
NIAC Status Report
for the
Kennedy Space Center
November 28, 2001
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NASA Institute for Advanced Concepts
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Wyn Wachhorst
The Dream of Spaceflight

It is at its frontiers that a species experiences the most perturbing stress. The urge to explore, the quest of the part for the whole, has been the primary force in evolution since the first water creatures began to reconnoiter the land. We humans see this impulse as the drive to self-transcendence, the unfolding of self-awareness…

Living systems cannot remain static; they evolve or decline. They explore or expire. The inner experience of this imperative is curiosity and awe. The sense of wonder—the need to find our place in the whole—is not only the genesis of personal growth but the very mechanism of evolution, driving us to become more than we are. Exploration, evolution, and self-transcendence are but different perspectives on the same process.


The visions we offer our children shape the future.
It matters what those visions are. Often they become
self-fulfilling prophecies. Dreams are maps.
– Carl Sagan, 1994, "Pale Blue Dot"
DaVinci
Galileo
Kepler
Verne
Jules Verne
E=mc2
limit of balloon, 20 miles
limit of atmosphere; 200 miles
Tsiolkovsky
Einstein
Goddard
Oberth
Korolev
2001 a space odyssey
Lee
Von Braun
Clarke
Sagan
O'Neill
Margulis

Wyn Wachhorst, <u>The Dream of Spaceflight</u>

The frontier, like the world of the child, is a place of wonder explored in the act of play. Work is self-maintenance; play is self-transcendence, probing the larger context, seeking the higher order…

Joseph Campbell has observed that in countless myths from all parts of the world the quest for fire occurred not because anyone knew what the practical uses of fire would be, but because it was fascinating. Those same myths credit the capture of fire with setting man apart from the beasts, for it was the earliest sign of that willingness to pursue fascination at great risk that has been the signature of our species. Man requires these fascinations, said the poet Robinson Jeffers, as "visions that fool him out of his limits."

Like the capture of fire, the longing for space-flight is rooted less in means than in meaning itself.

NIAC Charter

- **Focus on Revolutionary Advanced Concepts for Architectures and Systems**
- **Be an Institute Independent of NASA**
  - **-- Management and guidance external to NASA**
  - **-- Non-NASA (mostly) peer review**
  - **-- NIAC issues and manages research grants/contracts**
  - **-- Contractually reports to GSFC with funding from NASA HQ**
- **Operate as a Virtual Institute over the Internet (http://www.niac.usra.edu)**
  - **-- Calls for proposals issued through NIAC website**
  - **-- Proposals only accepted electronically**
  - **-- All abstracts, reports, web links and presentations are available on NIAC website**
- **Succinct Technical Proposal Requirements and Peer Review**
  - **-- Phase I (12 pages), Phase II (25 pages)**
  - **-- Typical evaluation process, 2 - 2.5 months from receipt of proposal to award**

'Visions of the future may affect our interpretation of and appreciation for the present. Our focus on the future turns our minds towards possibilities and away from more immediate conflicts and helps to remind us that there will be a future."

Robert A. Cassanova

NASA Institute for Advanced Concepts

Where have we been?

Where are we going?

We shall not cease from exploration
And in the end of all our exploration
Will be to arrive where we started
And know the place for the first time.

– T. S. Eliot, “Little Gidding”

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NIAC Investments To-Date

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Future Interests and Challenges

- Fulfill the human desire to understand our place in the universe.
- Seek knowledge to understand how we evolved and what is our destiny.
- Search for life in the universe and understand cosmological phenomena.

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- Make possible the safe, affordable and effective exploration, development and self-reliant habitation of our solar system – and eventually space beyond our solar system – by humans and their agents.
- Mediate the effects of the space environment, such as microgravity and radiation, on humans and other living things,

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- **Provide seamlessly integrated, safe, reliable, fast and efficient transportation network from the Earth's surface to distant locations in space as well as portal to portal on the Earth's surface.**

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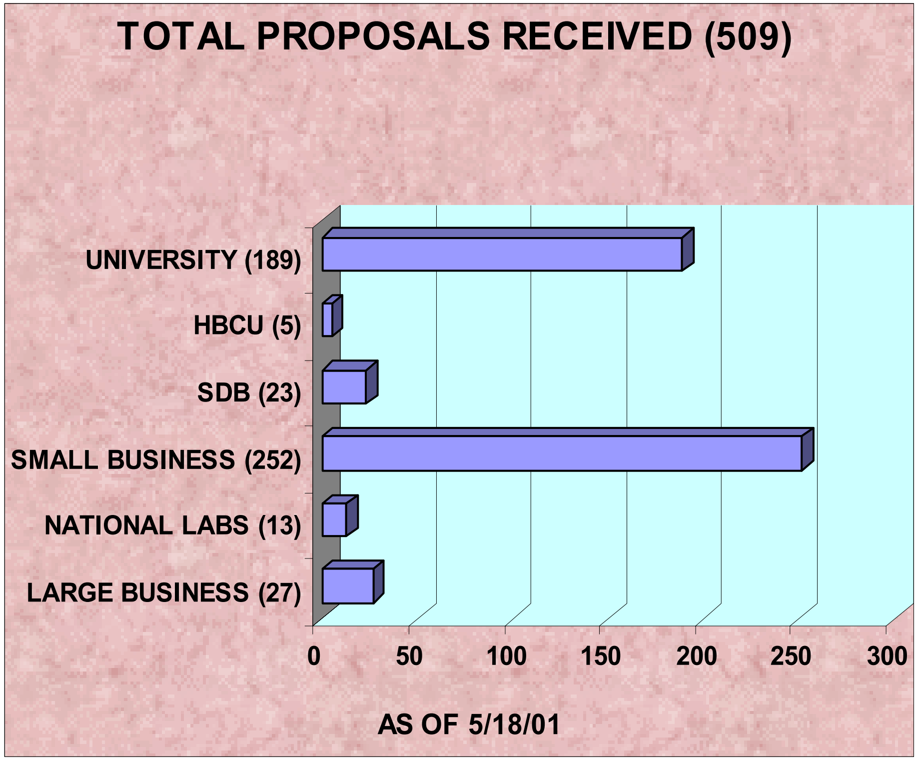
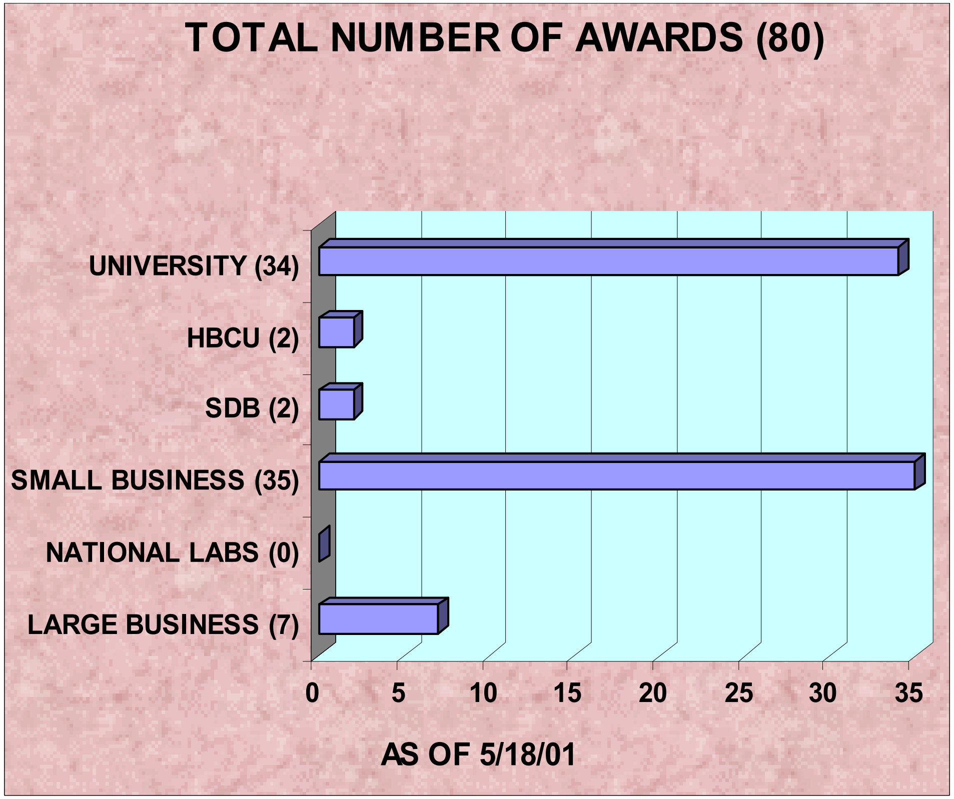
- **Understand the influence on the Earth system of the actions of mankind, the natural cyclic phenomena in the Earth's system and the interaction of the Sun-Earth system.**
- **Create tools and techniques to access, visualize and interpret data and model findings.**
- **Predict the future evolution of the Earth system and its relationship to natural phenomena and human activity, and validate this predictive capability.**

Proposals Received and Awards

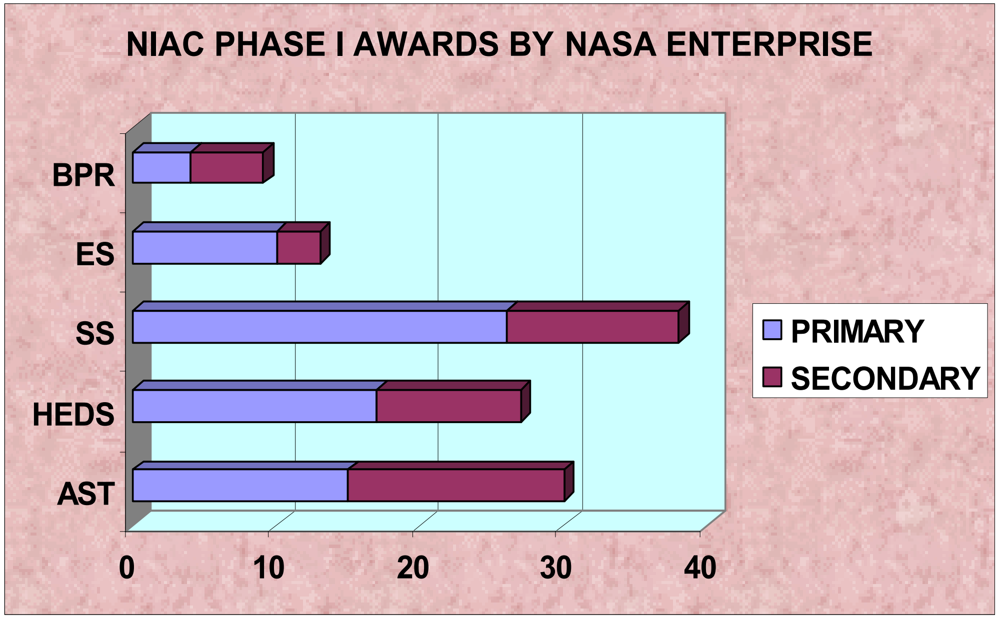
(through May 18, 2001)

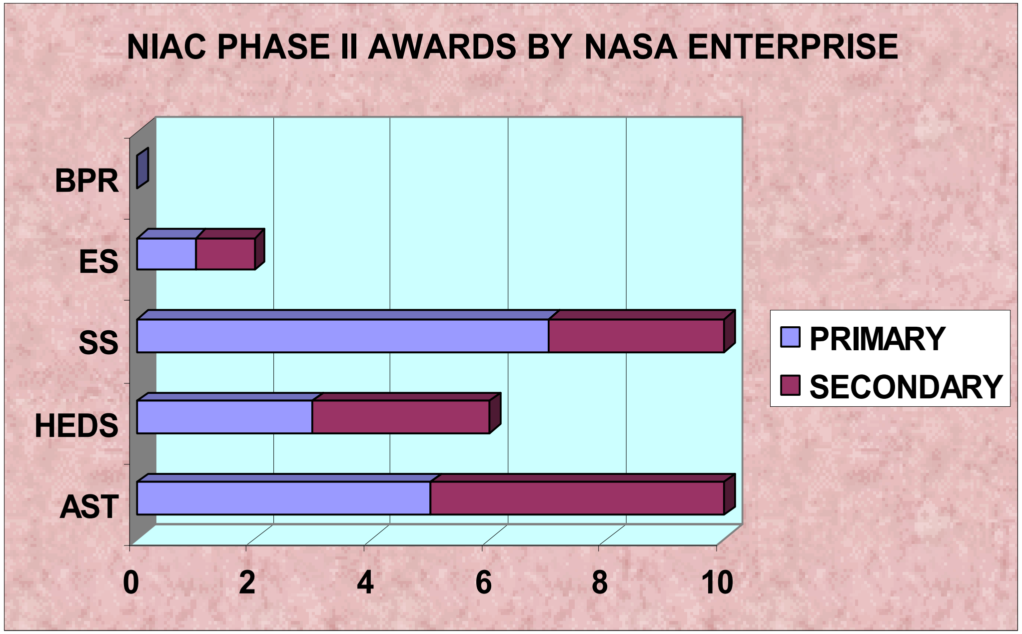




NIAC Awards

(through May 18, 2001)





Recent and Future Events

September 2001

Release of Next Phase I Call for Proposals with a due date of early February 2002

October 30-31, 2001

NIAC Phase I Fellows Meeting and Workshop
NIAC HQ, Atlanta, Georgia

November 6-7, 2001

Workshop on Revolutionary Aerospace Systems Concepts for Human/Robotic Exploration of the Solar System
NASA LaRC

June 4-5, 2002

NIAC 4th Annual Meeting
Lunar and Planetary Institute, Houston, Texas

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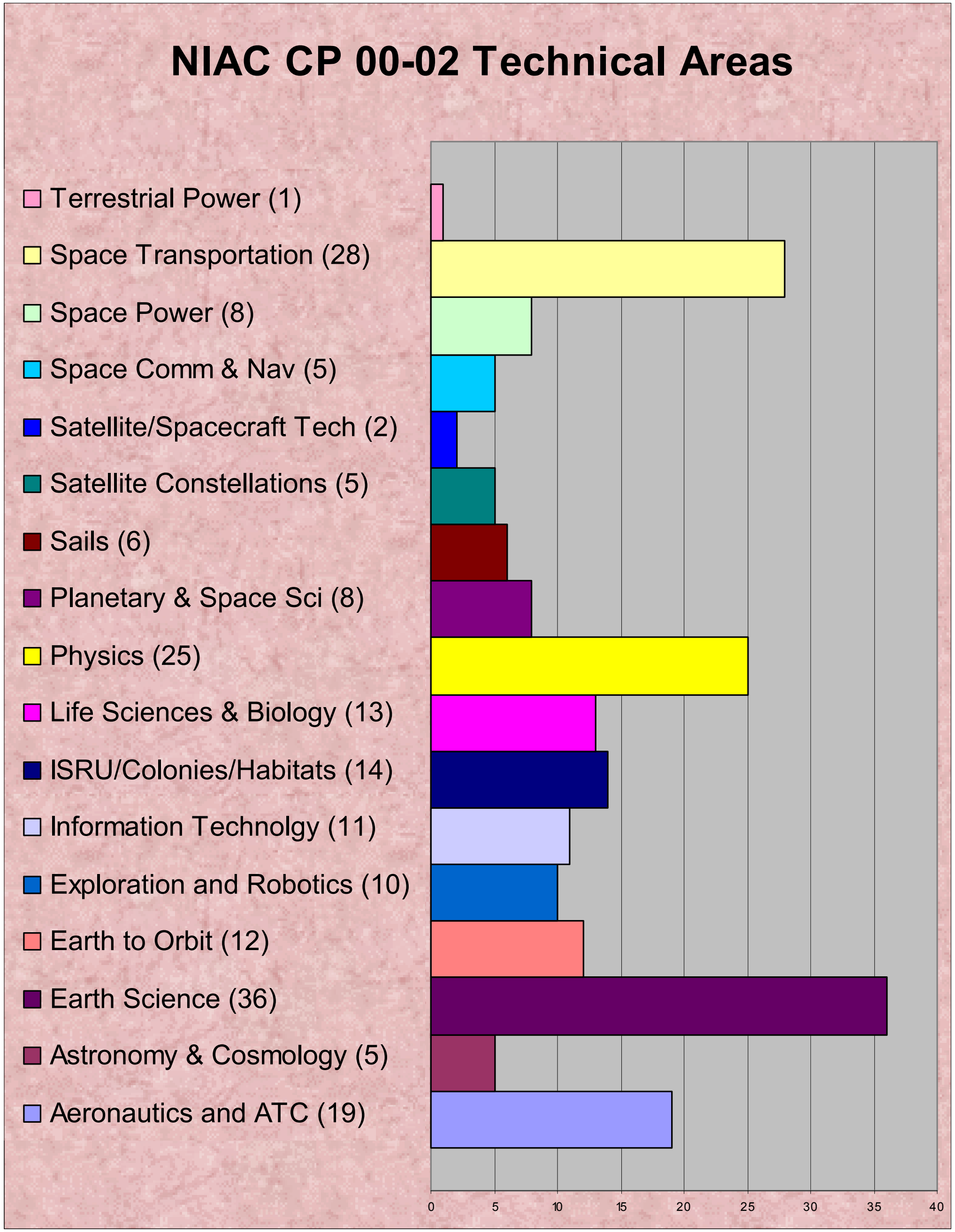
Phase I Awards

Call for Proposals: CP 00-02

Performance Period: June 1 – November 30, 2001

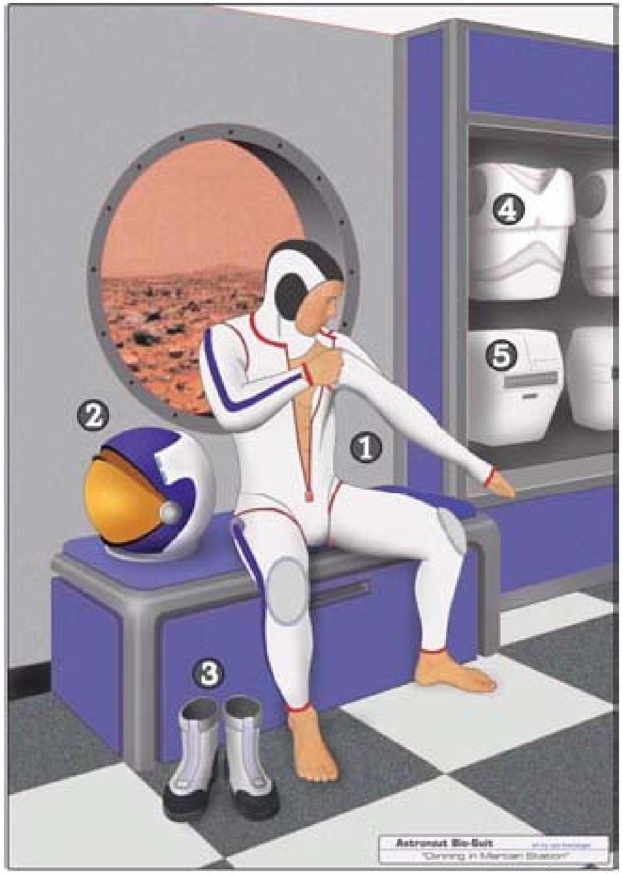
CP 00-02 Proposals

Total Proposals = 172
Some are double counted
In multiple technical areas

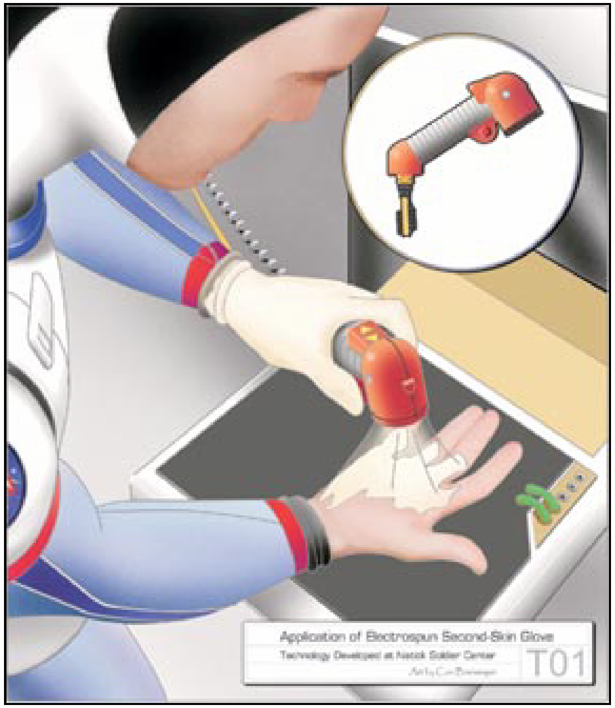


Astronaut Bio-Suit System for Exploration Class Missions

Dava Newman, Massachusetts Institute of Technology



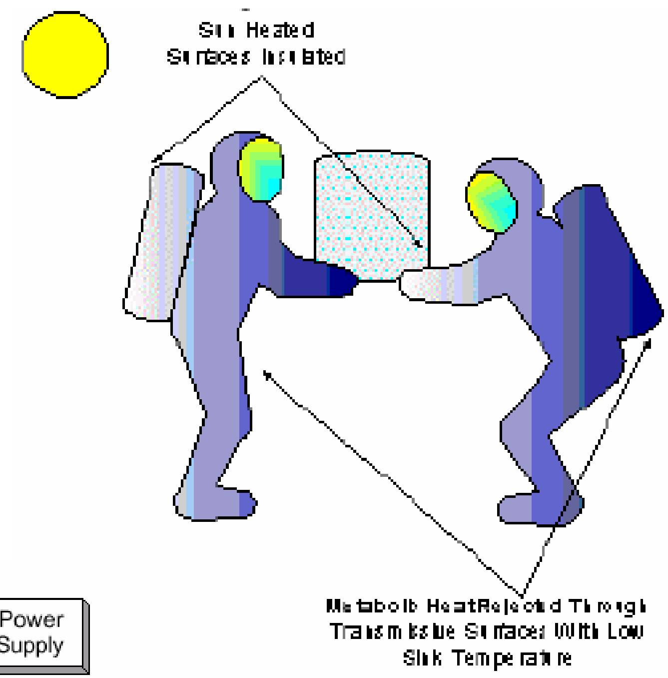
An astronaut on Mars donning the comfortable elastic bio-suit layer (1). The hard torso shell (4) is donned next and seals with couplings at the hips and shoulders. The hard backpack, or portable life support system, (5) attaches mechanically to the hard torso shell, and provides gas counter pressure. Gas pressure flows freely into the helmet (2) and down tubes on the elastic bio-suit layer to the gloves and boots (3). The bio-suit layer is lightweight and easy to don and doff. It is custom fitted to each astronaut using a laser scanning/electrospinlacing process (Natick Soldier Center). Remaining suit elements are simple, functional, interchangeable and easy to maintain and repair.

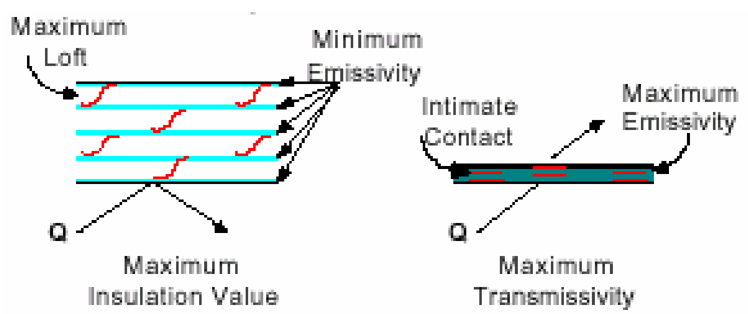


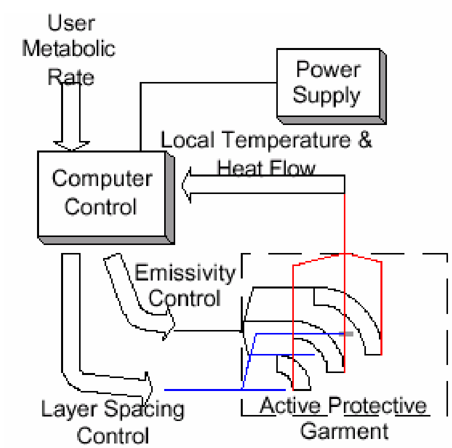
Electrospinlacing is a process where a multi-filament fiber of polymer is sprayed onto a grounded surface, which is achieved by charging a suspended drop of polymer with tens of thousands of volts. At a characteristic voltage the droplet forms a Taylor cone, and a fine jet of polymer releases from the surface in response to the tensile forces generated by interaction of an applied electric field with the electrical charge carried by the jet. The projected polymer can be collected as a continuous web of fibers in a range of thicknesses. Application can be made directly to the skin as shown, or to advanced 3D forms from laser scans. Wearable computers, smart gels and conductive materials could be embedded between polymer layers in future space suit applications. Electrostrictive gel is used to create a seamless mechanical counter-pressure (MCP) layer. A simple hand-held spray device is used for self application.

A Chameleon Suit to Liberate Human Exploration of Space Environments

Edward Hodgson
Hamilton Sundstrand Space Systems International

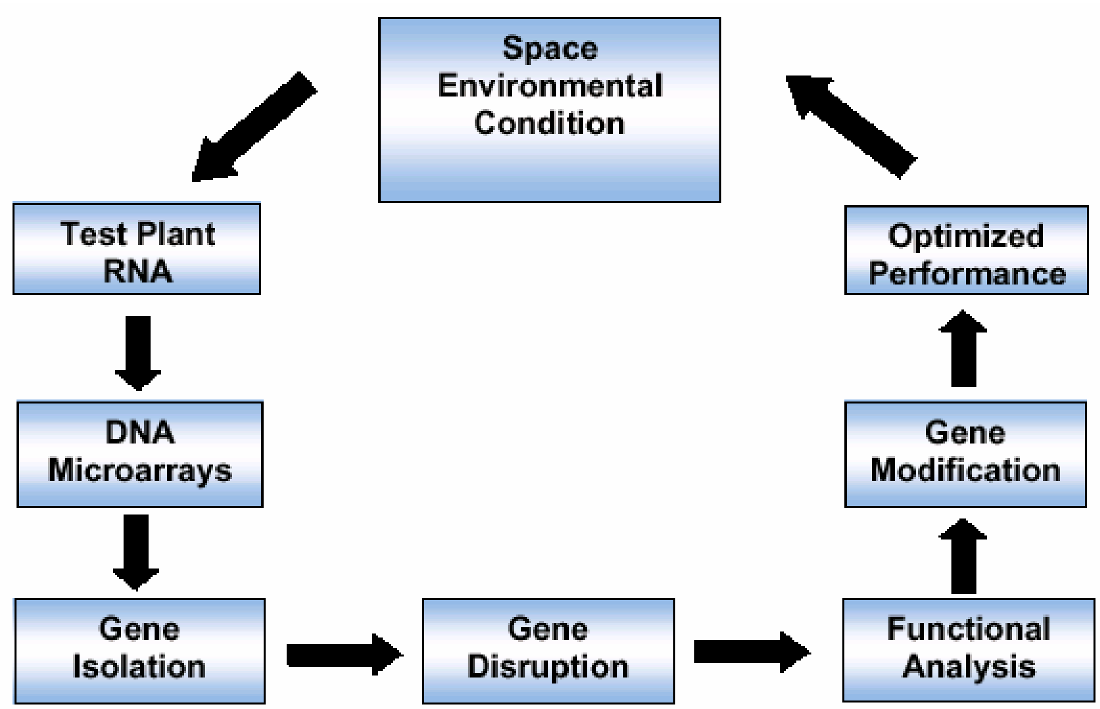






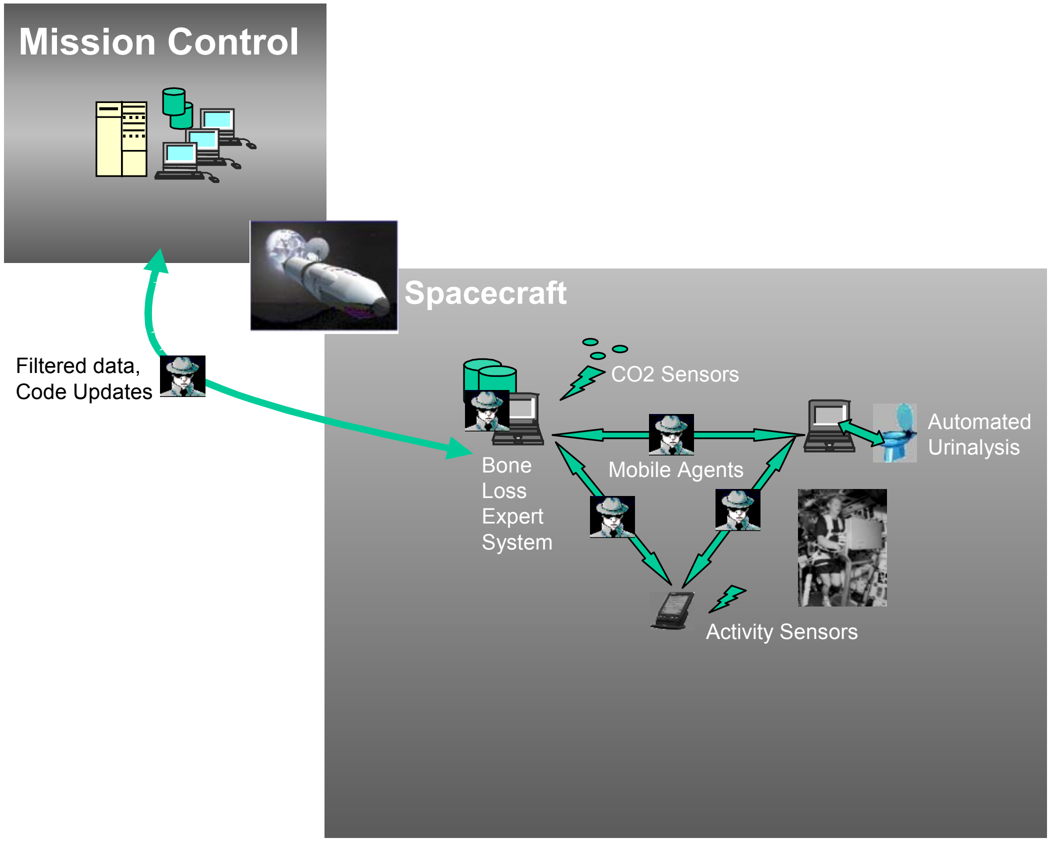
A Flexible Architecture for Plant Functional Genomics in Space Environments

Terri Lomax
Oregon State University



A Novel Information Management Architecture for Maintaining Long Duration Space Crews

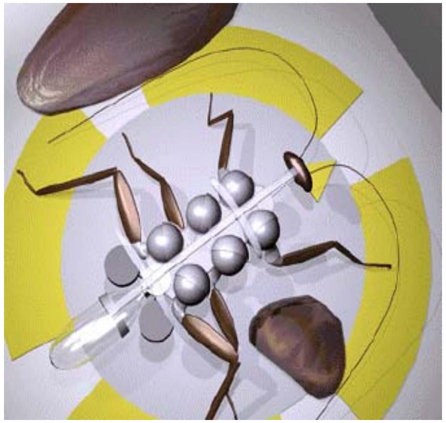
George Cybenko
Dartmouth College

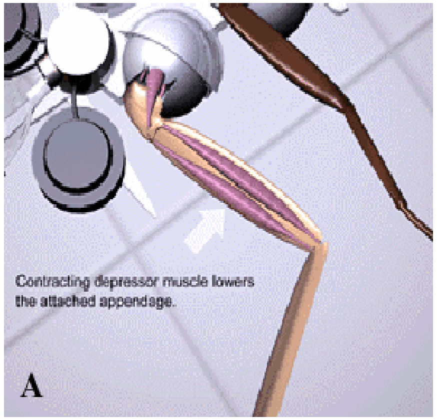


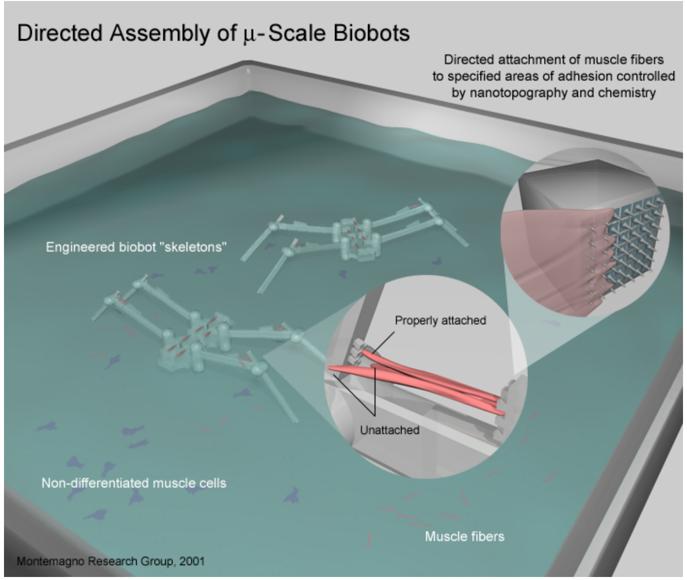
- *Agents transmit information to and from Mission Control.*
- *Agents ability to analyze information prior to moving saves bandwidth.*
- *Code and data can be updated throughout the mission, enabling increased performance and adaptation to mission conditions.*

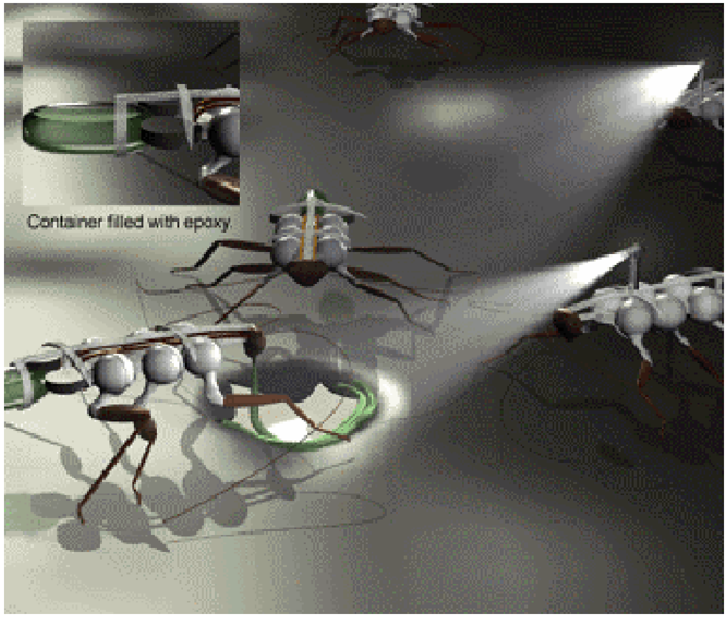
Directed Application of Nanobiotechnology for the Development of Autonomous Biobots

Carlo Montemagno
Cornell University



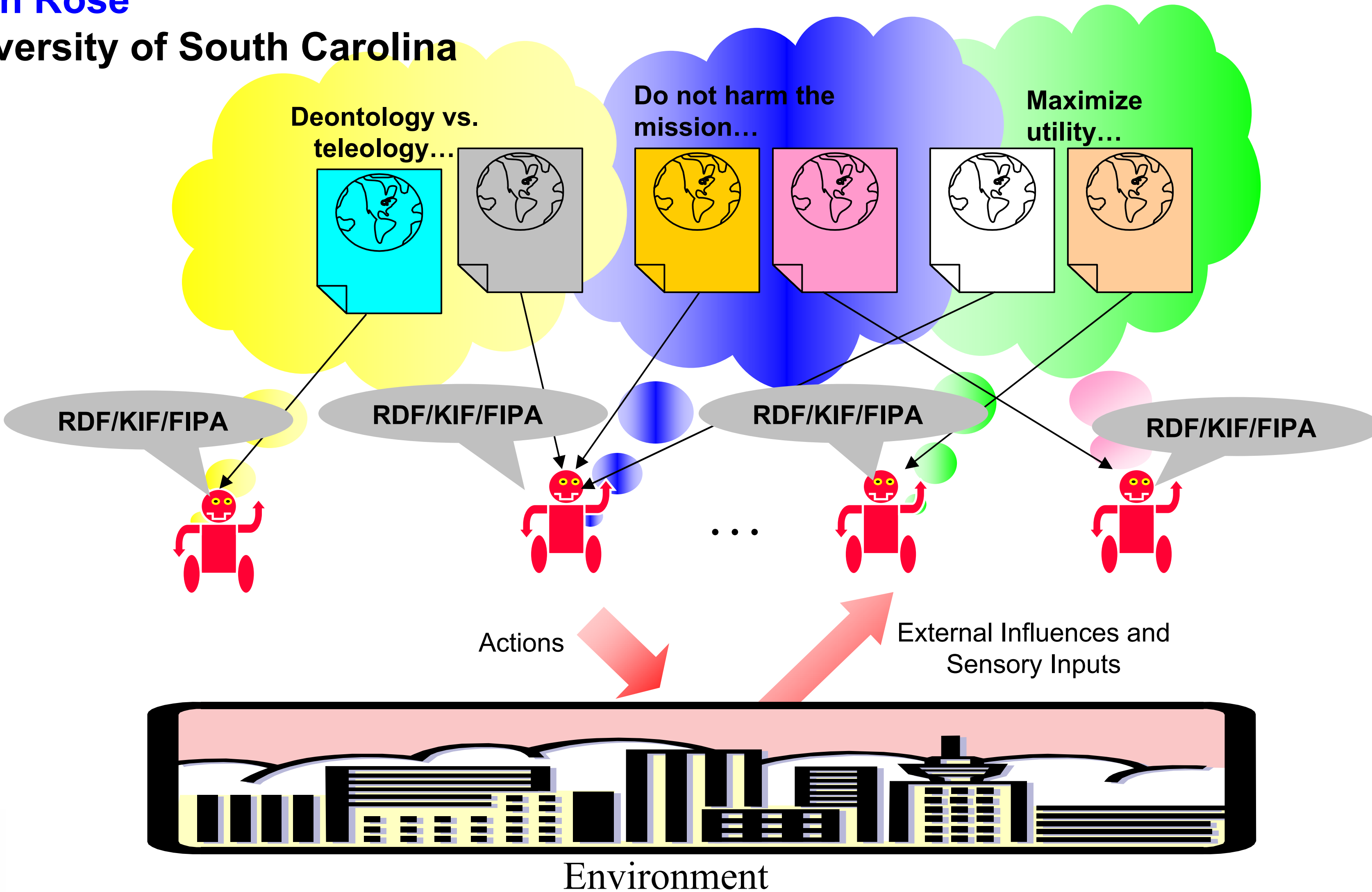






Achieving Comprehensive Mission Robustness

John Rose
University of South Carolina



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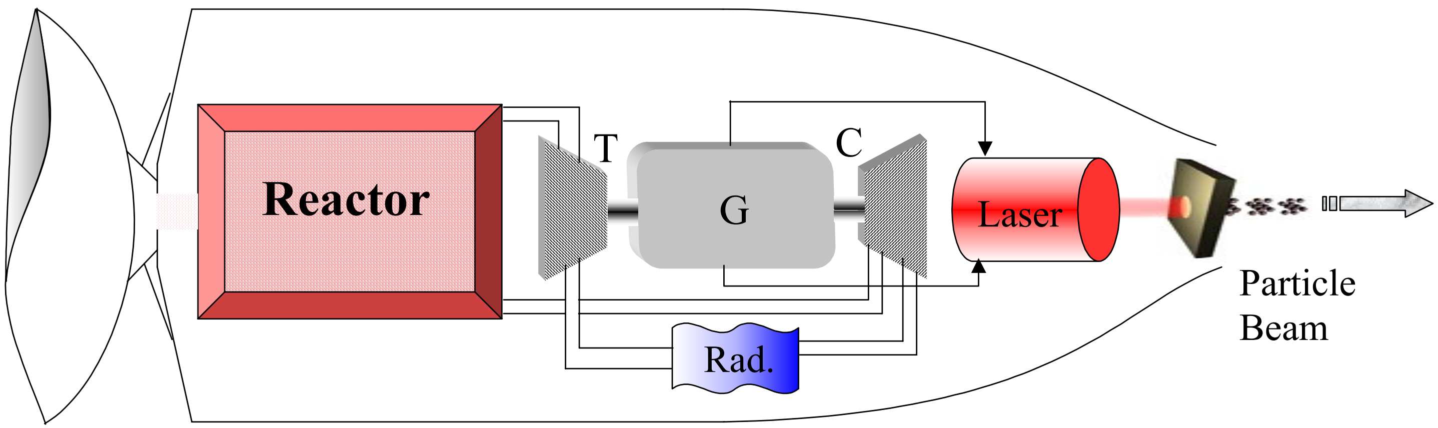
Ultra-Fast Laser-Driven Plasma for Space Propulsion

Terry Kammash
University of Michigan



Laser-Accelerated Plasma Propulsion System
(LAPPS)

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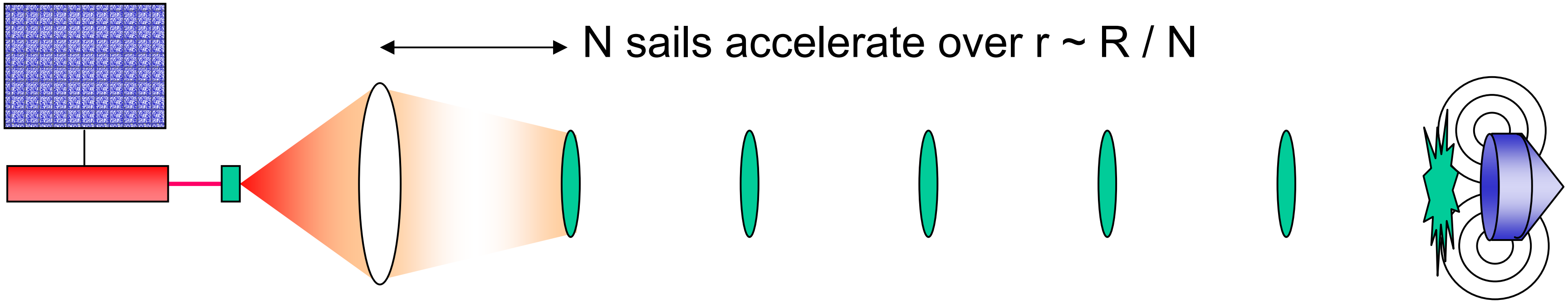
High Acceleration Micro-Scale Laser Sails for Interstellar Propulsion

Jordin Kare
Kare Technical Consulting



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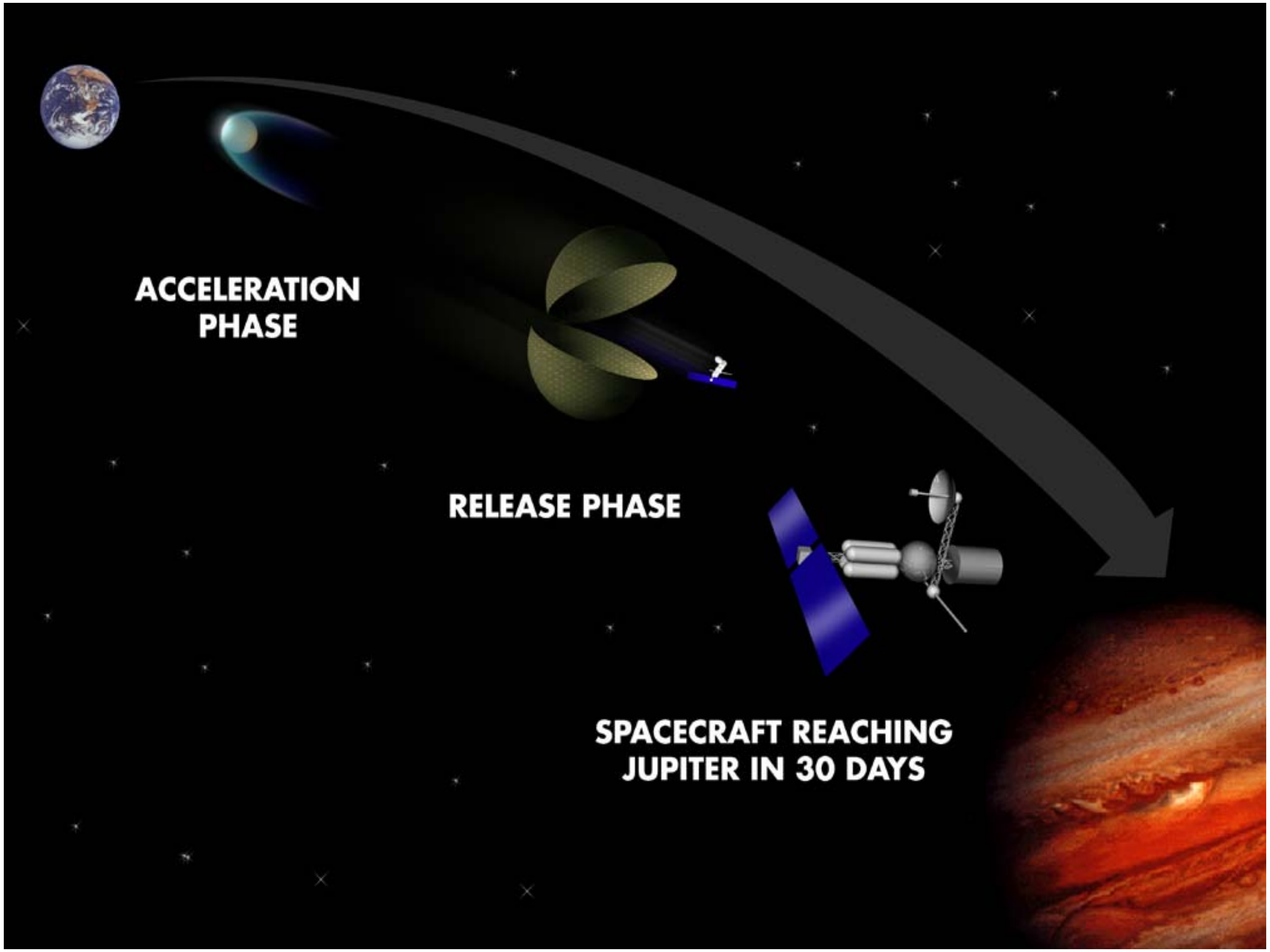
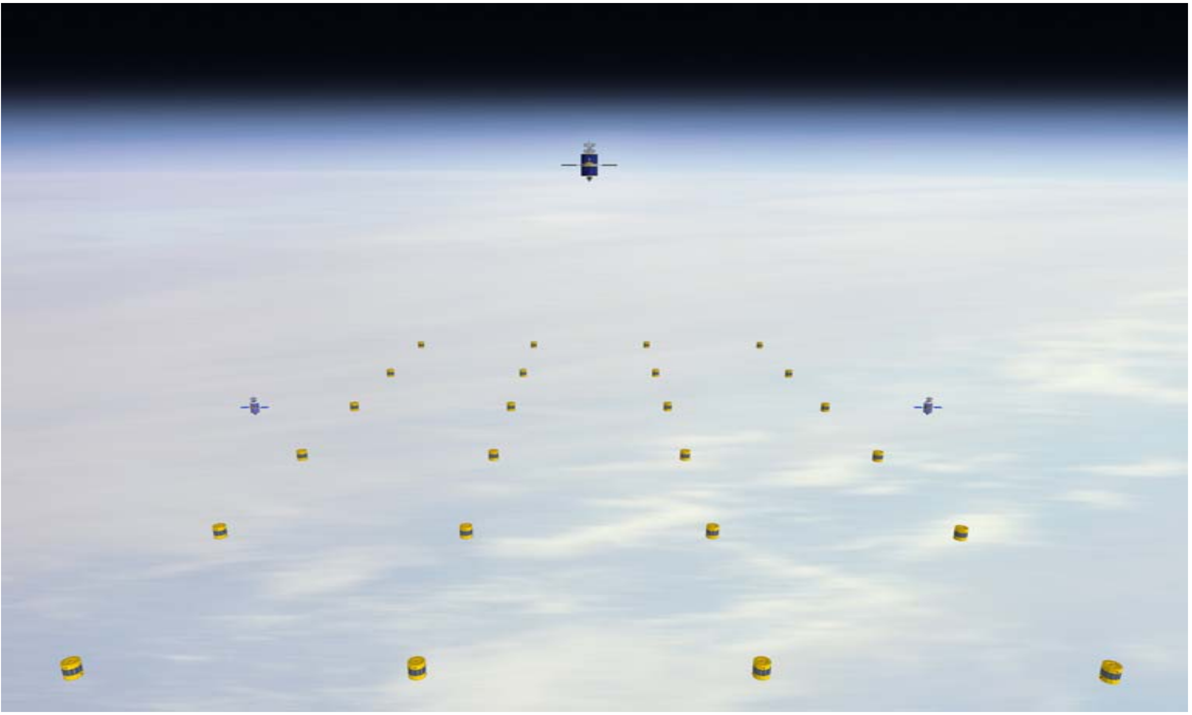
High Speed Interplanetary Tug / Cocoon Vehicles (HITVs)



Nick Omidi
Scibernet, Inc.

Formation Flying with Shepherd Satellites

Michael LaPointe,
Ohio Aerospace Institute



- Proposed shepherd satellite concept is based on established optical gradient force trapping techniques
- Focused electromagnetic radiation from shepsats interacts with applied dipole moments on microsats, providing electromagnetic gradient forces to position and maneuver the formation-flying array
- Individual microsats can devote their limited mass and power to instrumentation and observation

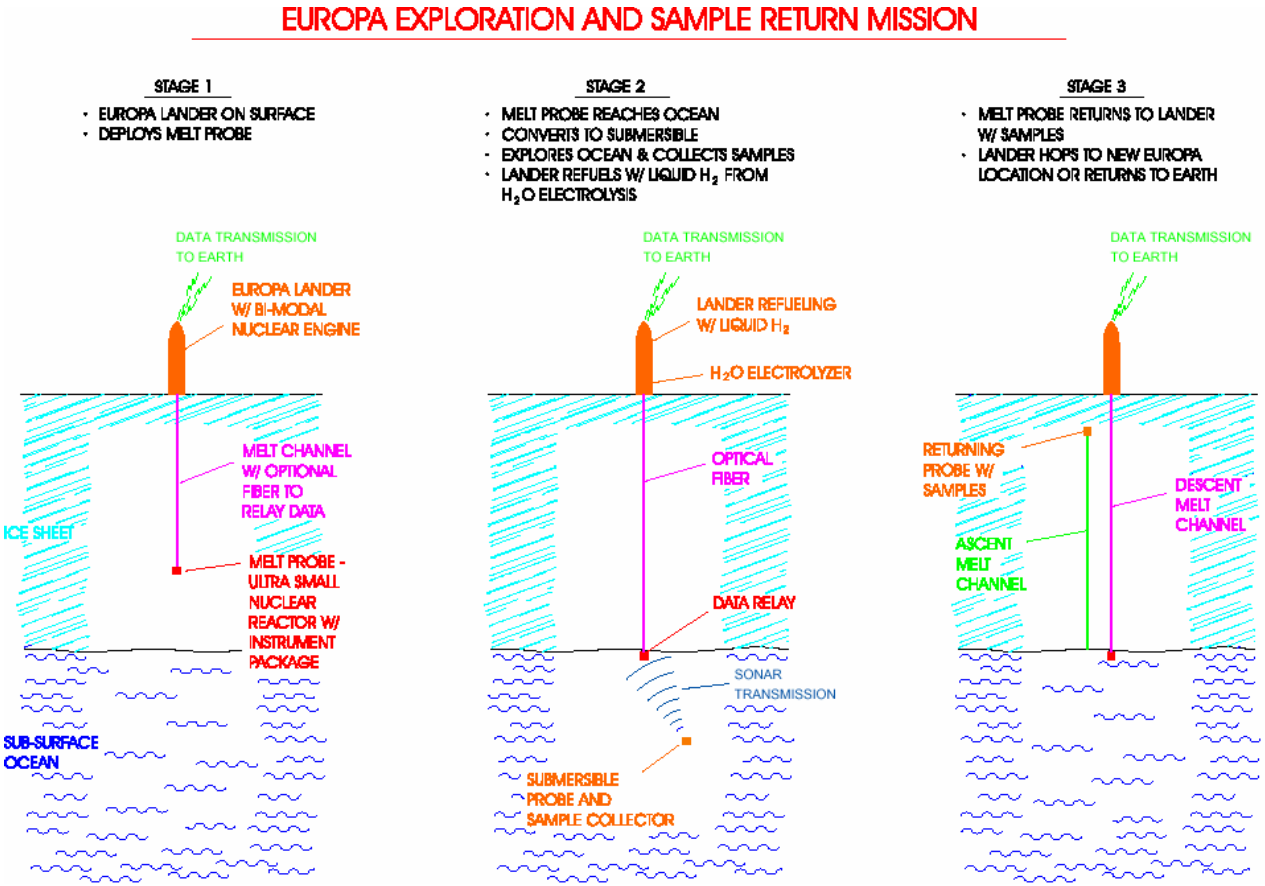
Propellantless Control of Spacecraft Swarms using Coulomb Forces

Brad King
Michigan Technology University

- Potentially feasible to generate tens of micro-Newtons of attraction and repulsion between spacecraft separated by tens of meters.
- Net spacecraft charge can be controlled by harvesting ambient space-plasma electrons or actively emitting electrons.
- Mutually interacting Coulomb spacecraft will be oriented in stable minimum energy arrays that can be configured using active control.
- Advantages
  - Circumvent need for micro-thrusters in satellite swarms
  - Increase formation mission lifetimes by harvesting in-space resources
  - Greatly improve fine position-keeping through active feedback
  - Facilitate wider range of satellite formation
  - Increase swarm robustness through fault-detection and reconfiguration

Europa Sample Return Mission utilizing High Specific Impulse Propulsion Refueled with Indigenous Resources

John Paniagua
Plus Ultra Technologies, Inc.



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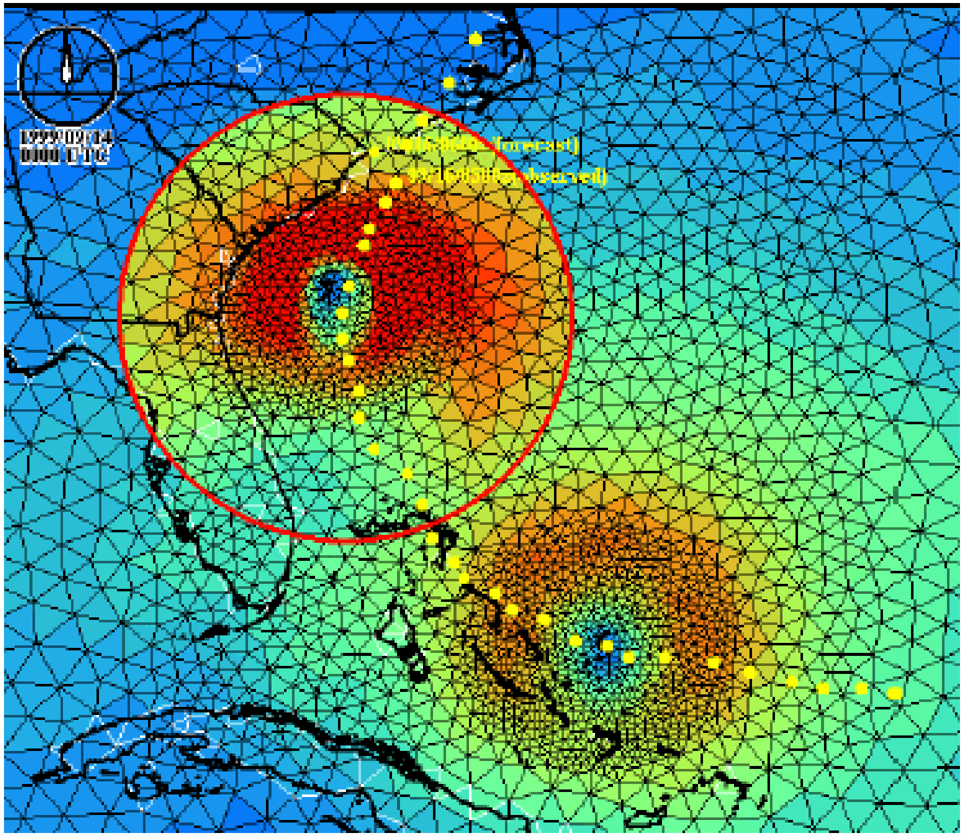
Adaptive Observation Strategies for Advanced Weather Prediction

David Bacon
SAIC, Center for Atmospheric Physics

Michael Kaplan
North Carolina State University



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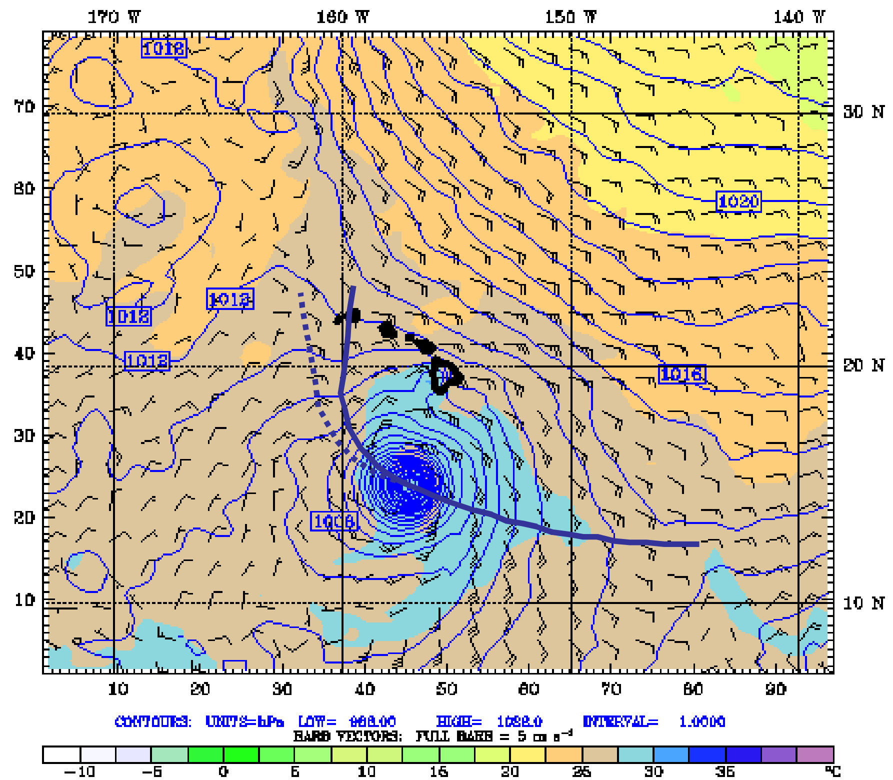
Controlling the Global Weather

Ross Hoffman, **Atmospheric and Environmental Research, Inc.**

Unperturbed Initial State of MM5
Hurricane Iniki, valid 06 UTC 10 September 1992



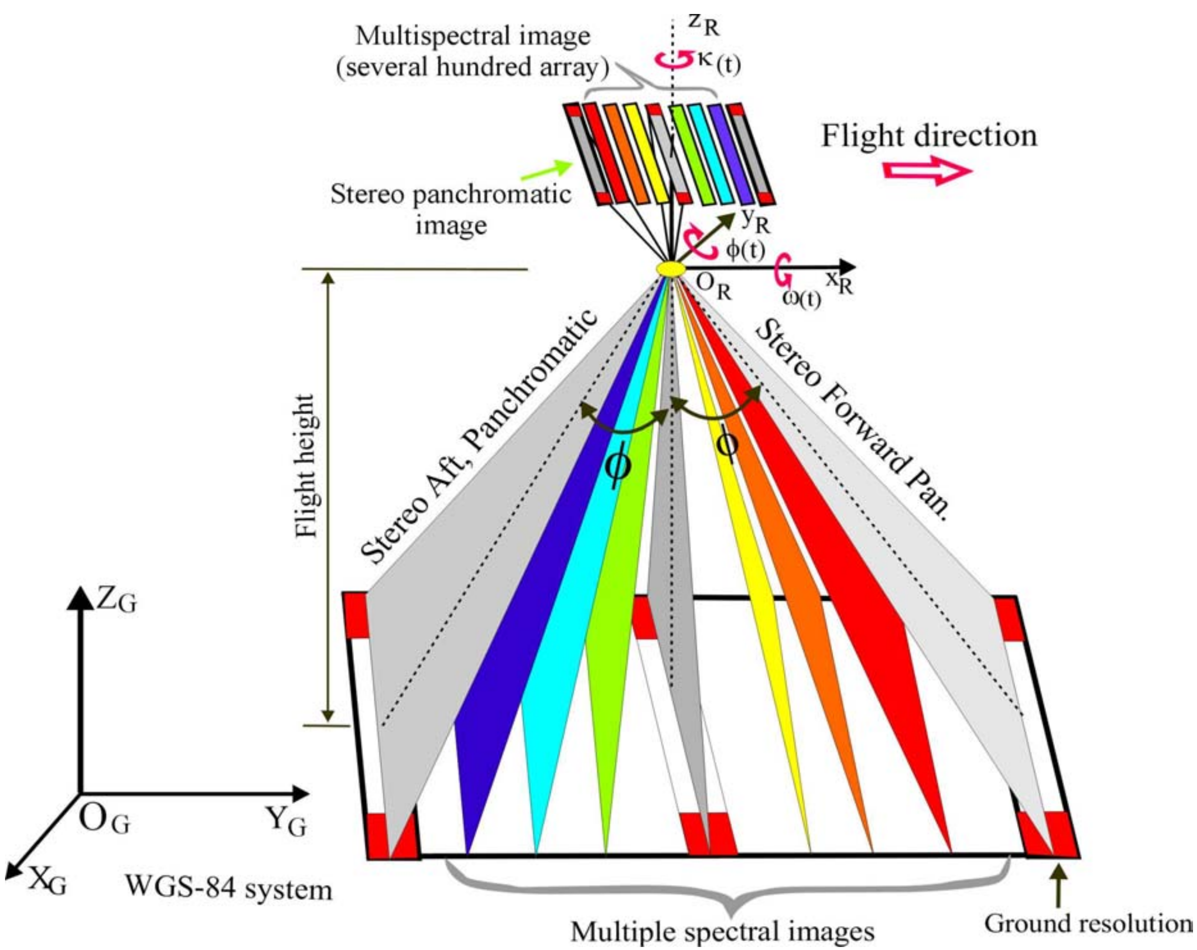
SLP (contoured), 1000-hPa wind (barbs) and temperature (shaded)

Observed track ..... Perturbed track

Architecture of "Intelligent" Earth Observation Satellite for Common Users in 2010-2050

Guoqing Zhou

Old Dominion University



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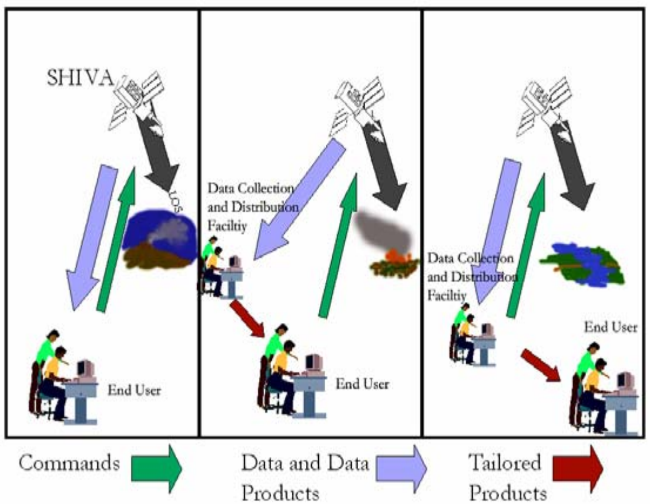
Global Observations and Alerts from Lagrange-Point, Pole-Sitter, and Geosynchronous Orbits (GOAL&GO)

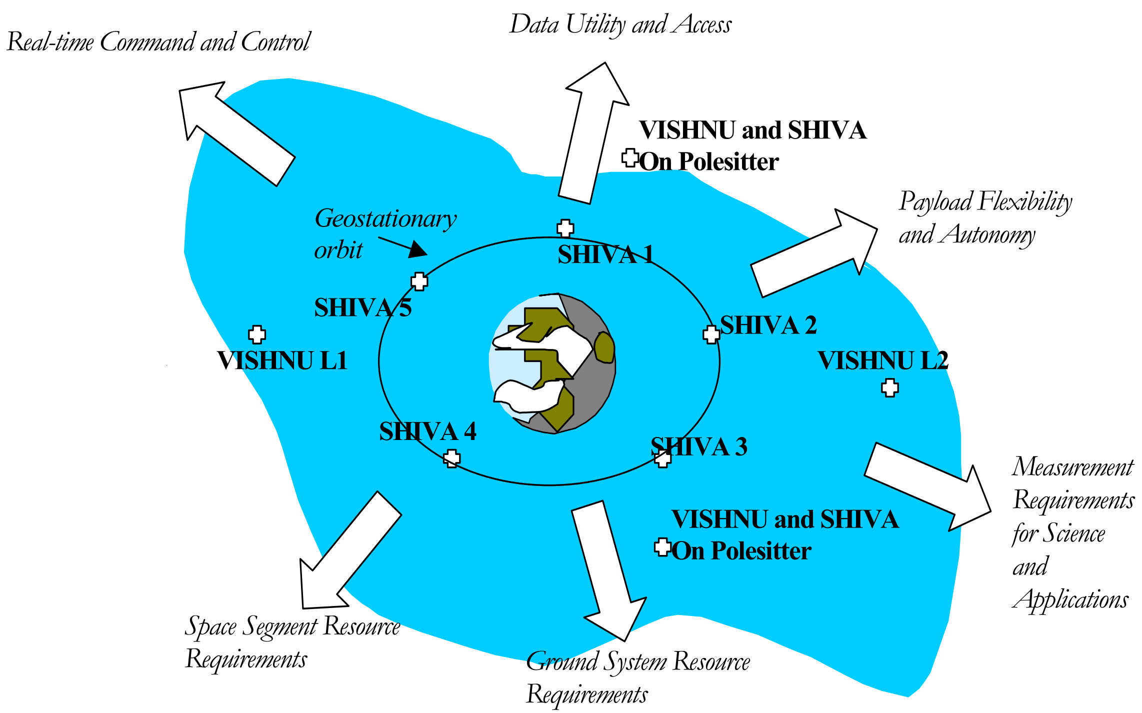
Larry Paxton

Johns Hopkins University

Applied Physics Laboratory



The SHIVA system uses multiple, selectable bands as commanded by remotely located users to search for, identify, and report geophysical events. A pointed telemetry system reduces the ground system requirements.



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3D Viewing of Images on the Basis of 2D Images

H. John Caulfield
Fisk University

- Analogous to how nature allows you to see a 3D image using only one eye at a hyperfocal distance from your eye
- Connected set of computer programs that start with any digitized 2D image and convert it into a pair of images for 3D visualization
- Will be tested on telescopic and microscopic images in Phase I
- Feasibility established for simple objects in the near field
- Will record simulated scenes of interest for NASA and blur them by various amounts digitally to simulate telescopic images
- Attempt 3D visualization of local regions
- Design software for a hardware system to be built in Phase II

Ultra-High Resolution X-ray Astronomy using Steerable Occulting Satellites

Glenn Starkman
Case Western Reserve University

- Occultation of an X-ray telescope by a steerable satellite may allow binary point source resolution better than milli-arcsecond with little or no re-design of X-ray telescopes.

- Model reconstructive capabilities of the technique and adjust satellite shape so as to maximize those capabilities.

- Evaluate possible scientific payback from implementing this approach in conjunction with planned facilities, such as Constellation-X.

- Occulter design considerations to be investigated.
  - Thickness
  - Size
  - Steerability
  - Binary point source resolution
  - Compound source resolution
  - Target sources

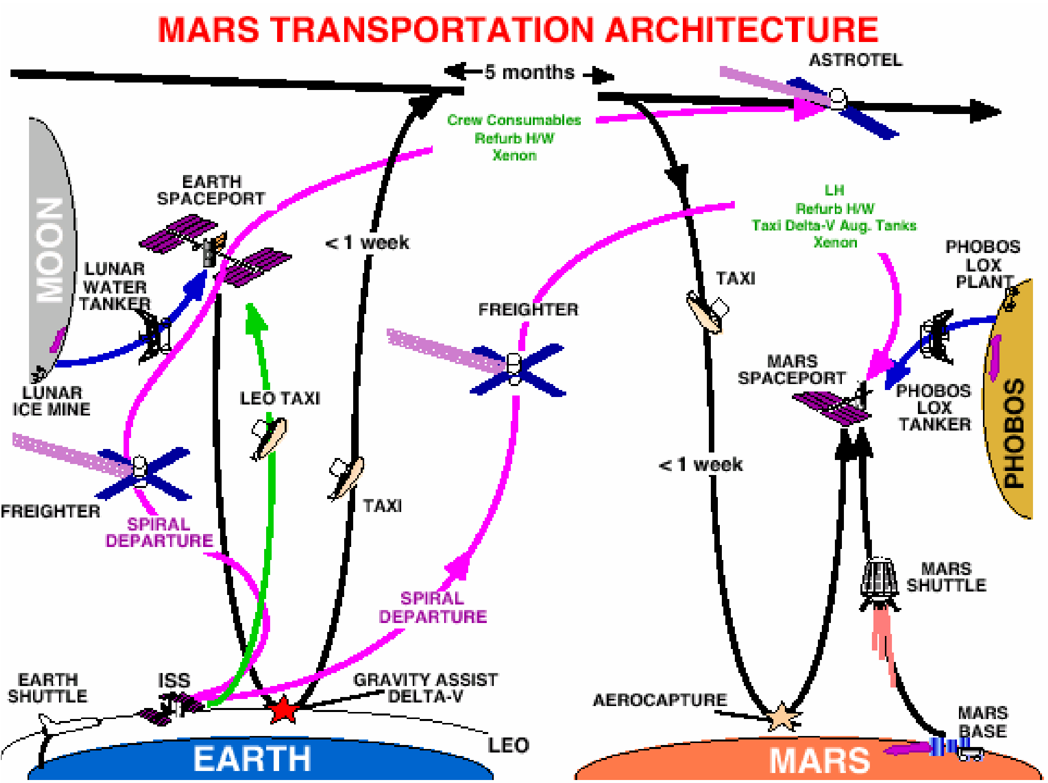
Phase II Awards

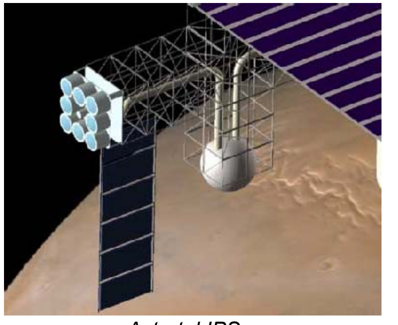
Calls for Proposals: CP 99-01, CP 99-02, CP 00-02

Cyclical Visits to Mars via Astronaut Hotels

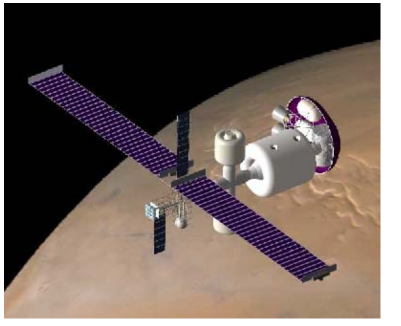
Kerry Nock, Global Aerospace Corporation

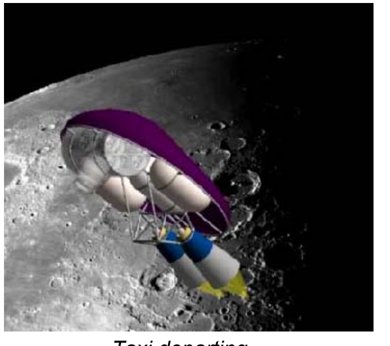
Phase II Performance Period: March 1, 2001 to January 31, 2003





Astrotel IPS





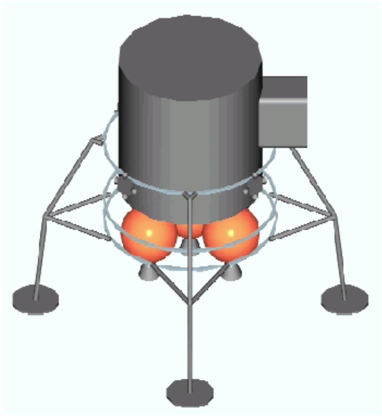
Taxi departing

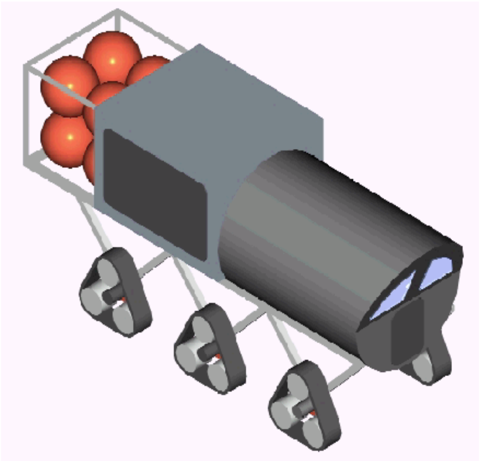
Taxi during Mars Aerocapture

Advanced System Concept for Total ISRU-Based Propulsion and Power Systems for Unmanned and Manned Mars Exploration

Eric Rice, Orbital Technologies Corporation

Phase II Performance Period: April 1, 2000 to March 31, 2002





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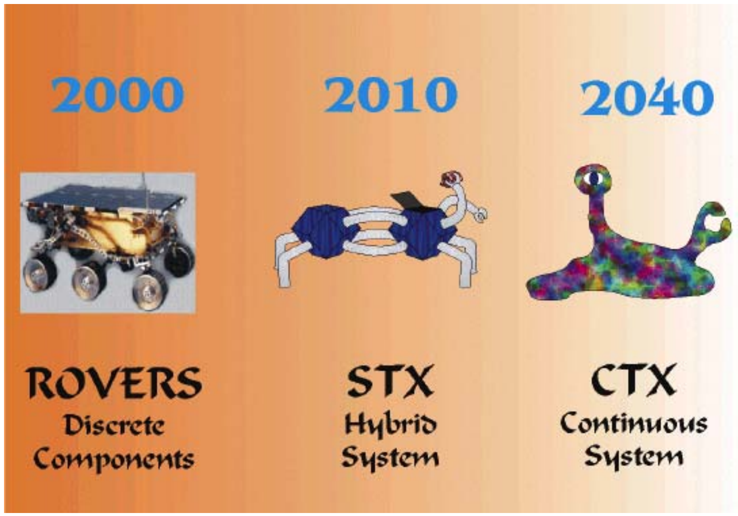
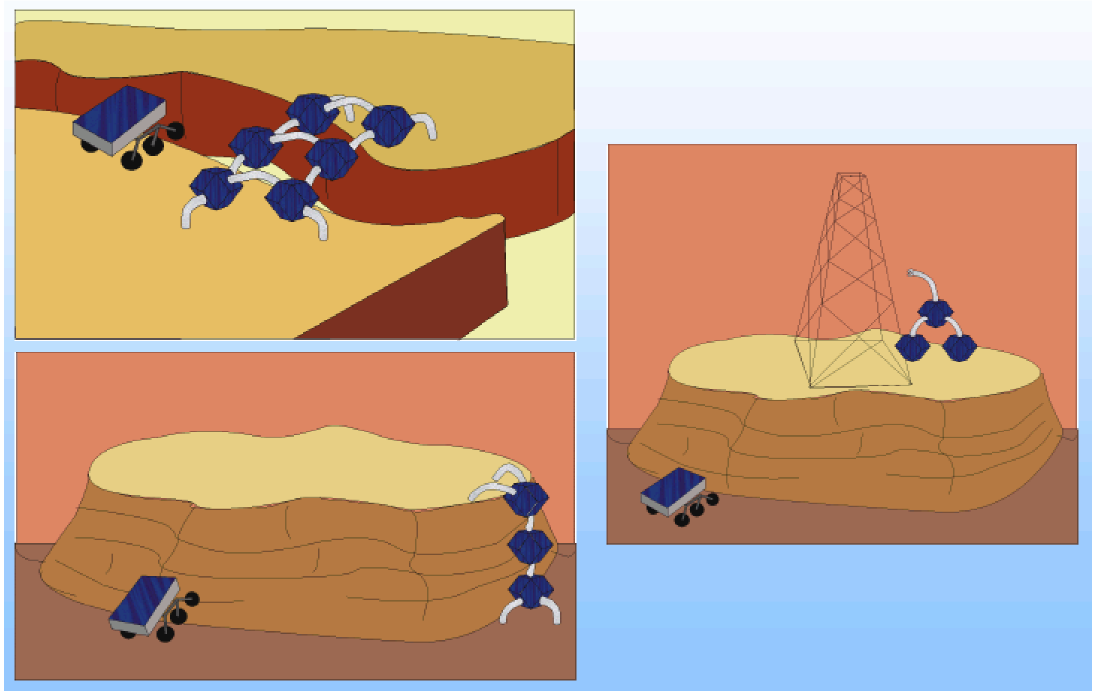
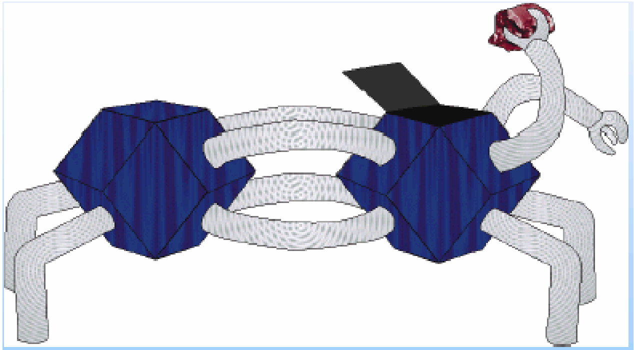
Self-Transforming Robotic Planetary Explorers

Steven Dubowsky, Massachusetts Institute of Technology

Phase II Performance Period: September 1, 1999 to August 31, 2001







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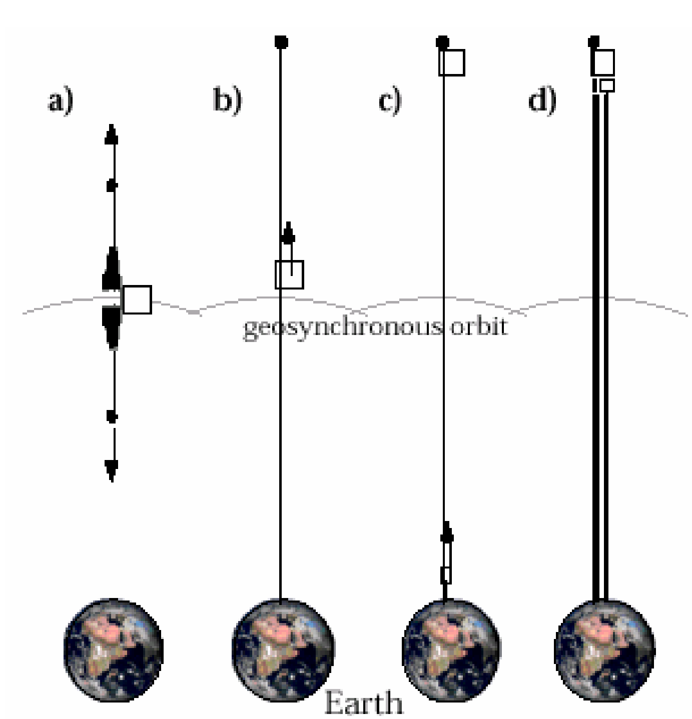
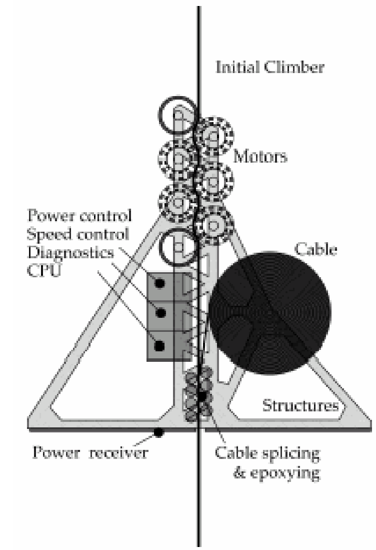
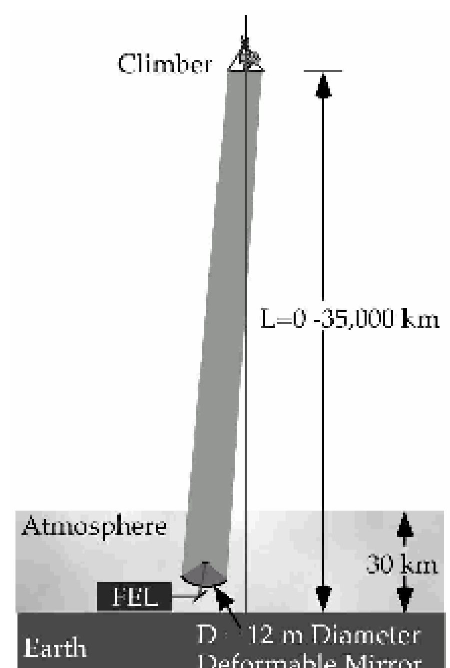
The Space Elevator

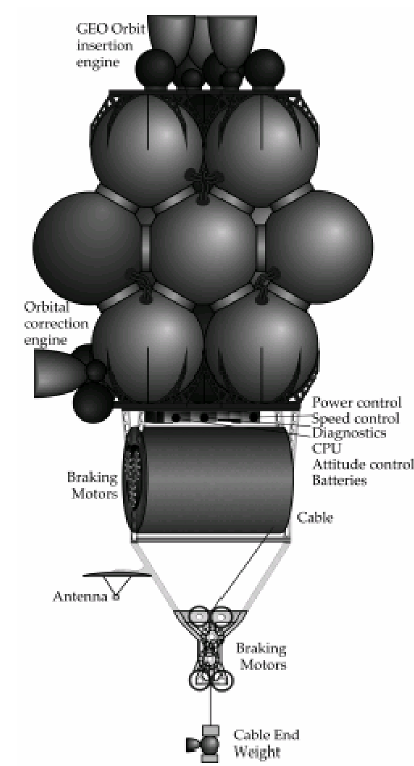
Bradley Edwards, Eureka Scientific

Phase II Performance Period: March 1. 2001 to January 31, 2003









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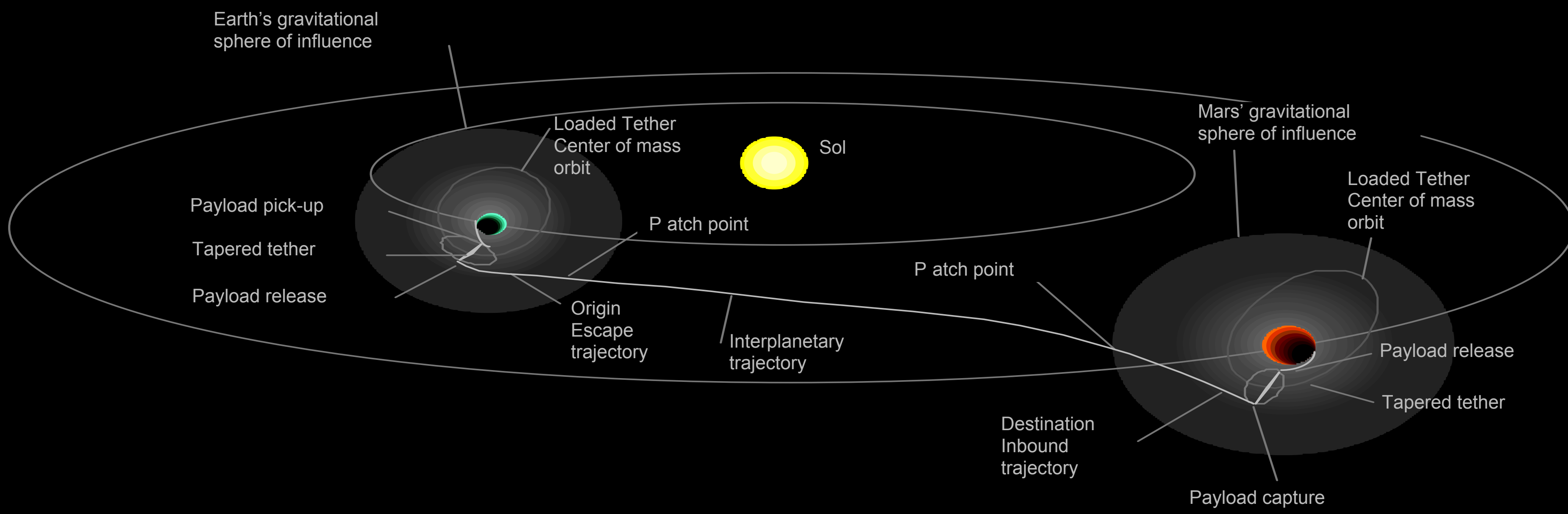
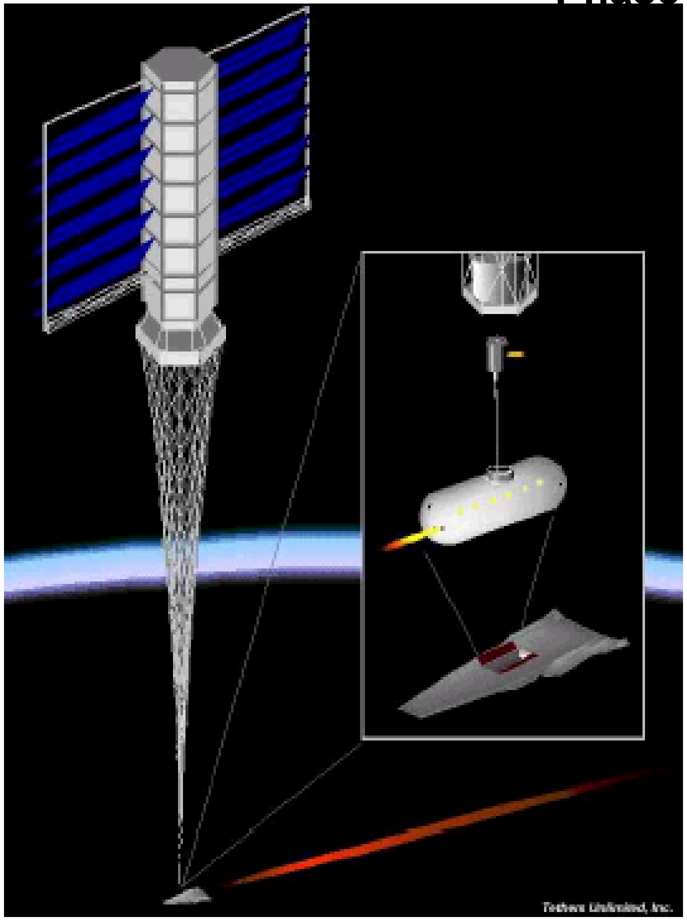
INTERPLANETARY TRANSPORT USING ROTATING TETHERS

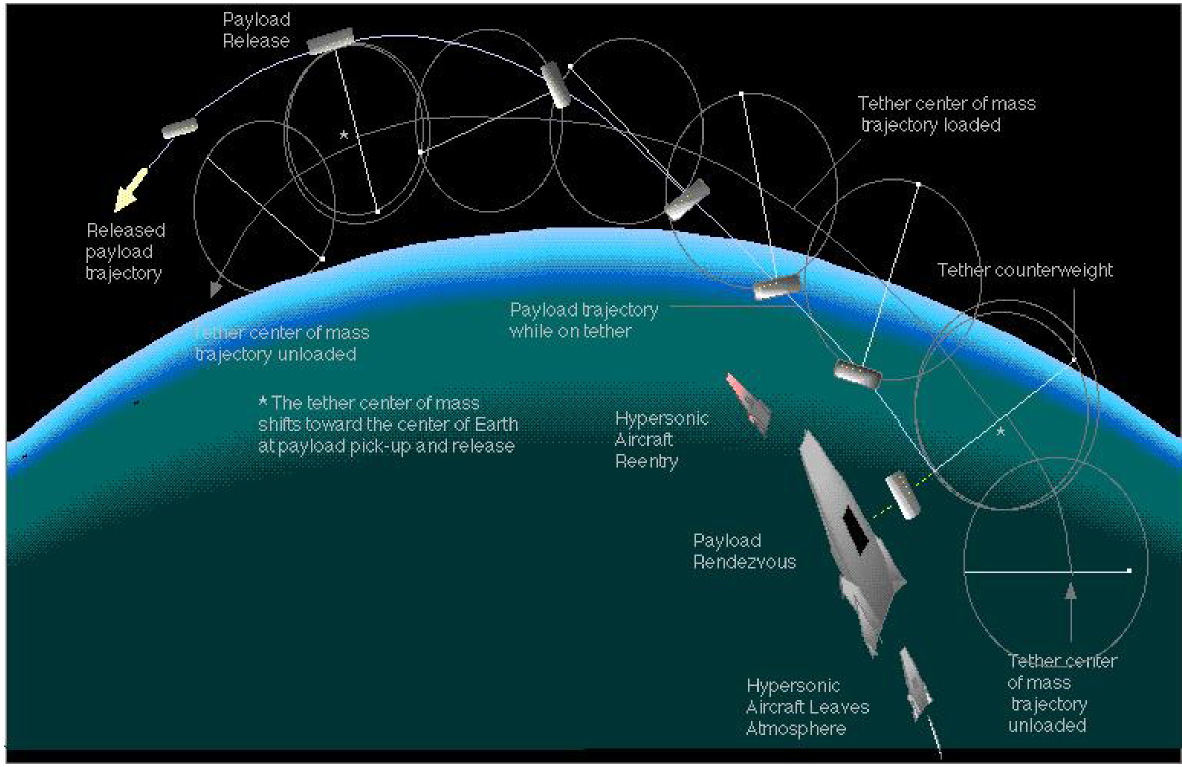


Hypersonic Airplane Space Tether Orbital Launch – HASTOL

John Grant, The Boeing Company

Phase II Performance Period: April 1, 2000 to September 30, 2001





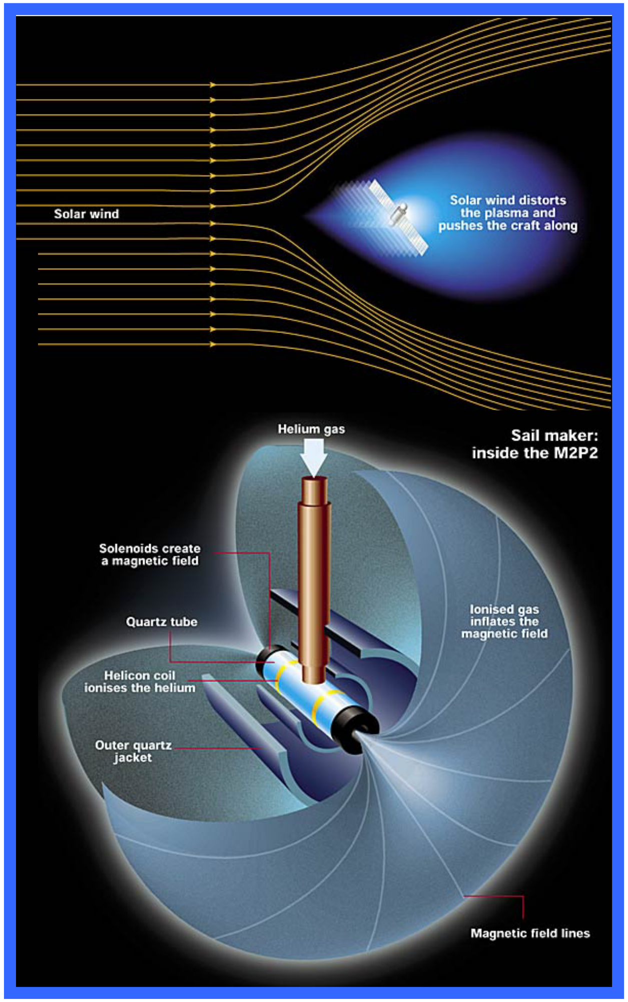
NIAC NASA Institute for Advanced Concepts

The Mini-Magnetospheric Plasma Propulsion System, M^2P^2

Robert M. Winglee, University of Washington

Phase II Performance Period: August 1, 1999 to July 31, 2001

Concept for interstellar propulsion and radiation shielding



Graphics by permission of *New Scientist*

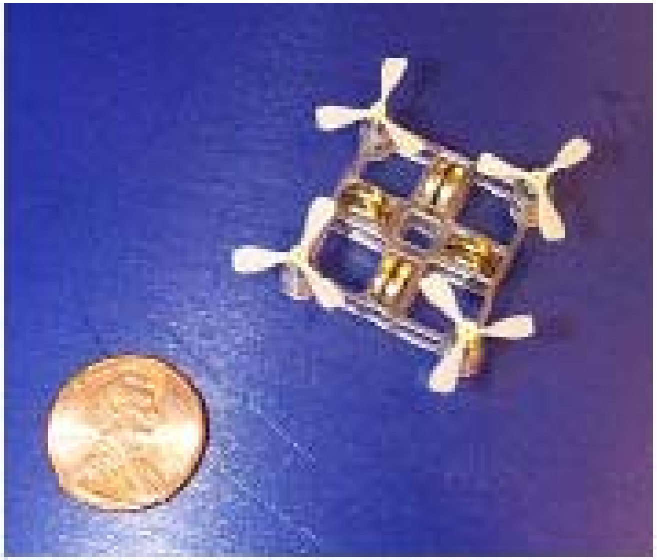
USRA

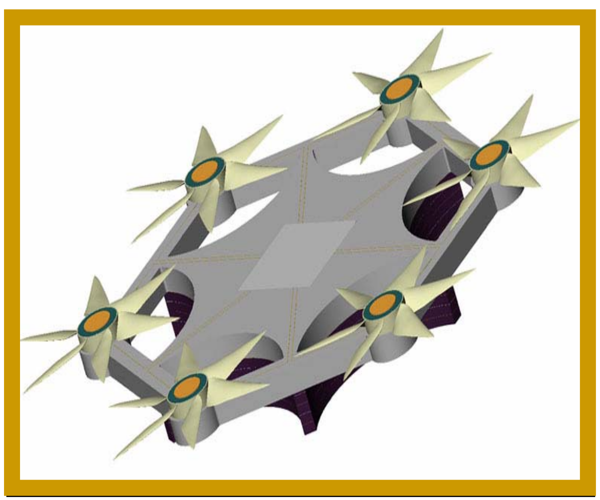
ANSER Analytic Services Inc.

Meso-Scale Flight Vehicle for Atmospheric Sensing

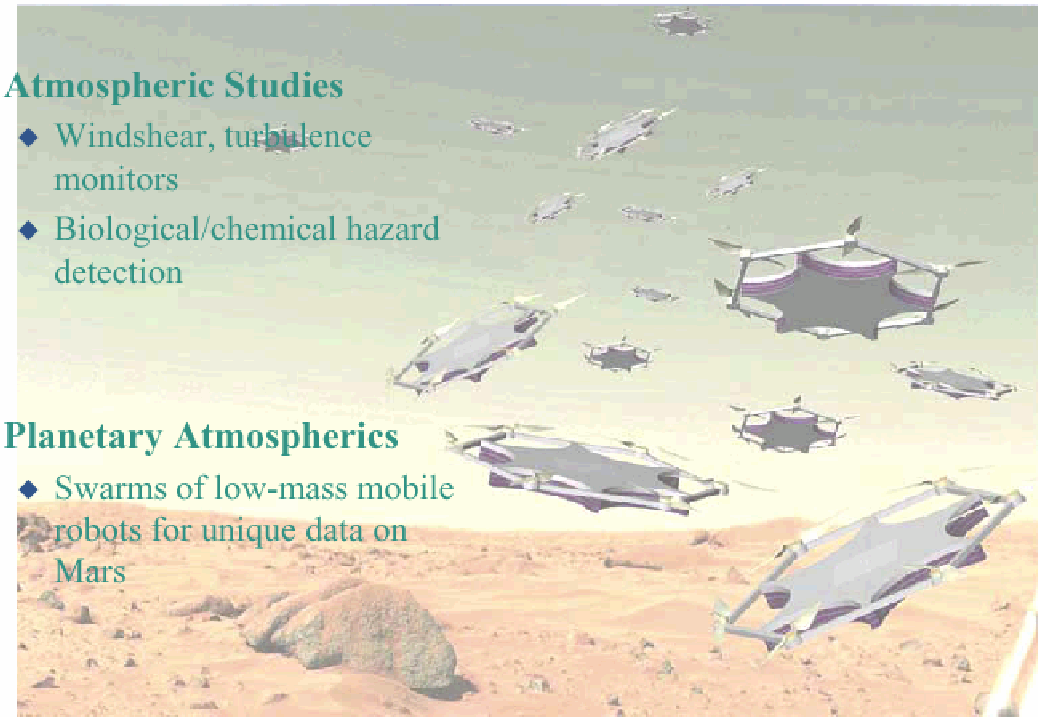
Ilan Kroo, Stanford University

Phase II Performance Period: August 1, 1999 to July 31, 2001





The Concept: Applications

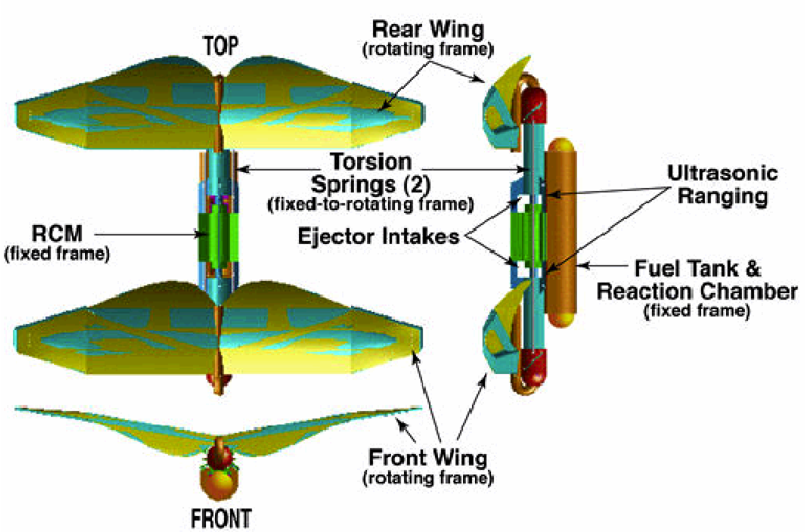


- **Atmospheric Studies**
  - Windshear, turbulence monitors
  - Biological/chemical hazard detection
- **Planetary Atmospherics**
  - Swarms of low-mass mobile robots for unique data on Mars

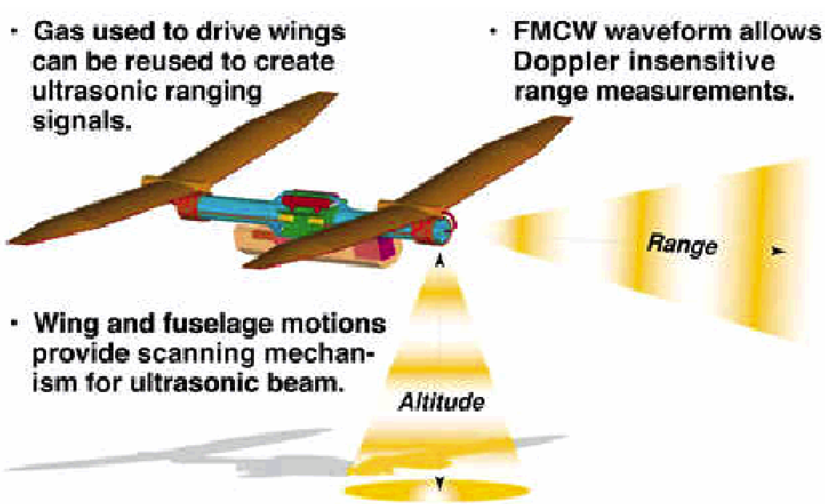
Planetary Exploration Using Biomimetrics

Anthony Colozza, Ohio Aerospace Institute

Phase II Performance Period: March 31, 2001 to August 31, 2002



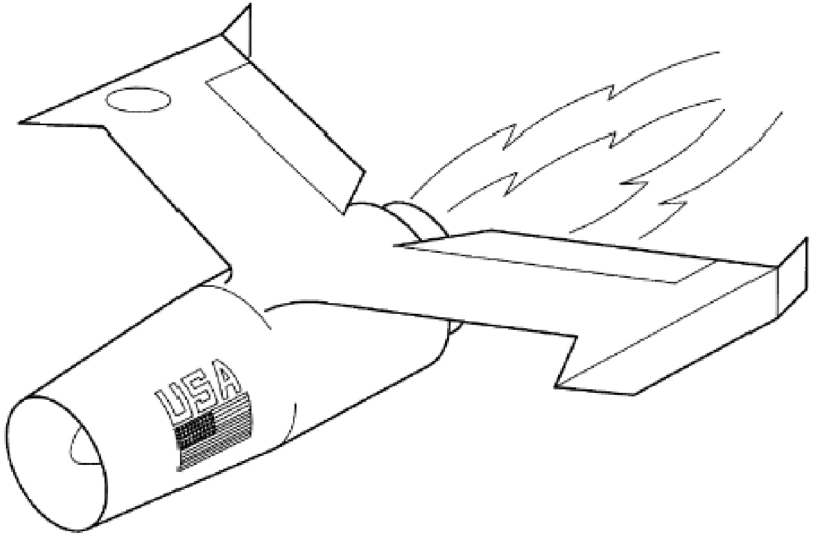
Click for movie



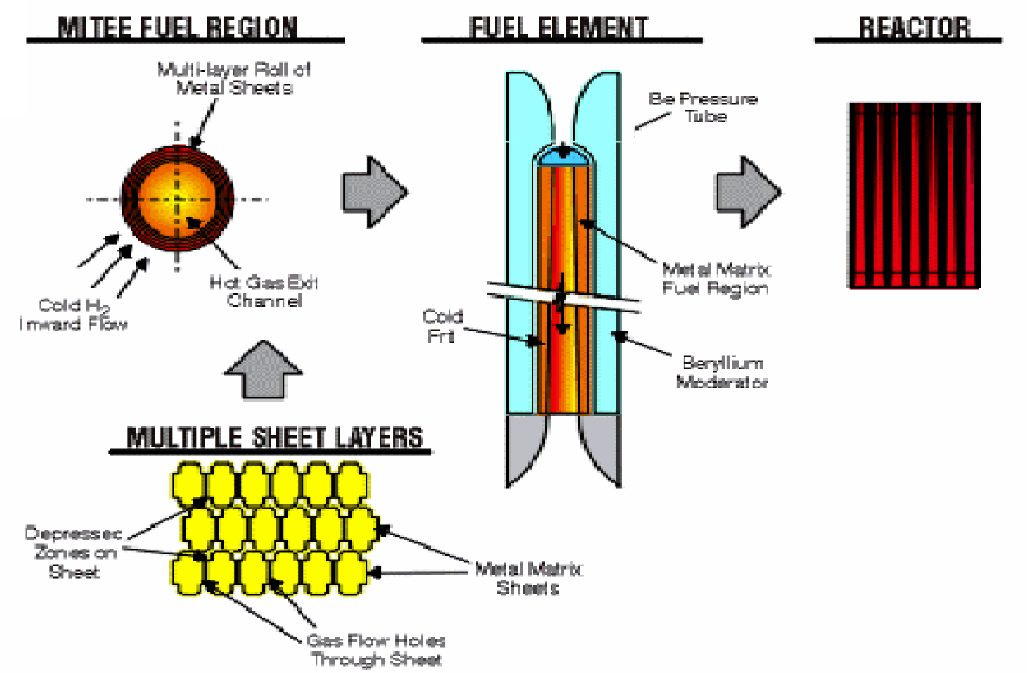
Exploration of Jovian Atmosphere Using Nuclear Ramjet Flyer

George Maise, Plus Ultra Technologies, Inc.

Phase II Performance Period: March 1, 2001 to January 31, 2003



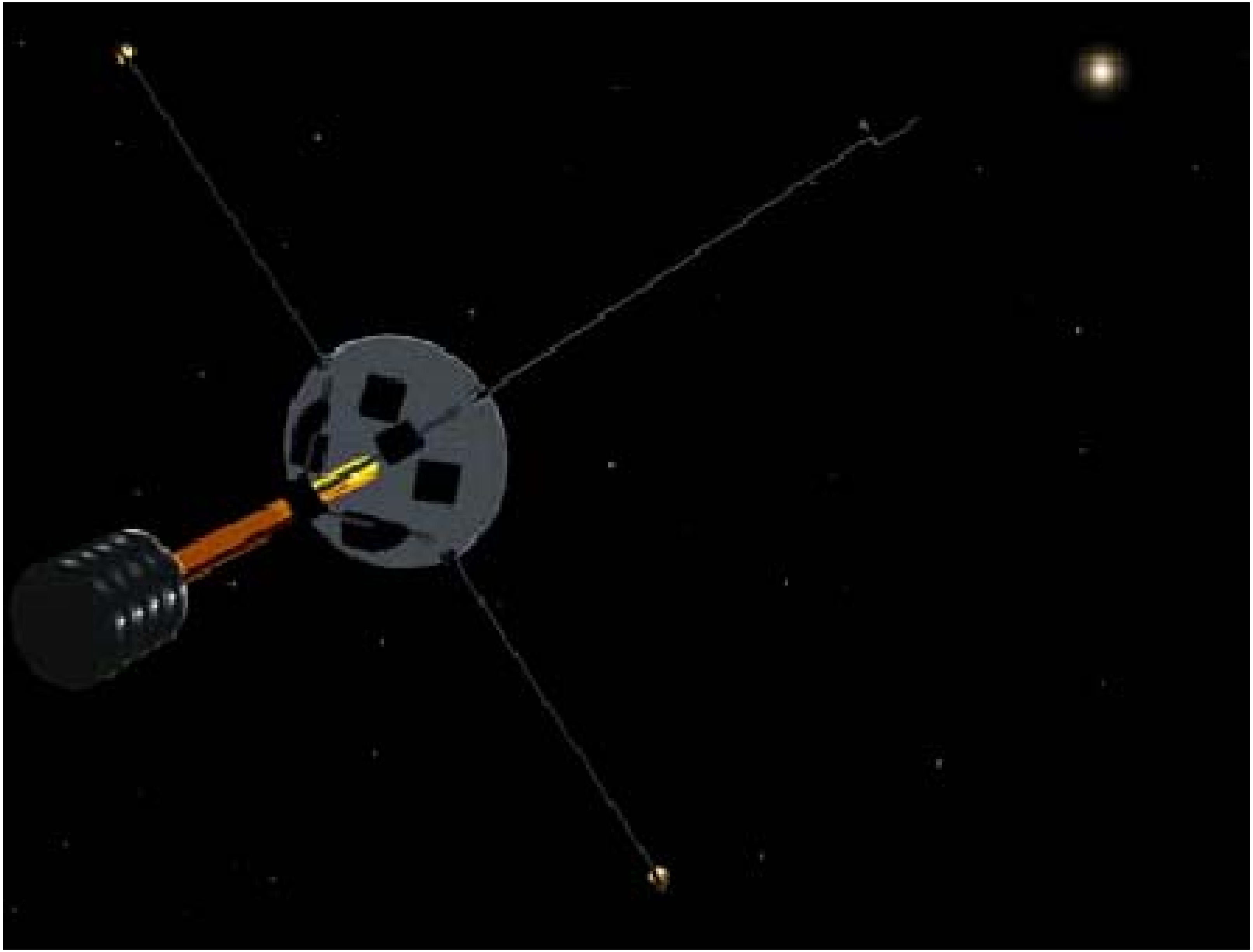
MITEE Nuclear Engine



A Realistic Interstellar Explorer

Ralph McNutt, Jr., Johns Hopkins Applied Physics Lab

Phase II Performance Period: April 1, 2000 to March 31, 2002



Very Large Optics for the Study of Extrasolar Terrestrial Planets

Neville J. Woolf, Steward Observatory, University of Arizona

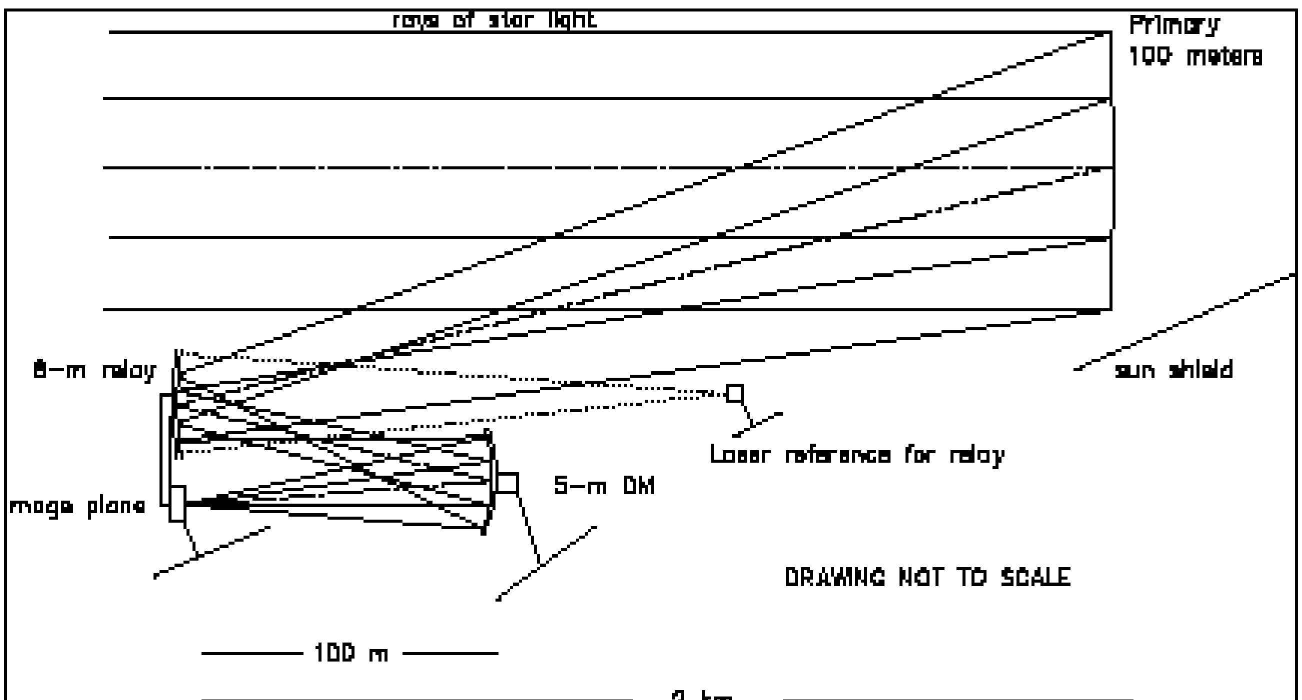
Phase II Performance Period: August 1, 1999 to July 31, 2001

Hubble Space Telescope (operational)

Next Generation Space Telescope (technology development)

Terrestrial Planet Finder (concept development)

Life Finder

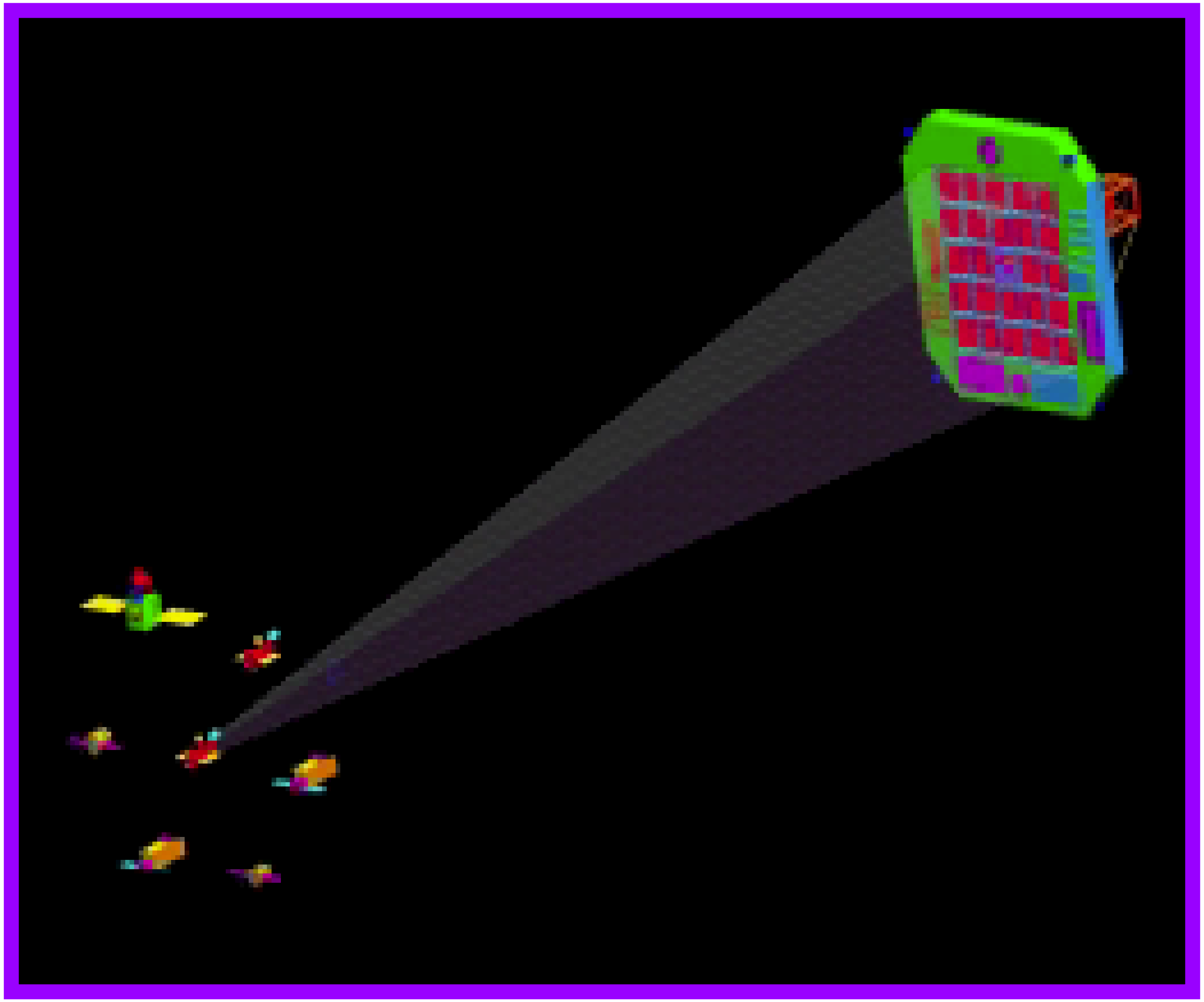


NASA Institute for Advanced Concepts

An Ultra-High Throughput X-Ray Astronomy Observatory with A New Mission Architecture

Paul Gorenstein, Smithsonian Institute, Astrophysical Observatory

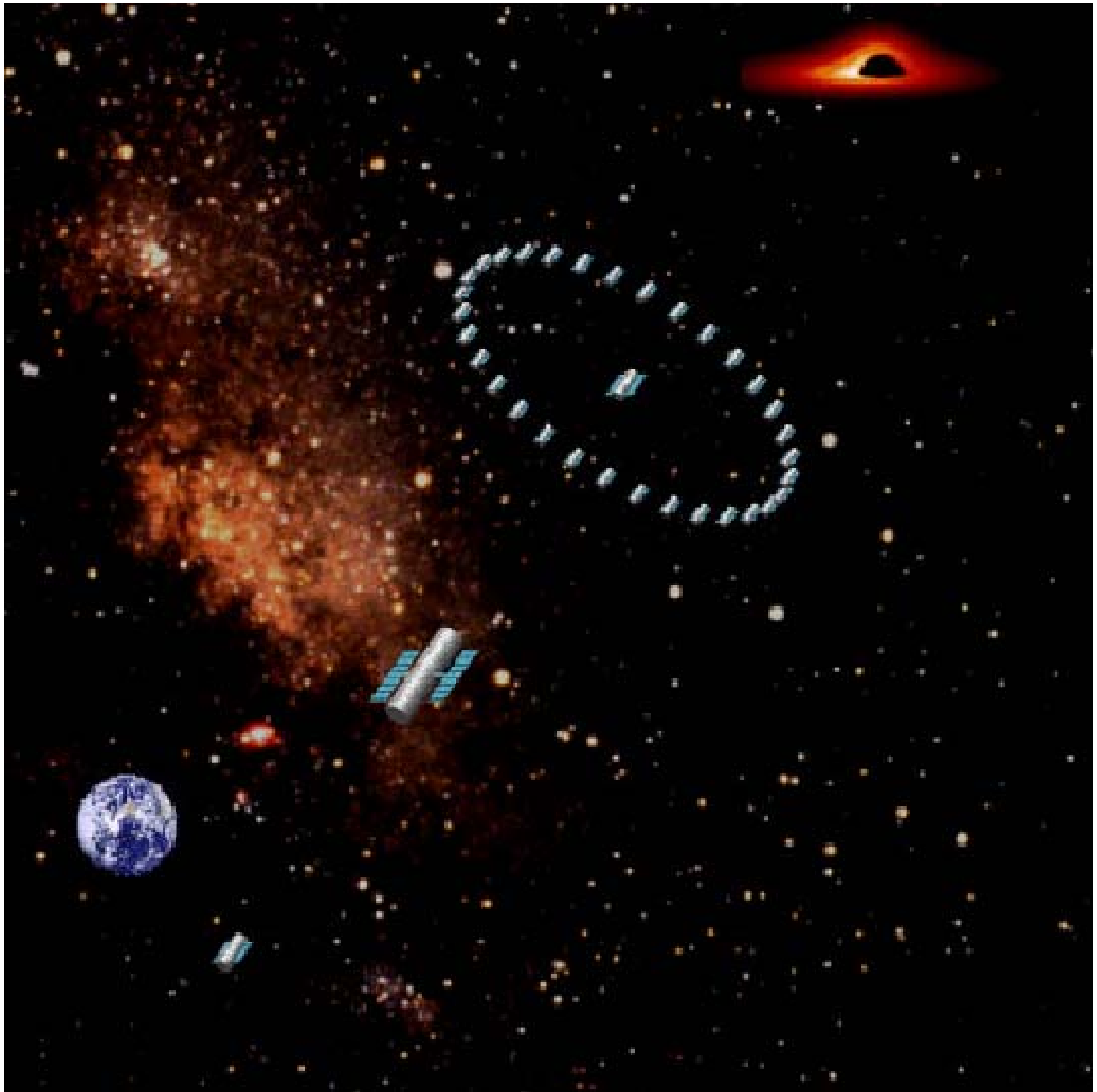
Phase II Performance Period: August 1. 1999 to July 31, 2001



X-ray Interferometry - Ultimate Astronomical Imaging

Webster Cash, University of Colorado

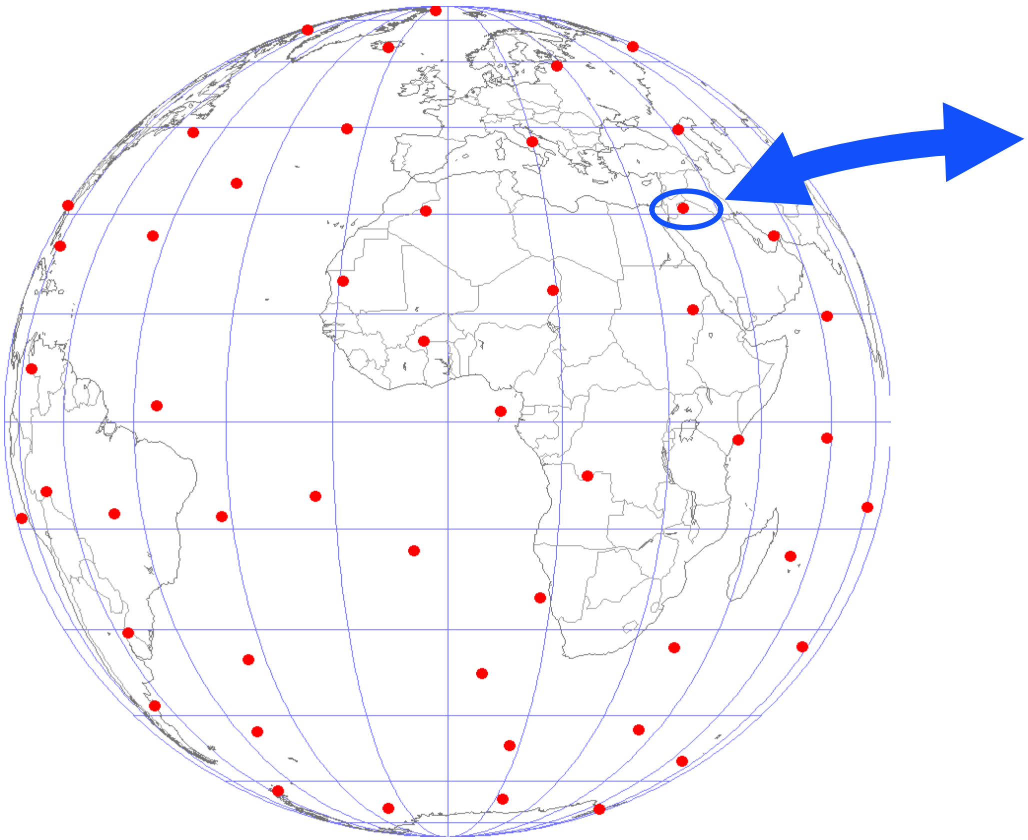
Phase II Performance Period: April 1, 2000 to March 31, 2002

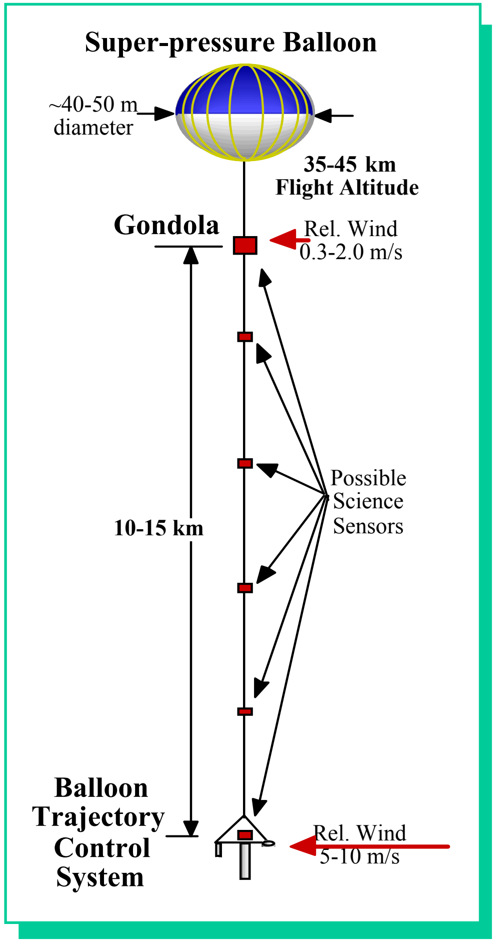


Global Constellation of Stratospheric Scientific Platforms

Kerry Nock, Global Aerospace Corporation

Phase II Performance Period: April 1, 2000 to February 28, 2002

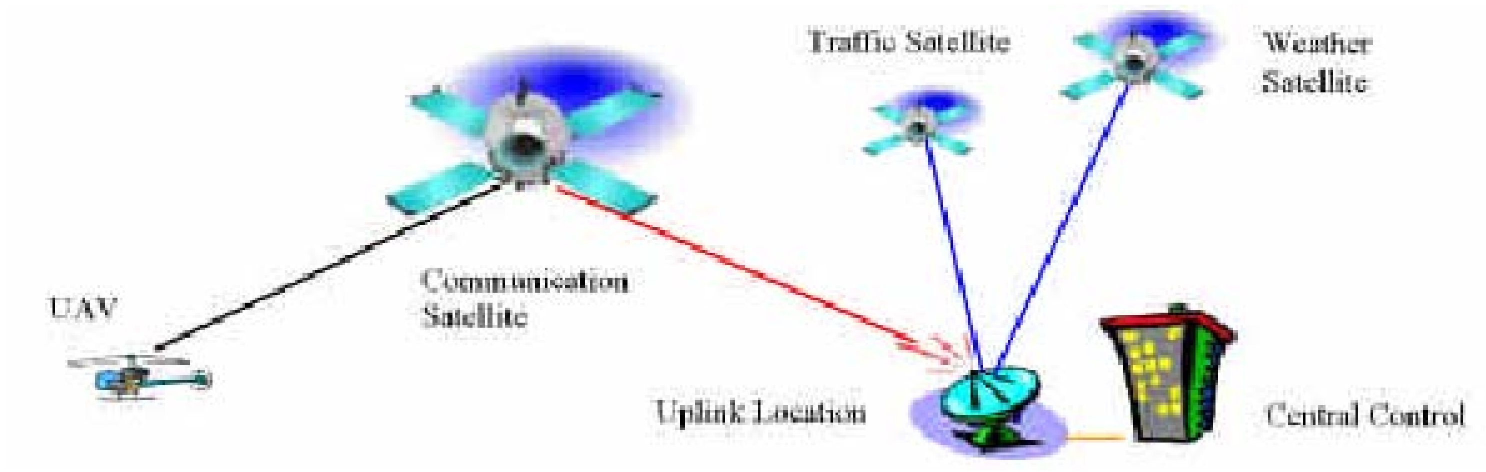


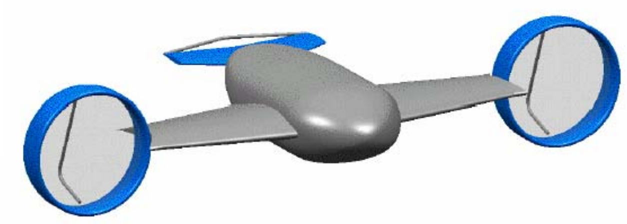


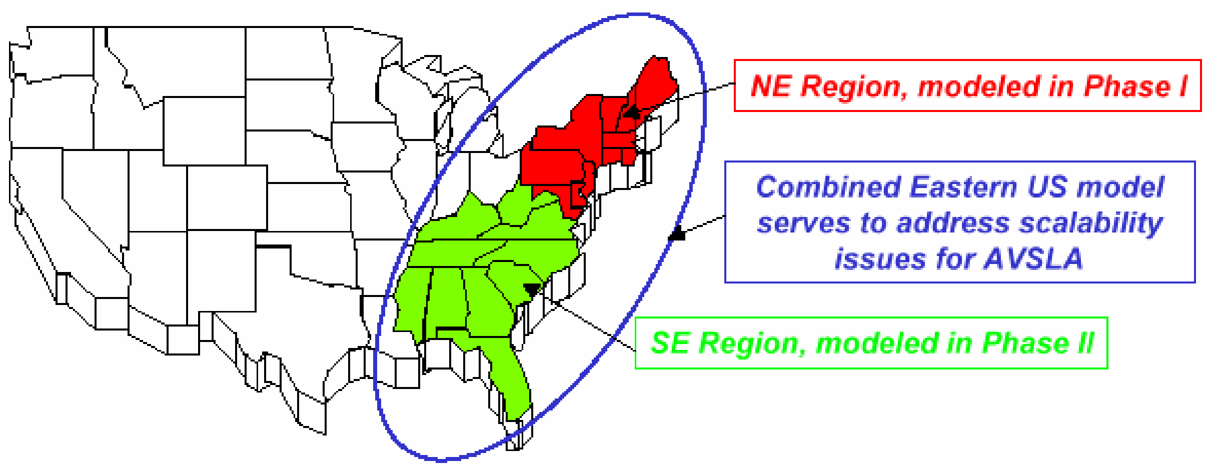
Methodology for Study of Autonomous VTOL Scalable Logistics Architecture

Andrew Keith, Sikorsky Aircraft Corporation

Phase II Performance Period: March 1, 2001 to January 31, 2003







Human/Robotic Exploration of the Solar System

Sponsored by RASC Activity at NASA LaRC through ICASE

- **New task**

  Funded from the LaRC RASC activity through the USRA ICASE contract. Led by ICASE with NIAC involvement in the RFI and Workshop

- **Human & Robotics Exploration Mission Objective:**

  Identify key revolutionary technologies for Human and Robotics systems which have the potential, when synergistically combined, to reduce the time, distance and safety barriers associated with scientific exploration beyond Low Earth Orbit (LEO)

- **Activities:**

1. **Orchestrate a collaborative effort of industrial, government and academic experts.**

- **Determining the appropriate mix of autonomous systems, and crewed systems necessary to yield the greatest scientific benefits from the destination at which the systems will be deployed.**

3. **Global survey of both the human and robotic exploration activities in NASA, and elsewhere, to determine how this mix might evolve with the incorporation of revolutionary advanced systems concepts to achieve a maximum of scientific return.**
4. **Conduct a NIAC-Style Request for Information (RFI), due September 24, 2001**
5. **Organize and lead a workshop, November 6-8, 2001 at NASA LaRC**
6. **Identify key technologies that should be pursued.**