Defense Modeling and Simulation

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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.
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)
- Hyperspectral Imaging
- Starfire
Future Revolutionary Capabilities

- Microsatellites
- Joint Strike Fighter
- Micro Air Vehicles
- Flexible Sensor Skins
- Augmented Reality
- Micro Robots
- Bio Sensors
- DD-21
- 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 = $37.6B
(6.1 thru 6.7)

(6.6 + 6.7 = $14.8B)

Science and Technology
(6.1 + 6.2 + 6.3 = $8.4B)

Technology Base
(6.1 + 6.2 = $4.6B)

21% of RDT&E

6.7 Operational Systems Development ($12.2B)

6.6 RDT&E Management Support ($2.6B)

6.5 Engineering and Manufacturing Development ($7.9B)

6.4 Demonstration and Validation ($6.5B)

6.3 Advanced Technology Development ($3.8B)

6.2 Applied Research ($3.4B)

6.1 Basic Research ($1.2B)
DoD S&T Investment

Total FY00 S&T = $8.4B

- Army
- Navy
- Air Force
- DARPA
- OSD
- Other Def Agencies

- Basic Research (6.1)
- Applied Research (6.2)
- Adv Tech Dev (6.3)
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

<table>
<thead>
<tr>
<th></th>
<th>Ops &amp; Maint</th>
<th>Procure/RDT&amp;E</th>
<th>S&amp;T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today's Force</td>
<td>Army 78.9</td>
<td>Navy 64.1</td>
<td>AF  59.5</td>
</tr>
<tr>
<td></td>
<td>Readiness</td>
<td>Modernization</td>
<td>Future</td>
</tr>
<tr>
<td>Next Force</td>
<td>19.2</td>
<td>34.2</td>
<td>1.9</td>
</tr>
<tr>
<td>Force After Next</td>
<td>39.1</td>
<td>1.7</td>
<td>1.4</td>
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Service Investment in Science & Technology

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

$ in billions/FY00 Constant

<table>
<thead>
<tr>
<th>Army S&amp;T</th>
<th>Navy S&amp;T</th>
<th>Air Force S&amp;T</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY89</td>
<td>FY90</td>
<td>FY91</td>
</tr>
<tr>
<td>FY92</td>
<td>FY93</td>
<td>FY94</td>
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<td>FY96</td>
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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

Robot III

K²T

Millibots

Mini Flail
Basic Research - Micro Air Vehicles

MAVs (3.5 in. and 6 in. models)

- Exoskeletal Chemical Muscle Reaction Chamber
- Exhaust Ports
- Wing Hinges
- Thermoelectric Generator
- Intensity Sensor-Actuated Trinary Steering
- Inflight, widely spread Surface Locomotors 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

Micro Bat

Entomopter

Black Widow
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

DoD Science & Technology
Information Assurance

Cyberterrorism

Hackers
Inside Attacks
Information Warfare

DoD Science & Technology

Firewalls
Malicious Code Detectors
Encryption
Correlation Technologies
Hardened and Deeply Buried Targets

WMD and Missile Concealment
- Detection
- Characterization
- Neutralization

Overhead Imagery
- Computational Modeling
- Sensors
- Delivery Systems

DoD Science & Technology
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

DoD Science & Technology
Impact of Software, HPC and M&S

**Basic Research**
Simulating High-Energy Density Rocket Fuels

**Advanced Technology**
Armor and Projective 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
**Objective:** Evaluate blast effects on multi-story building structures

**Objective:** Armor and projectile design

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**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**
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

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

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

Codes are classified or ITAR restricted; Data frequently classified

Availability varies from commercial to public domain

Commercial
**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

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

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

Codes are classified or ITAR restricted; Data frequently classified

Availability varies from commercial to public domain

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.

JSIMS interacts with separately developed systems via well defined interfaces.
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
DARPA

Expanded Resource Base
Interagency

New Ideas, Knowledge
Universities
Industries

High Risk, High Payoff

Maximum National Security Payoff
Coalition Capability

International

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.