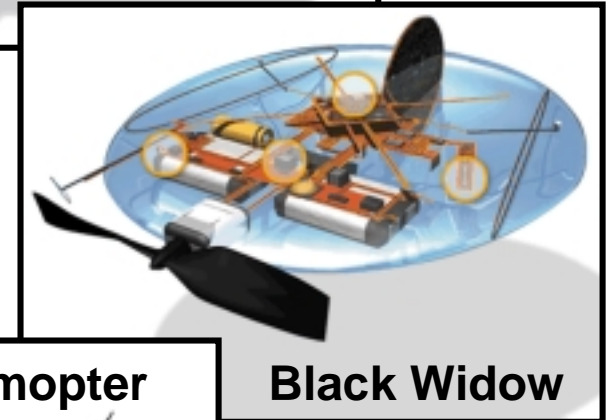
Basic Research-Micro Air Vehicles



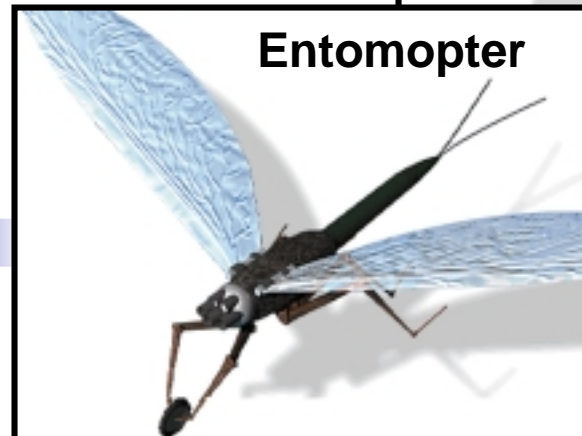
MAVs
(3.5 in. and 6 in. models)



Micro Bat



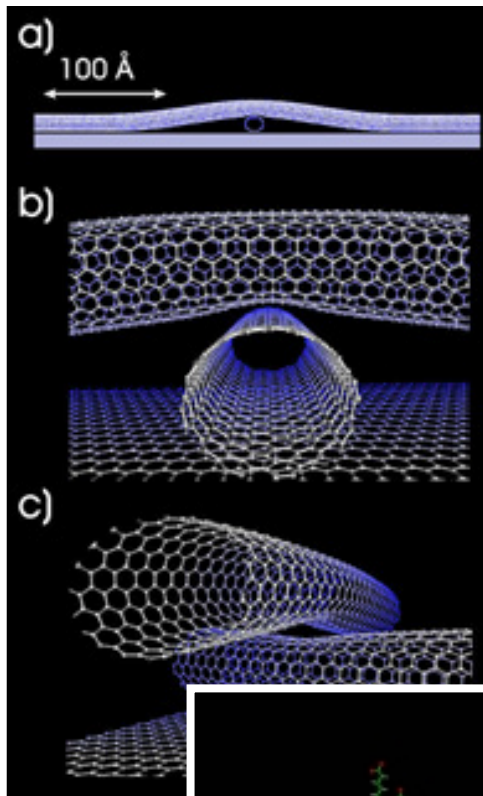
Black Widow



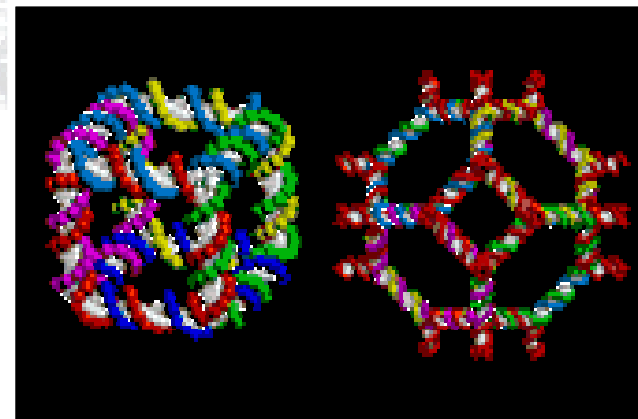
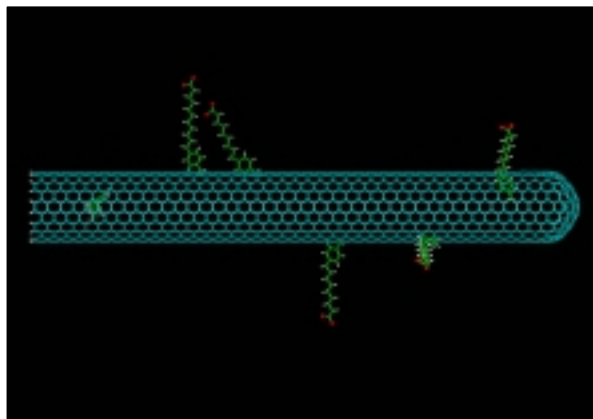
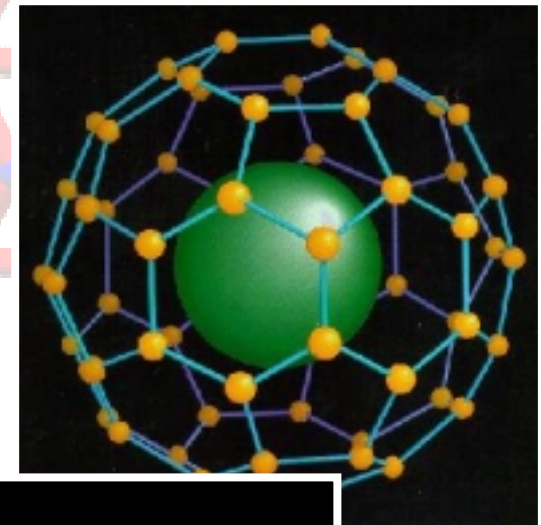
Entomopter

- 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**



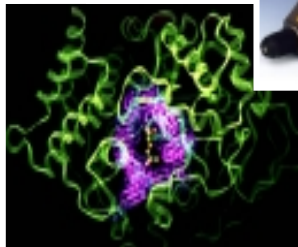
Chemical & Biological Defense



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

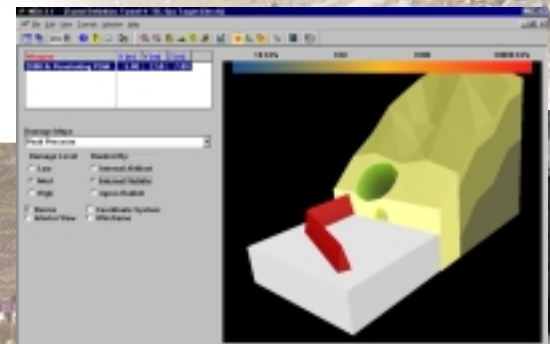
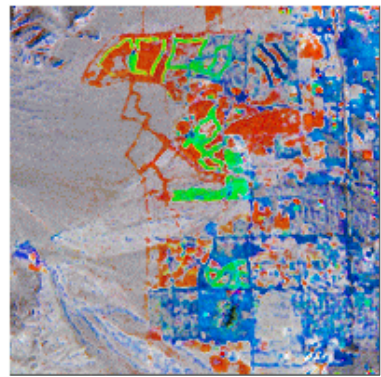
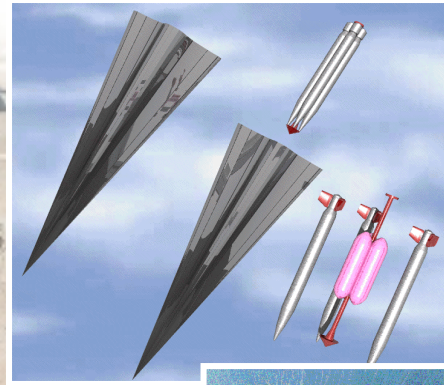
Hardened and Deeply Buried Targets



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



Cognitive Readiness



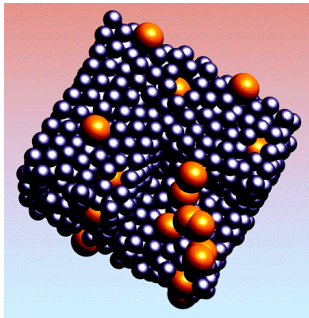
Human Optimization

Sustained Operations
Environmental Ambiguity
Distributed Learning
Information Overload

Physiological Monitoring
Embedded Training
Learner-centric Instruction
Augmented Reality

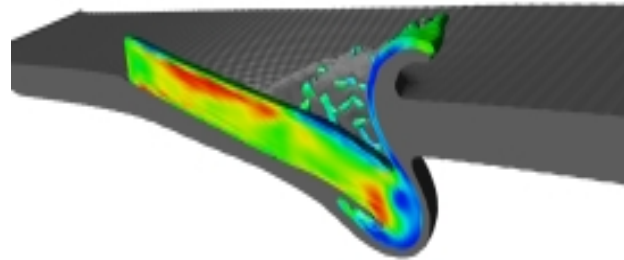


Impact of Software, HPC and M&S



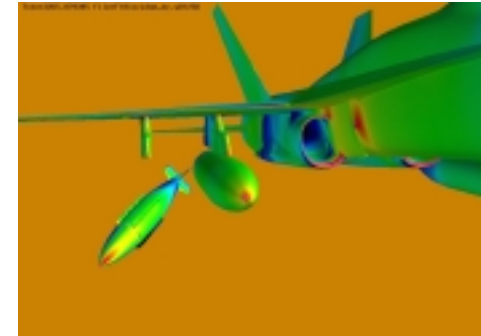
Basic Research

Simulating High-Energy Density Rocket Fuels



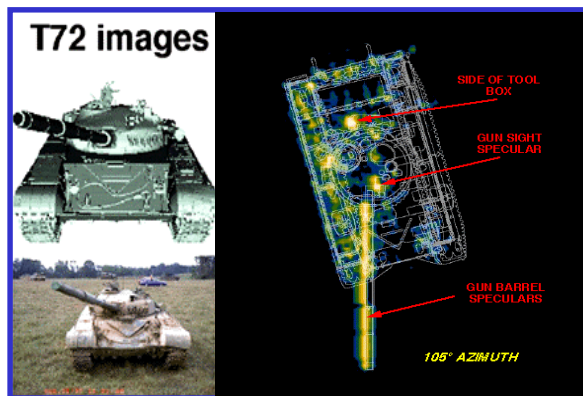
Advanced Technology

Armor and Projectile Design



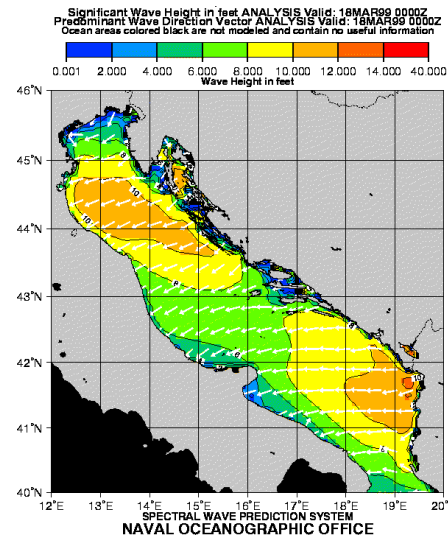
Developmental T&E

Support of Aircraft-Store Compatibility and Weapons Integration



Intelligence

Radar Cross-Sections Predictions



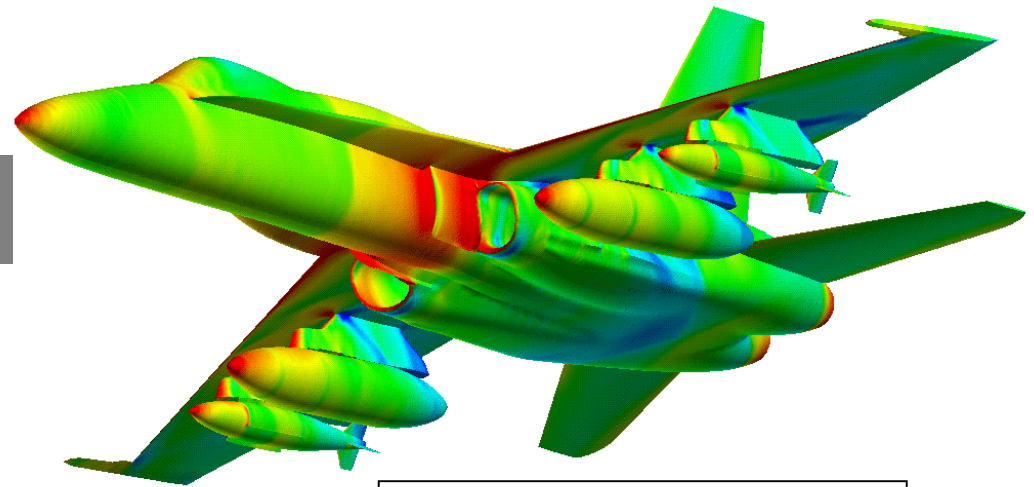
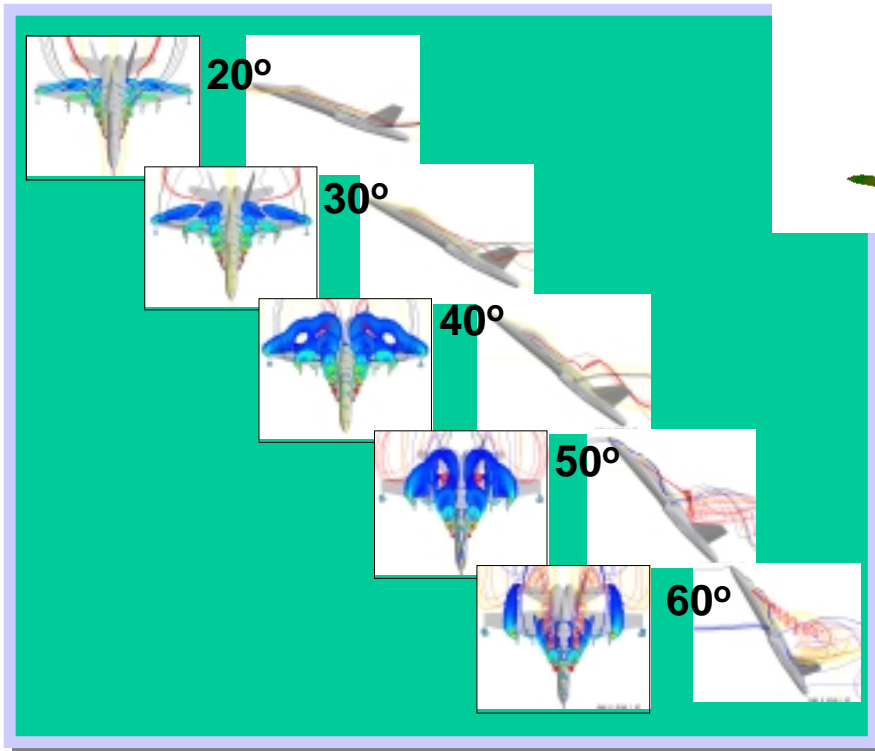
Operations

Ocean/wave forecasting

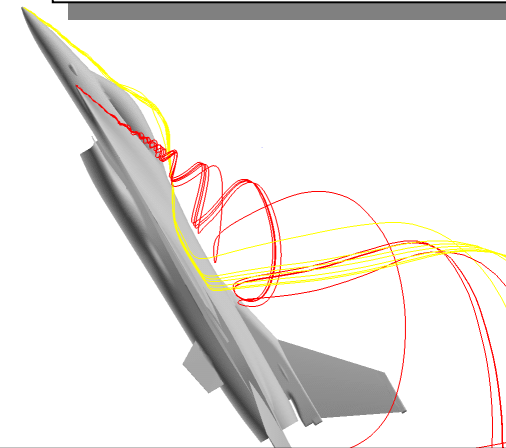
Contributions to Aircraft Design & Analysis



Unsteady Aerodynamic Analysis



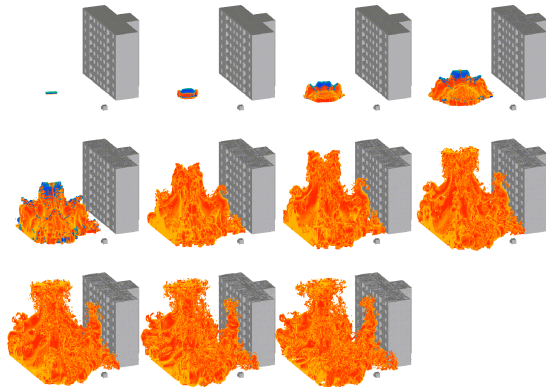
Stores Certification



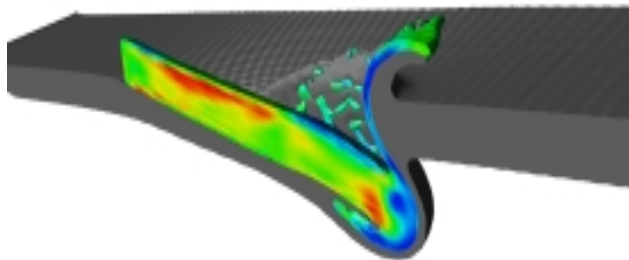
Nose-slice Departure

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

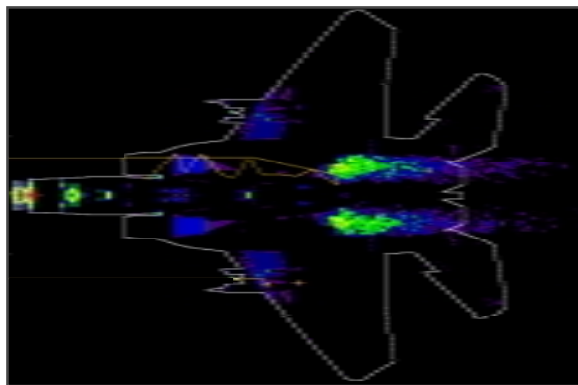
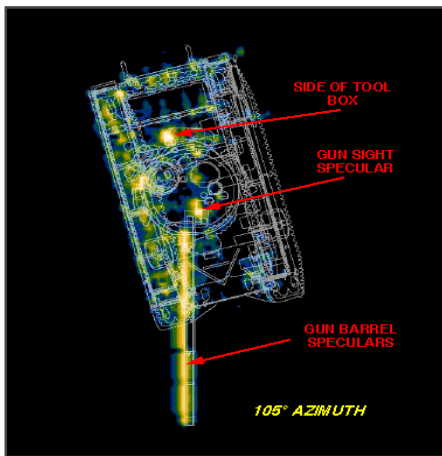
Computer Hardware:

- 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

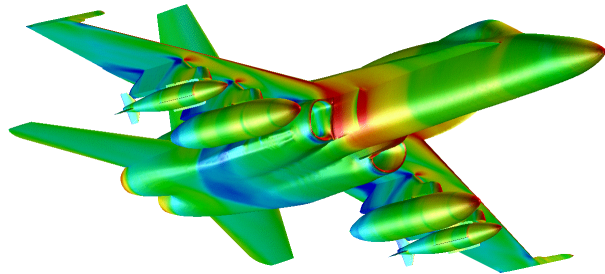
Computer Hardware:

- 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

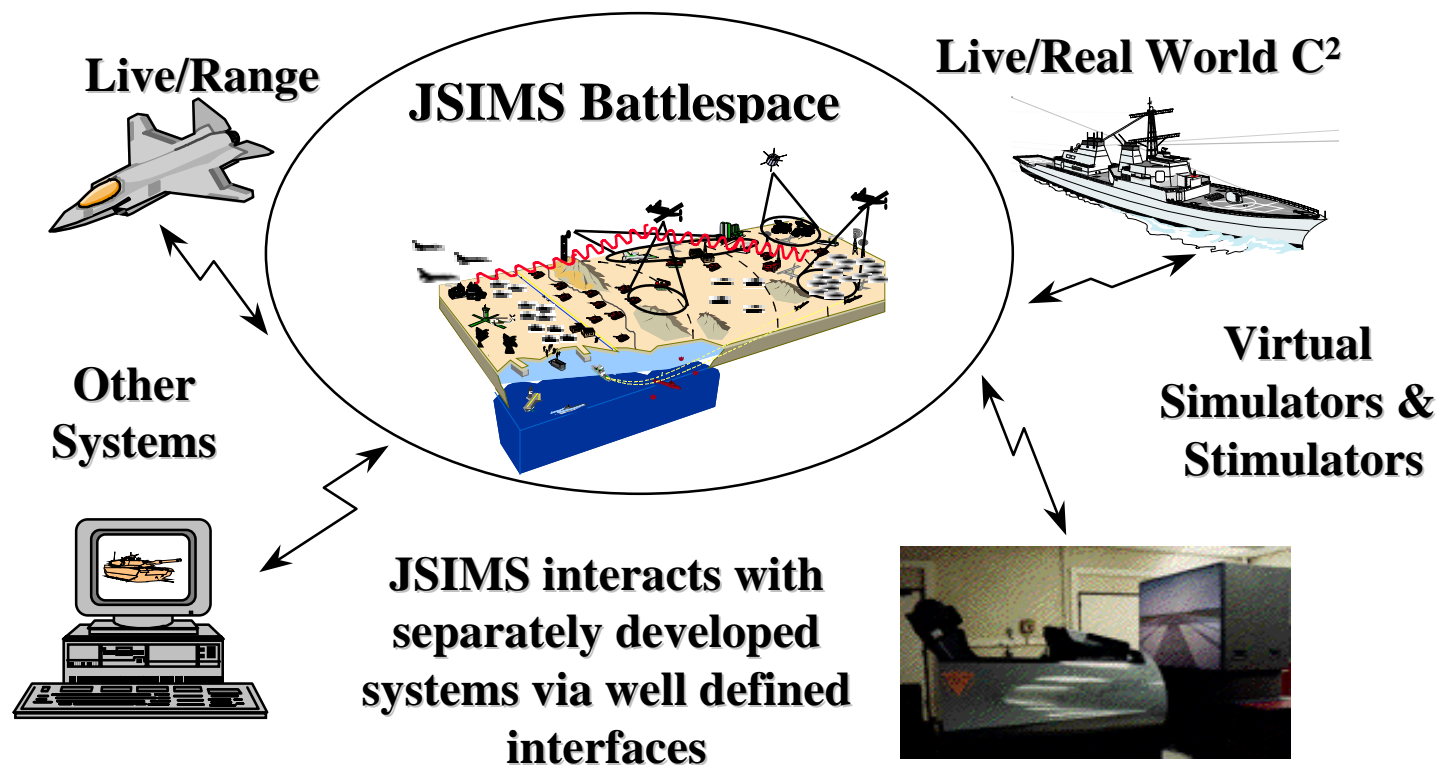
Commercial

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

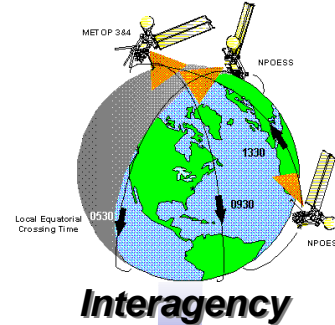


Stable, Long Term Investment



Service Labs

Expanded Resource Base

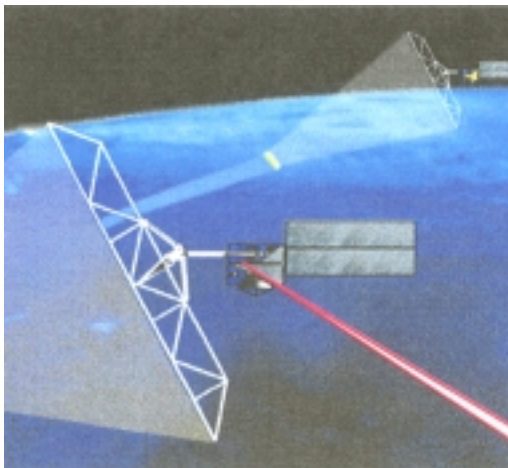


New Ideas, Knowledge



Universities

DARPA



High Risk, High Payoff

Maximum National Security Payoff

Industries



Innovation, Transition

International



Coalition Capability

*Technical Superiority is
Critical for National Security.*

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

