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TITLE: 12th Annual SO/LIC Symposium

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Event #1880

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ADP010797 thru ADP010815

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**Department of Defense
Science and Technology Program**

12th Annual SO/LIC Symposium

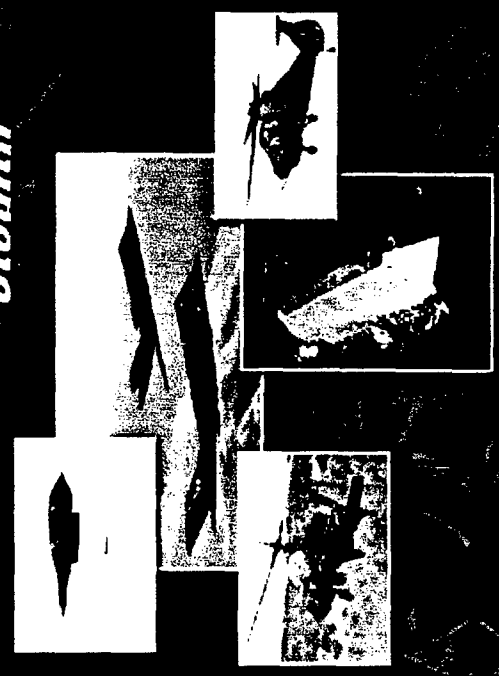
13 February 2001

Dr. Delores M. Etter
Deputy Under Secretary of Defense (Science & Technology)



A Focus on Revolutionary Advances

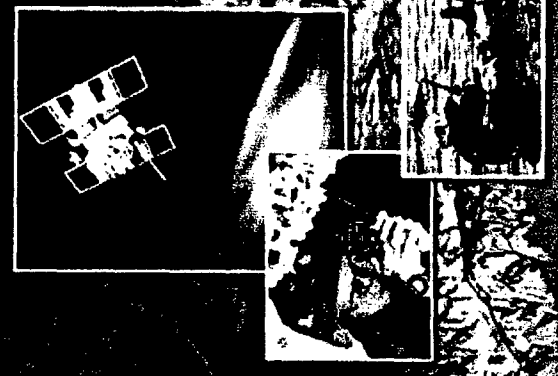
Stealth



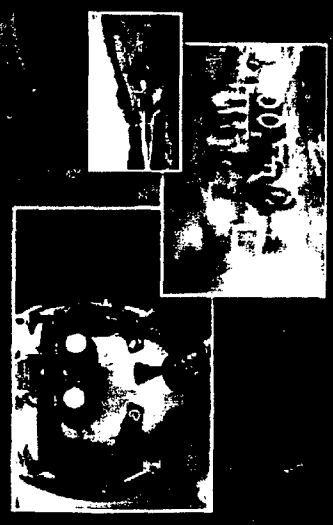
*Adaptive Optics
and Lasers*



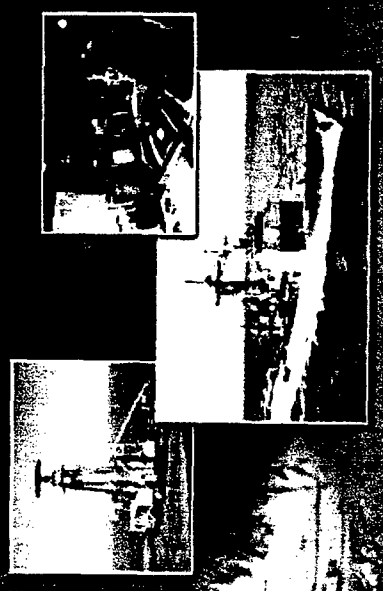
GPS



Night Vision



Phased Array Radar



Strategic Environment



Global US Interests

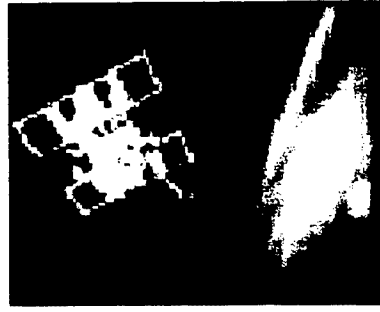
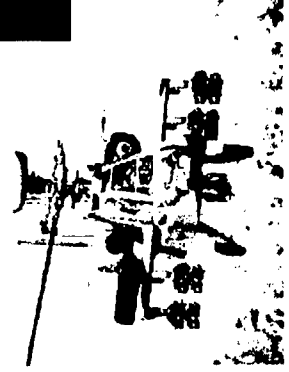
Political - Economic - Humanitarian



Globalization of Technology

Asymmetric Threats

In any domain - Air, Land, Sea, Space or Information



DUSD (S&T) Priorities 2001



Technical

- Basic Research
- JV 2020 Capabilities
- Revolutionary Capabilities
- Enabling Capabilities

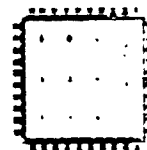
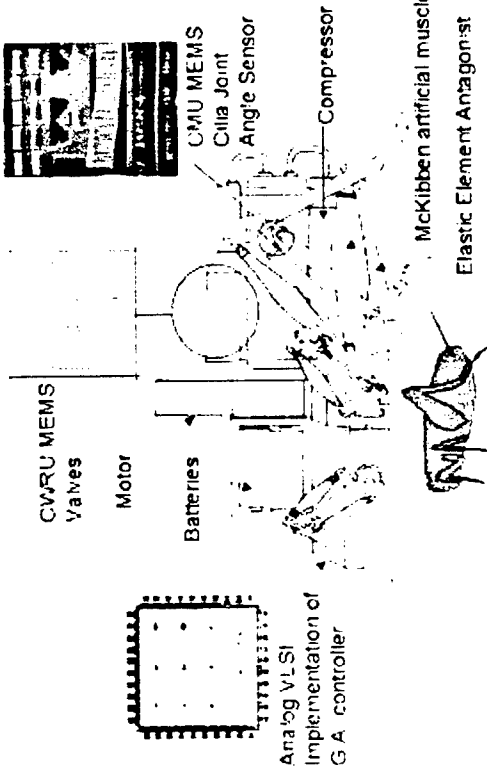
Non-Technical

- Funding Stability
- Technology Transition
- S&T Workforce

Basic Research: Micro Robotics

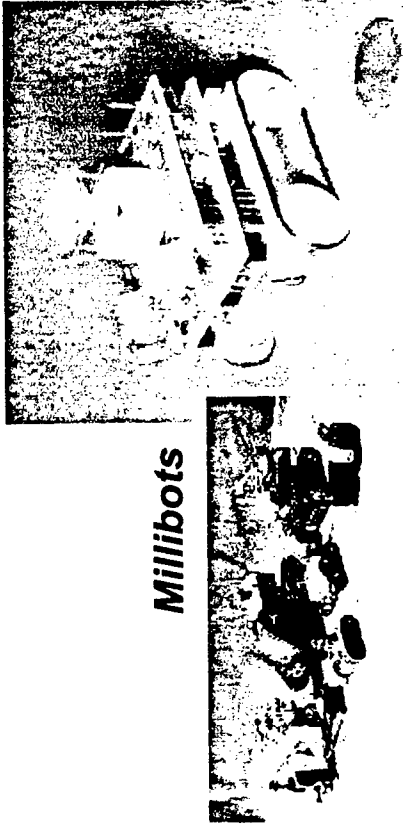


Cricket Micro-Robot



Analog VLSI Implementation of G.A. controller

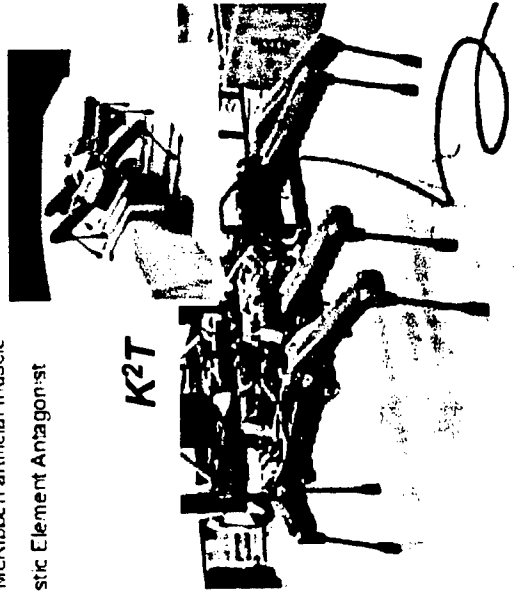
Millibots



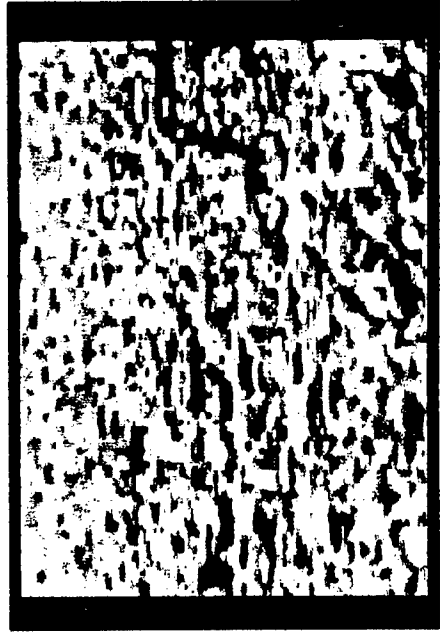
Robot III



K2T



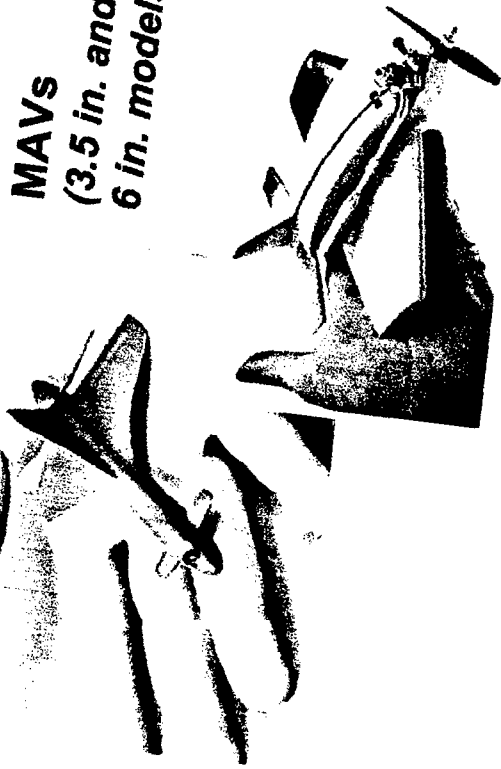
Underwater Robotarief



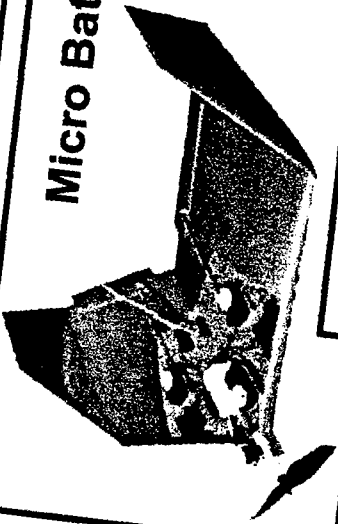
Basic Research: Micro Air Vehicles



MAVs
(3.5 in. and
6 in. models)



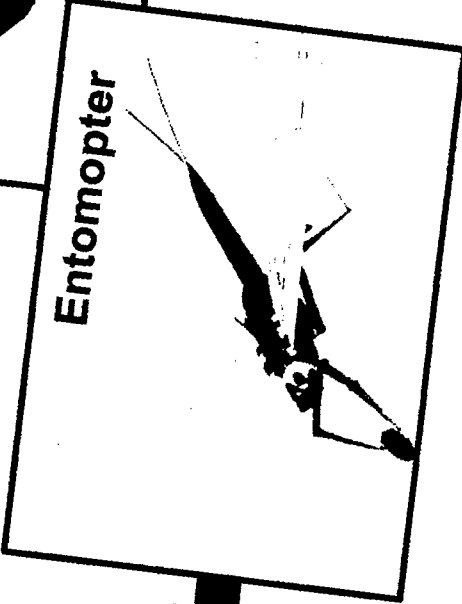
Micro Bat



Black Widow

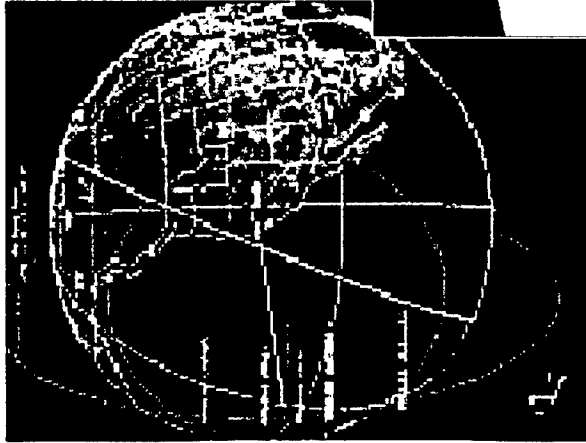


Entomopter

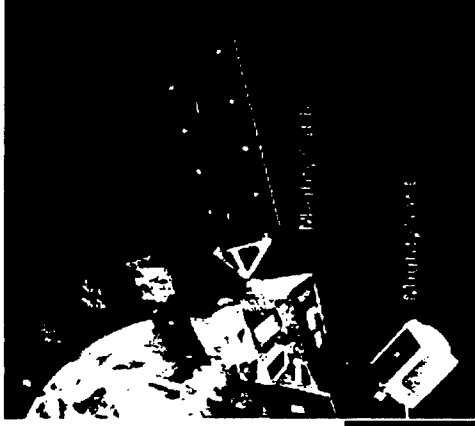
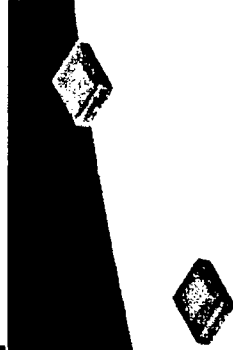


- Exoskeletal Chemical Muscle Reaction Chamber
- Exhaust Ports
- Wing Hinges
- Thermoelectric Generator
- Intensity Sensor-Actuated Trinary Steering
- Inflight, widely spread Surface Locomotors provide Anti-Roll Inertia with auxiliary fuel storage (mass) in legs/feet.
- Wing Ribs double as Gas Ducts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

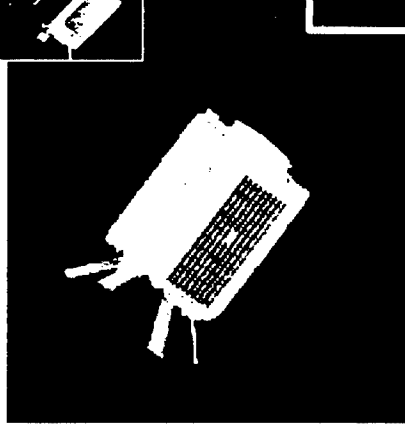
Basic Research: Micro Satellites



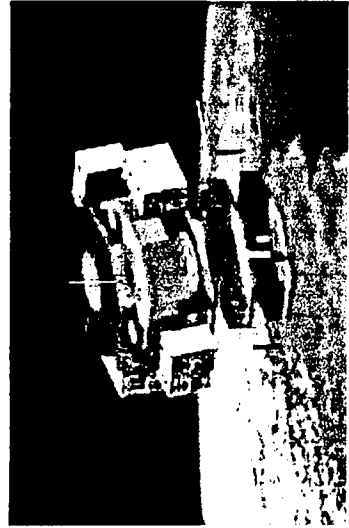
Picosatellites
< 2 Pounds



Small Satellites
200-2000 Pounds



Nanosatellites
2-20 Pounds

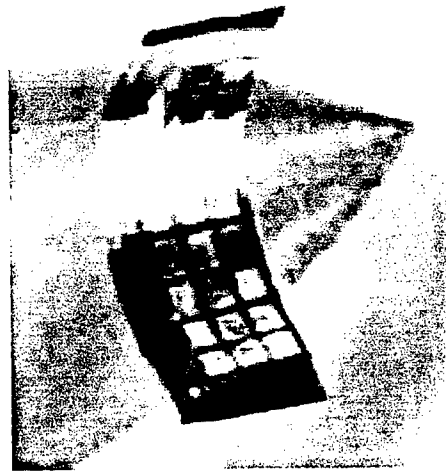


Microsatellites
20-200 Pounds

Basic Research: Smart Materials & Structures



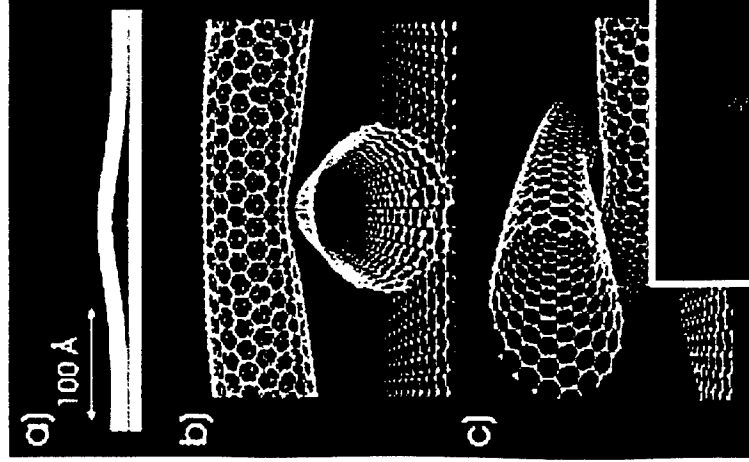
- Elastic active materials
- Smart skins and coatings
- Distributed sensors and actuators
- Armor materials by design
- Adaptive structures



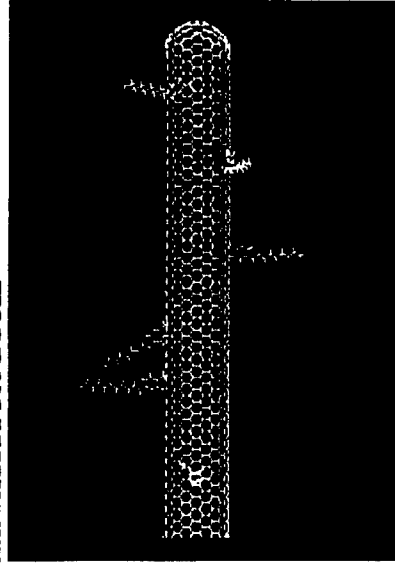
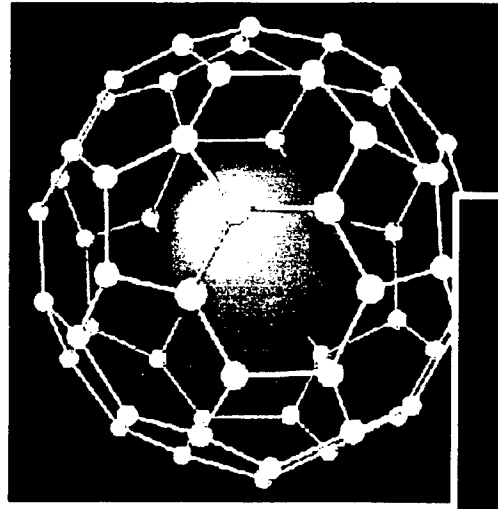
Flexible Sensor Skin

- Ultraquiet submarines,
- adaptive flight control,
- vibrational control,
- advanced stealth,
- armor materials

Basic Research: Nanotechnology



- *Carbon Computers*
- *Molecular Engineering*
- *Nanoscale Robots, Sensors, Machines*
- *Battery Electrode and Energy Storage*
- *Vacuum Microelectronics Devices*
- *Molecular Composites*



Multidisciplinary University Research Initiative (MURI)



MURI Themes for 2002

- **Energetics-** (explosives, propulsion, power)
- **Multifunction Materials-** (adaptive response to changing environments, sensors, warrior readiness, information flow)
- **Synergistic Sensing-** (battlespace awareness, combating terrorism, decision making)
- **Control for Adaptive and Cooperative Systems-** (adaptive command and control of swarms of micro air vehicles, robots, or satellite clusters)

Collective Behavior of Smaller, Smarter Systems



Goal: Collective Dynamic Intelligence in an Autonomous System

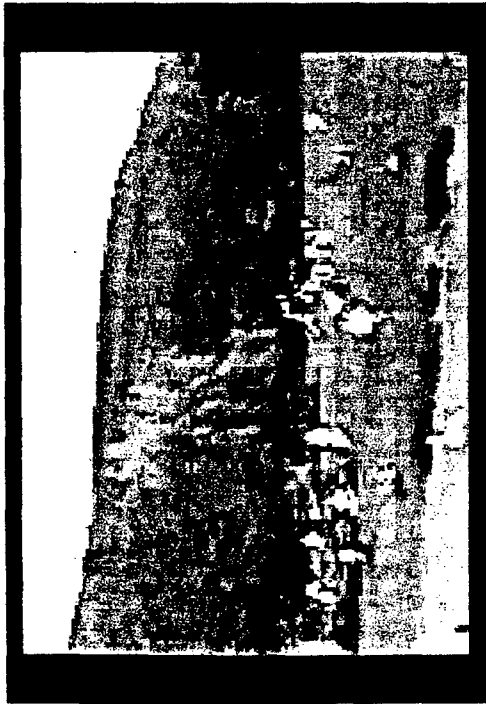
- Achieved By: Swarm Behavior in Low-Cost, Low-Tech Individual Entities & Cooperative Control



Lessons From Nature



Flocking Behavior



Collective Behavior



Collective Intelligence



- Systems Whose Purpose is:
 - To Act in Collaboration with Other Systems
 - To Produce Information that is Greater than the Sum of the Individual Components.

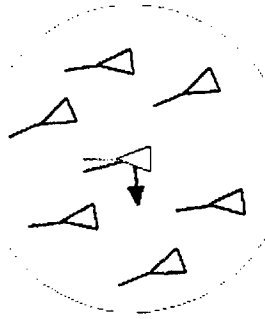


Swarm Movement

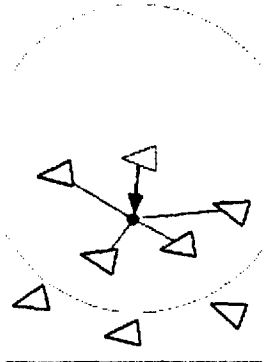


Let R be the
desired distance
between two
entities.

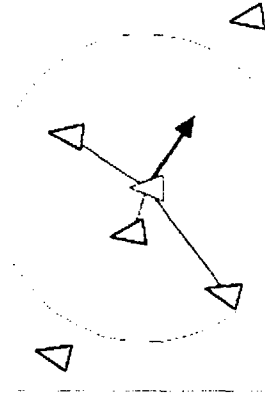
Let r be the
actual distance
between two
entities.



alignment

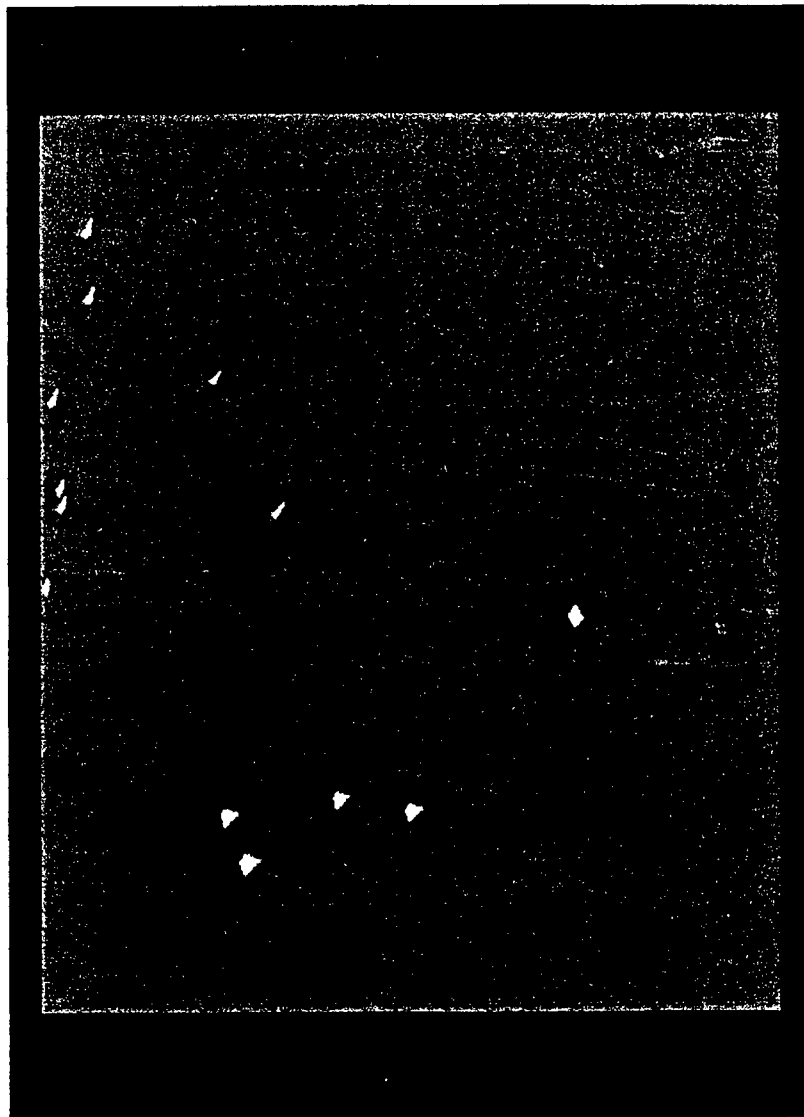


Cohesion
($r > R$)



Separation
($r < R$)

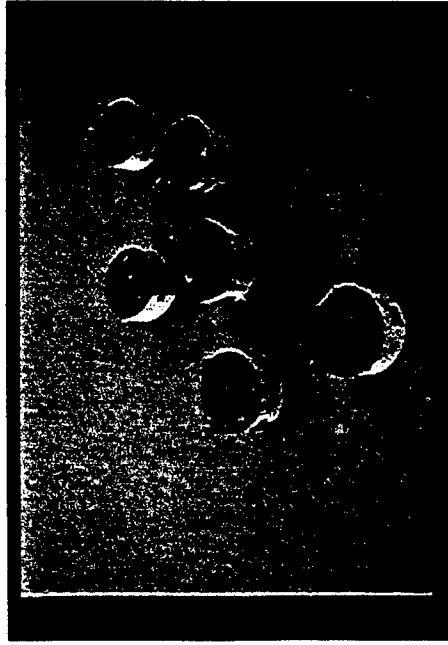
Swarm Movement Model



Simple Tasks with Collective Behavior



Move Items to Target Location



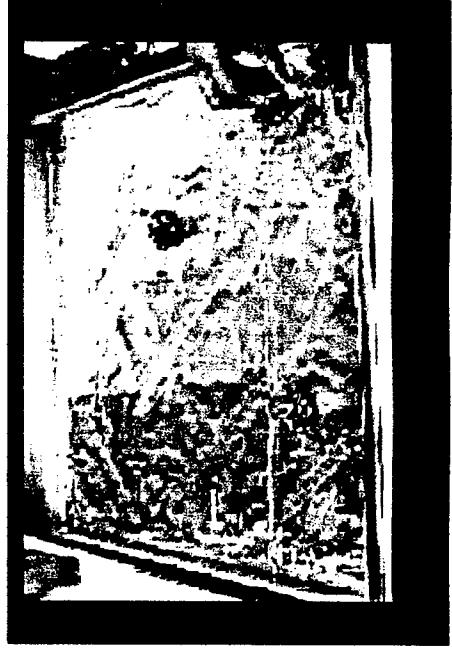
Locate Items and Cluster Around Them

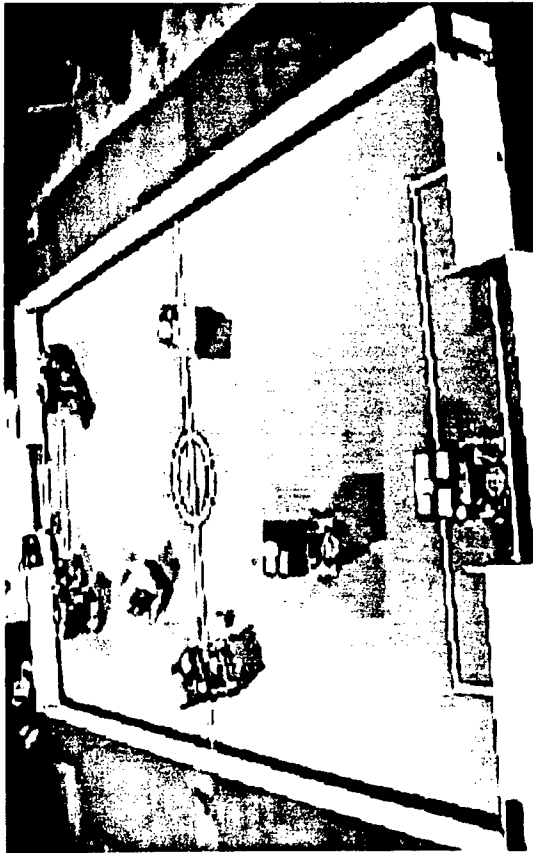


Follow Signals, Locate and Move Items

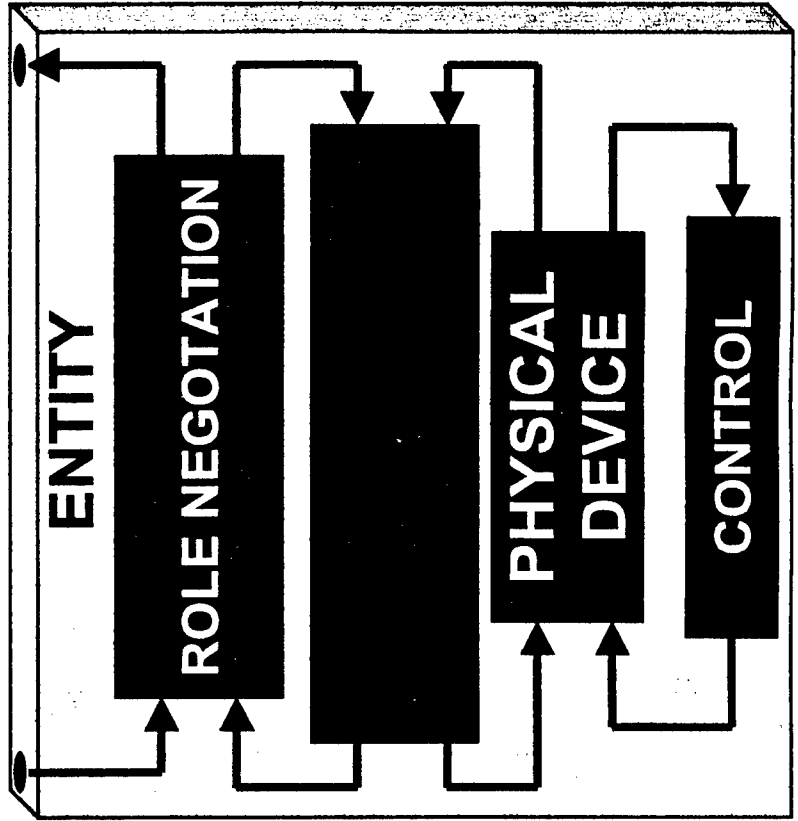
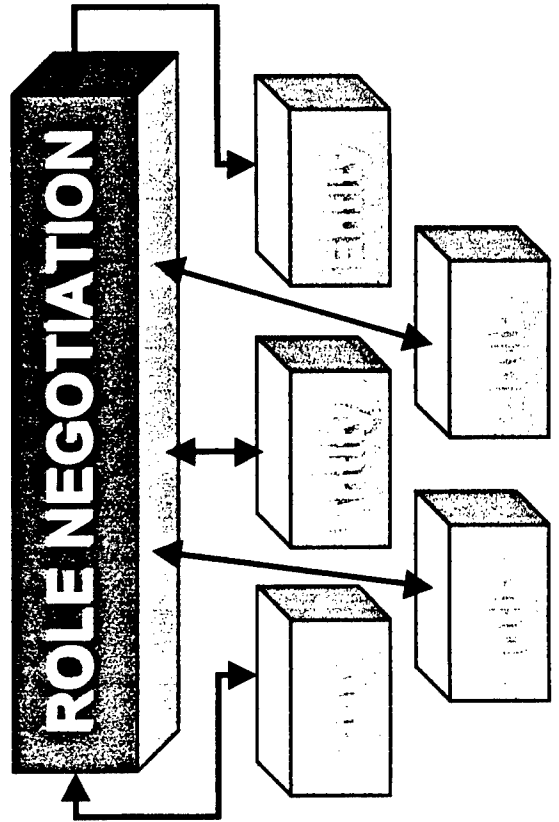


Role Playing - Tag You're It





Platform for Autonomous Control of Distributed, Multi-Entity Systems in an Adversarial, Evolving, and Uncertain Environment



Robocup Tournament



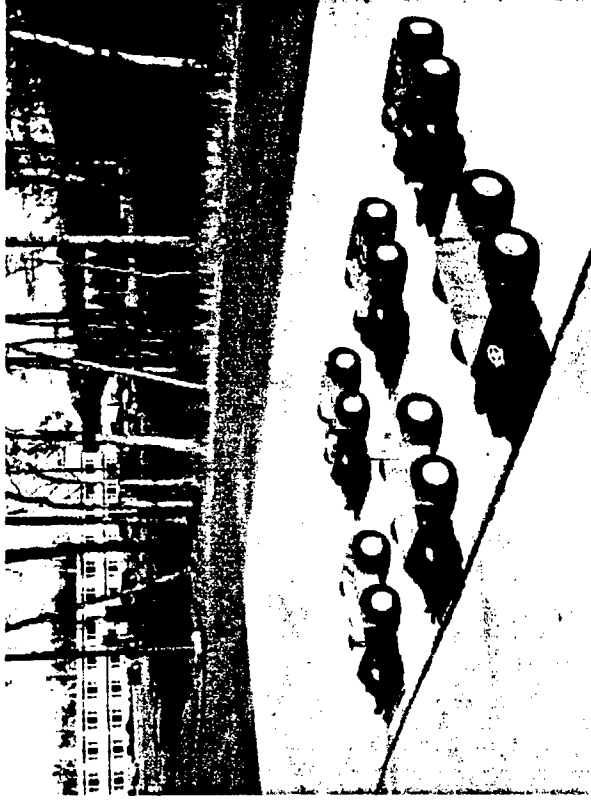
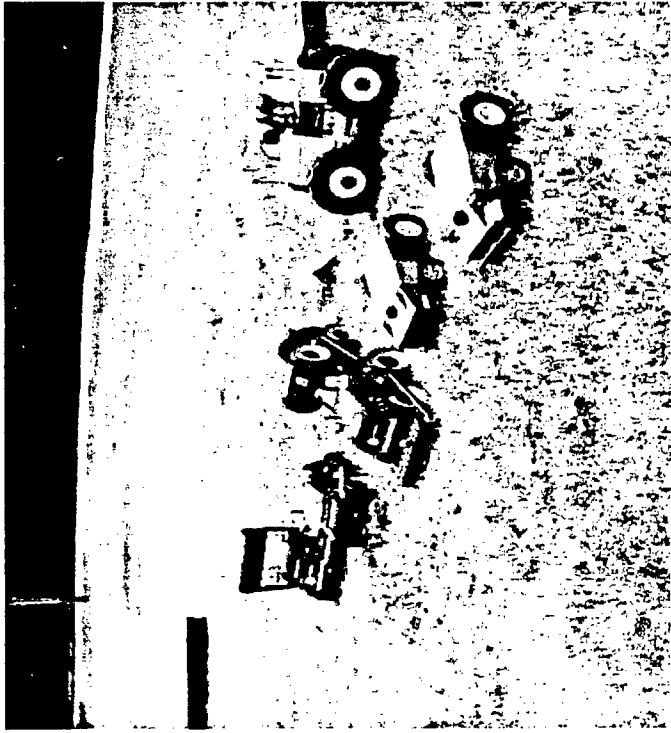
Basic UXO Gathering System (Bugs)



- Multiple Cooperative Behavior Robots

- Pick Up and Carry Away Submunitions

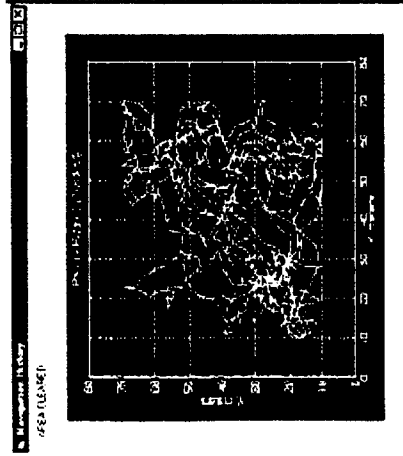
- Blow in Place*



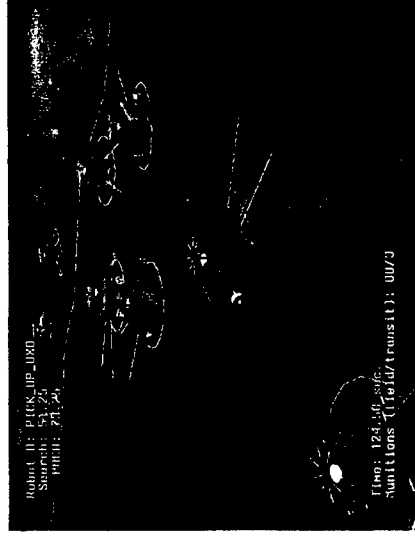
Basic UXO Gathering System (Bugs)



- Model Search Strategies



- Simulate Systems to Optimize Subsystems



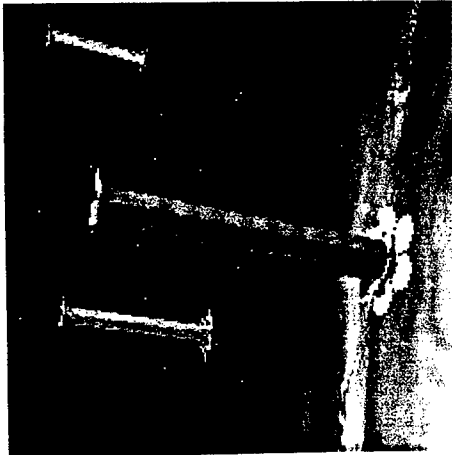
- Demonstrate Search Strategies Using Micro Robots



BUGS In Action



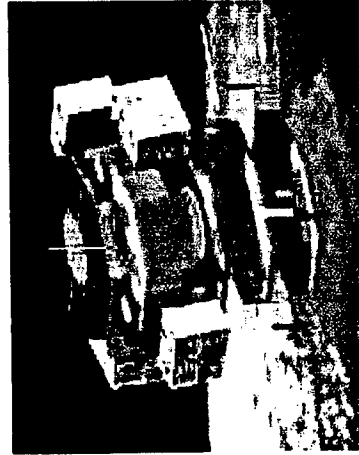
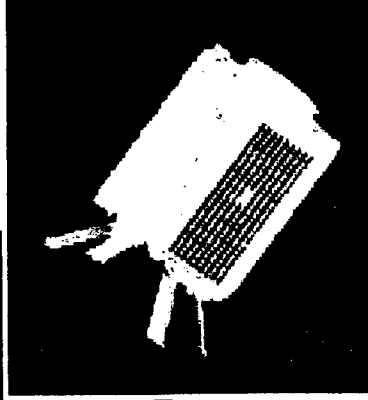
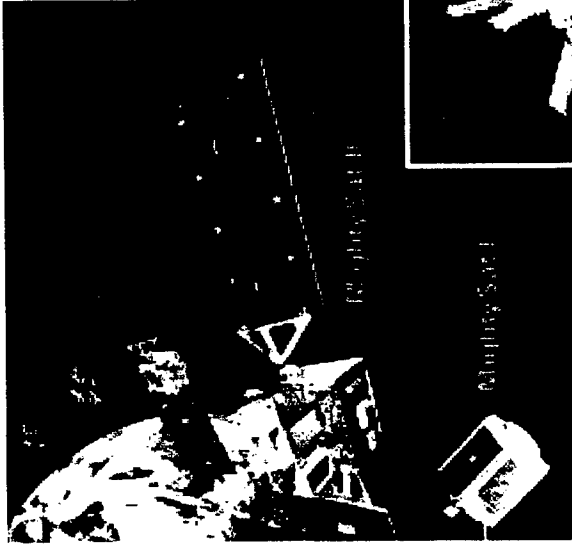
The Future of Satellites



Microsatellites



Smallsatellites

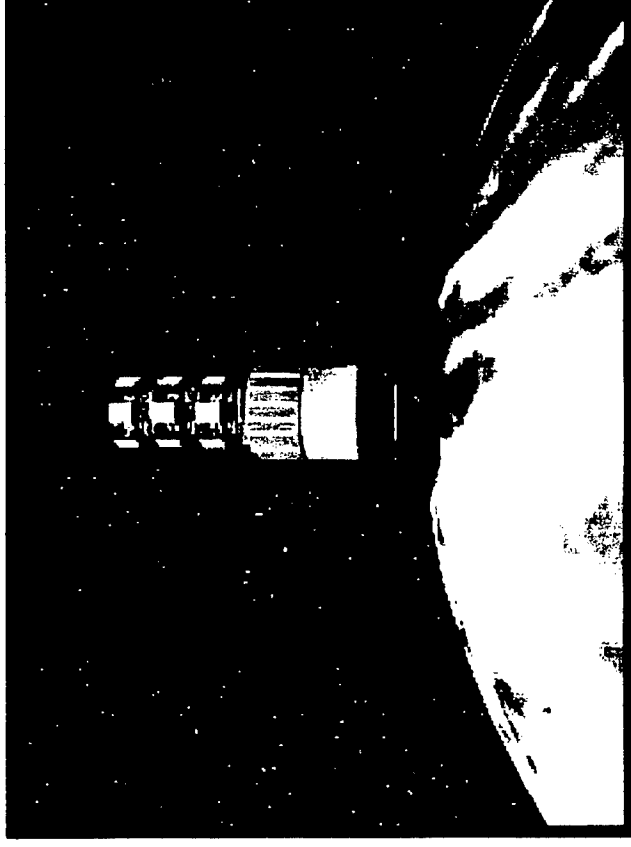


Nanosatellites

Collaborating Microsatellite Clusters TechSat 21

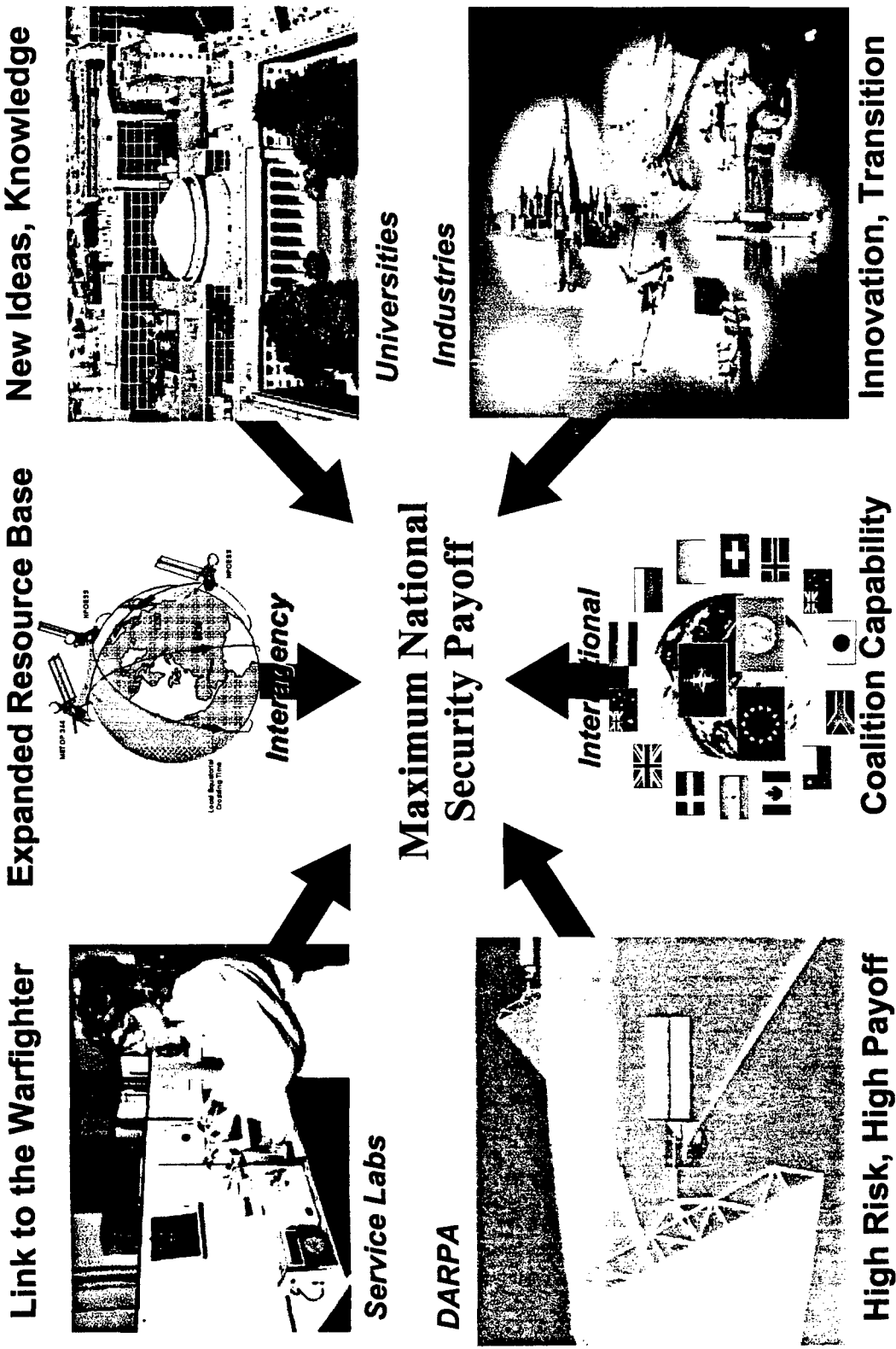


- Cluster of formation flying capable microsats form a “virtual satellite”
- Concept enables multi-mission capability
 - Space Based Radar
 - Communications
 - Geolocation

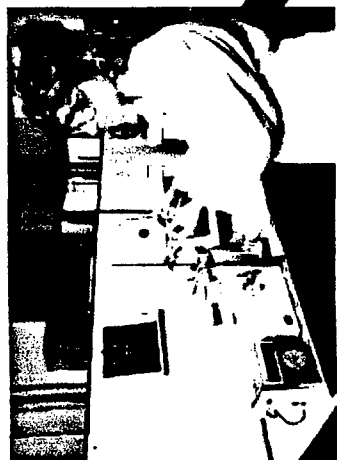


Goal: Affordable, Real-Time, On-Demand Global Awareness

Technology Transition Requires Strong Partnerships

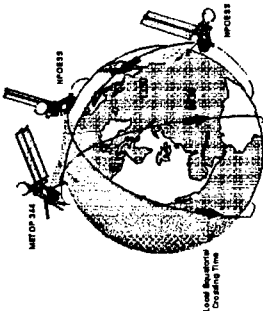


Link to the Warfighter



Service Labs

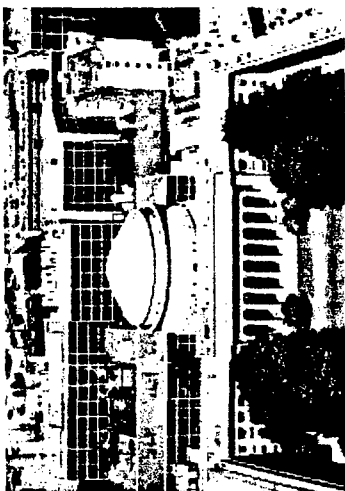
Expanded Resource Base



Interagency

Maximum National Security Payoff

New Ideas, Knowledge



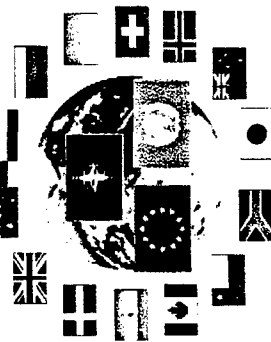
Universities

Industries



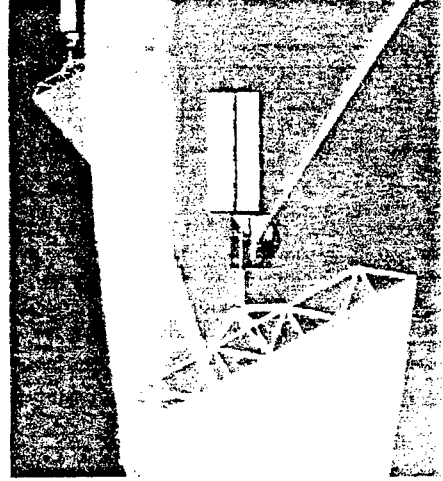
Innovation, Transition

Interagency



Coalition Capability

DARPA



High Risk, High Payoff

A Focus on Tomorrow's Possibilities



"**T**echnical Superiority is
Critical for National Security.

In peace, it provides deterrence;

In crisis, it provides options;

In war, it provides an edge."

Defense Science and Technology Strategy
May 2000