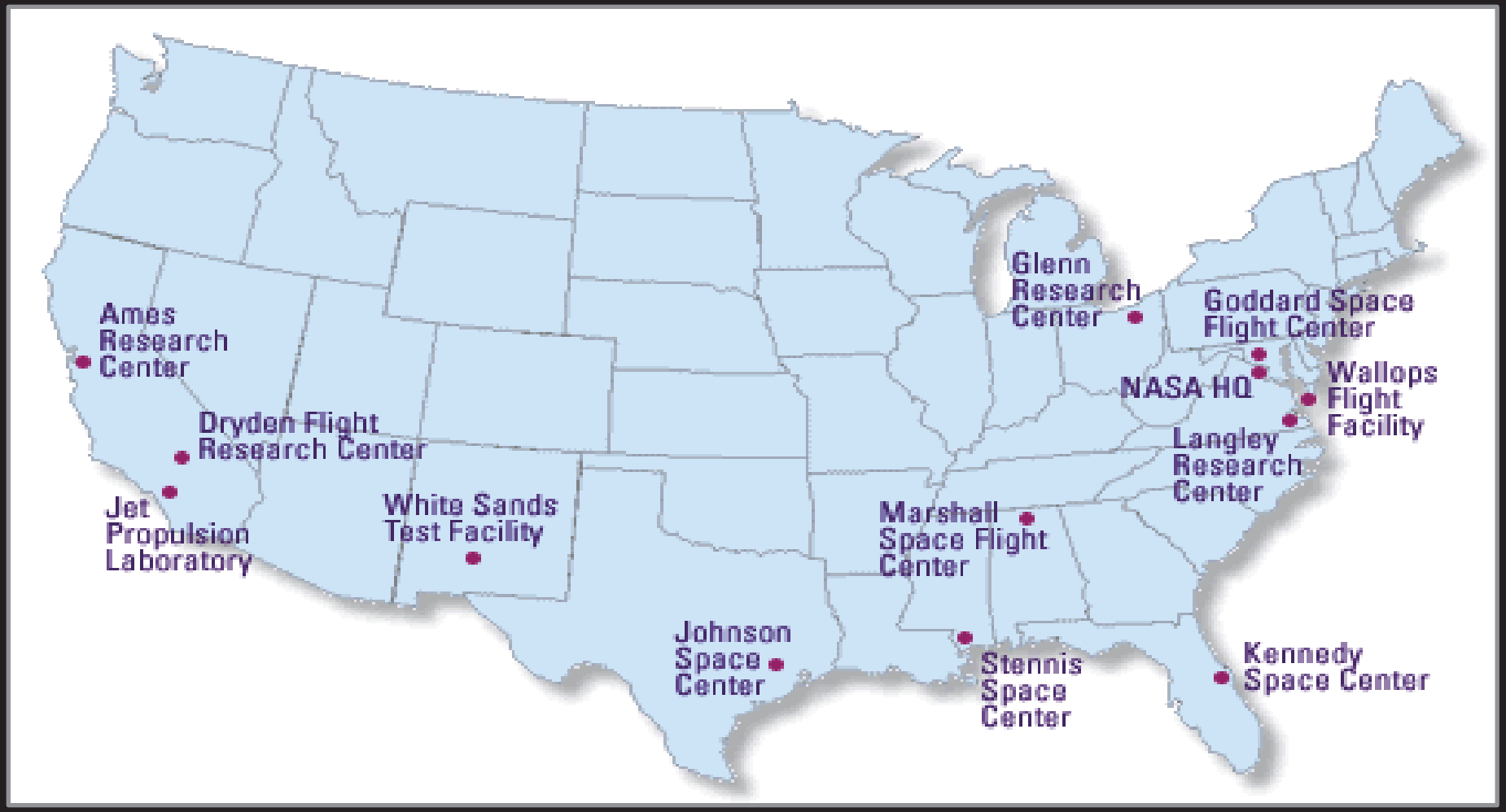
NASA
and the Need for Intelligent Systems in Exploration

First NASA Quantum Future Technology Conference - QFT 1.0

Dr. David Korsmeyer
Intelligent Systems Division
NASA Ames Research Center

NASA's 10 Centers (13 sites)



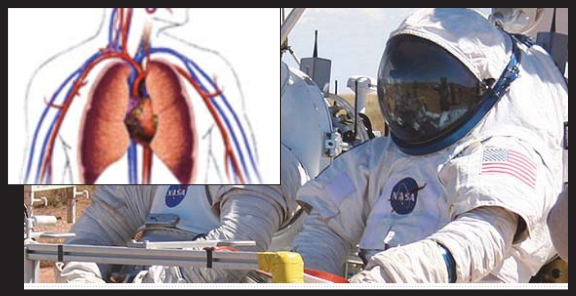
NASA Ames Research Center Today

- Intelligent Systems and High-End Computing
- Science (Earth-Life-Space)
- Astrobiology
- Science Missions
- Exploration Systems
- Small Satellites
- Aviation and Aeronautics
- Innovative Collaborations

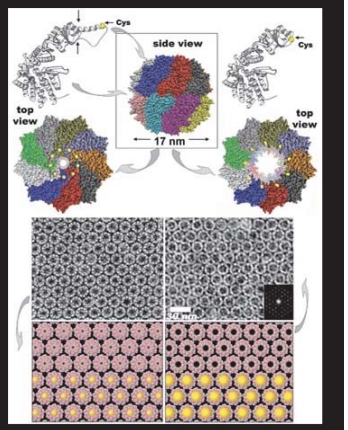
- 2400 Employees
- $700+ M Annual Budget

Ames Technology Areas

Aerospace and Aeronautics



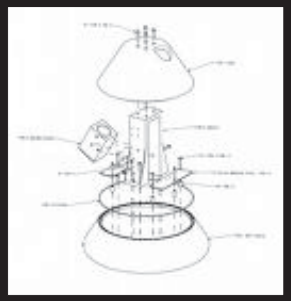
BioTech/Biomedical



Nanotechnology

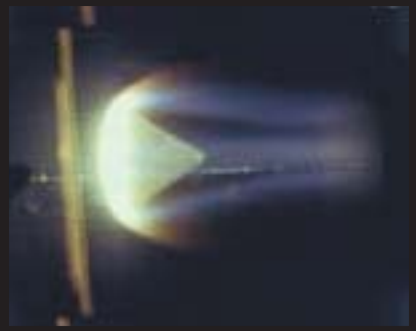
Integrated Systems Health Management (ISHM)

Small Satellite Systems



Systems Engineering and Design

Robotics and Artificial Intelligence



Materials Science and Entry Systems

Software and High-end Computing

Current Active Facilities, 2008

National Full Scale Aerodynamic Complex, 80x120 Wind Tunnel

Vertical Motion Simulator

Small Spacecraft Development Facility

Unitary Plan Wind Tunnel

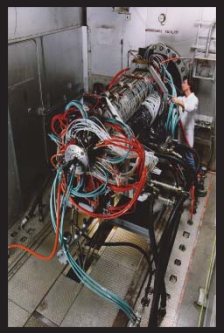
SOFIA

Machine Shops

Small Satellite Lab

Pleiades Super Computer

Ballistic Range



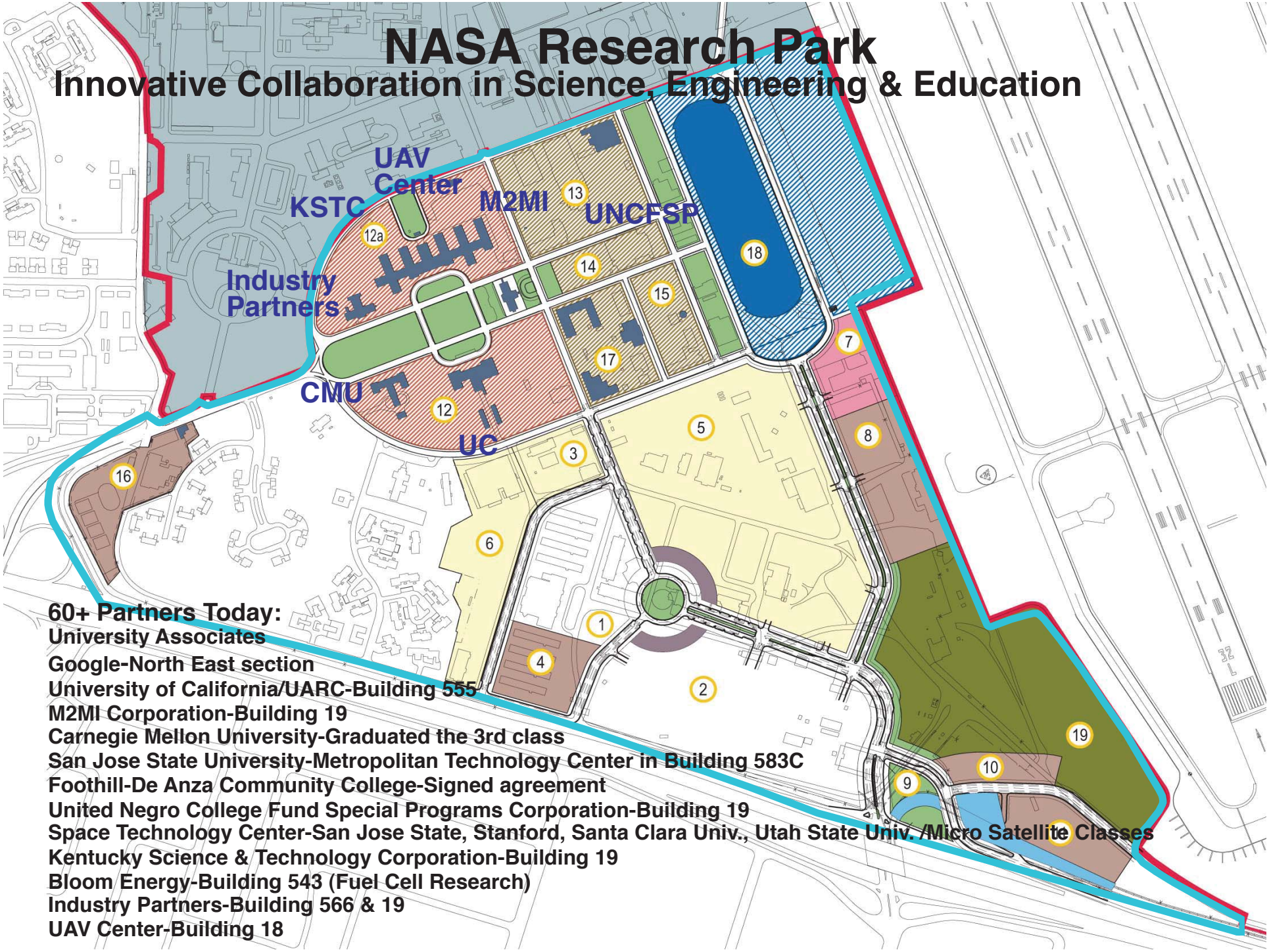
Arc Jets

Image copyright Dariusz Jezewski

Airfield and Hangars

NASA Research Park

Innovative Collaboration in Science, Engineering & Education



60+ Partners Today:

University Associates

Google-North East section

University of California/UARC-Building 555

M2MI Corporation-Building 19

Carnegie Mellon University-Graduated the 3rd class

San Jose State University-Metropolitan Technology Center in Building 583C

Foothill-De Anza Community College-Signed agreement

United Negro College Fund Special Programs Corporation-Building 19

Space Technology Center-San Jose State, Stanford, Santa Clara Univ., Utah State Univ. /Micro Satellite Classes

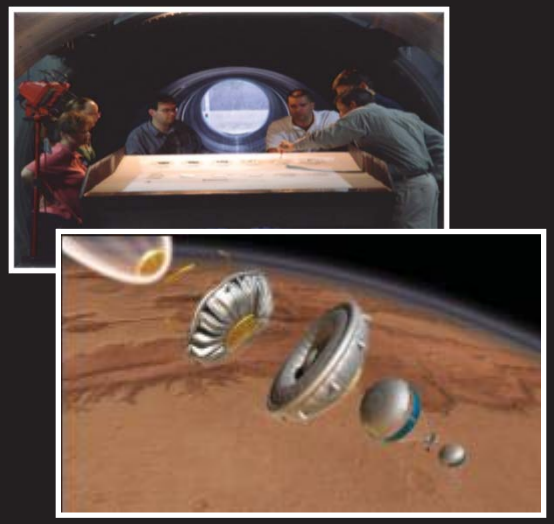
Kentucky Science & Technology Corporation-Building 19

Bloom Energy-Building 543 (Fuel Cell Research)

Industry Partners-Building 566 & 19

UAV Center-Building 18

Advanced Technology at NASA



- NASA pursues **breakthrough technologies** to expand our frontiers in aeronautics and space
- **Advanced technologies are critical** for accomplishing NASA's current missions, and today's **technology investments are required** for the bold missions of NASA's future
- These same investments **benefit the United States economy** through creation of new industries, products, services, scientific discoveries, and societal benefits
- NASA's basic and applied research programs **span all of NASA's mission areas**
- NASA is implementing a portfolio of broadly applicable Technology programs to take the **best ideas** of our nation's innovators **from concept to flight**

QFT Conference and NASA

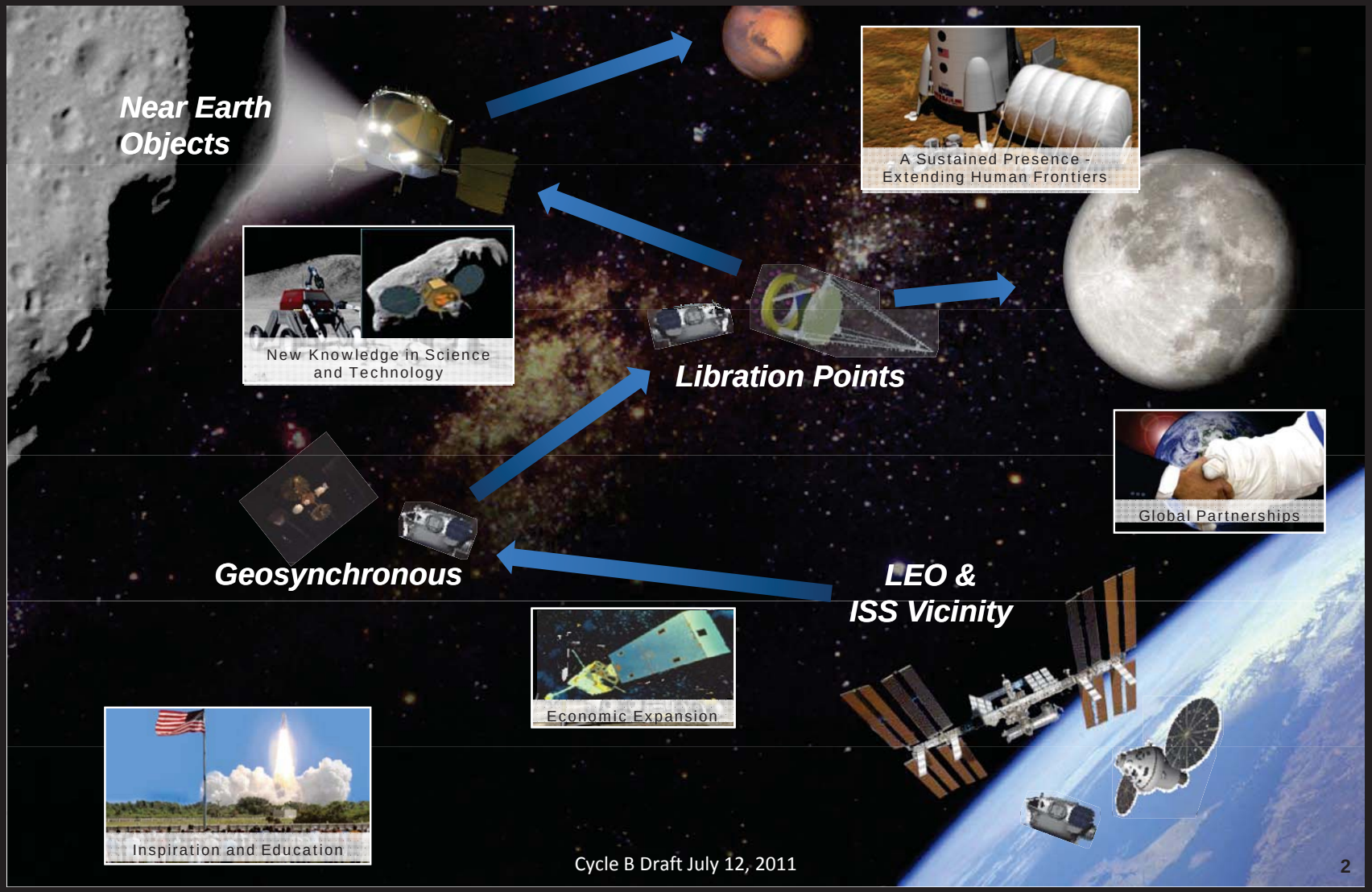
- **QFT Goals**
  - Discussion on how the Quantum technologies revolution can benefit NASA missions and objectives.
  - To help identify the areas and challenges in
    - Space Exploration,
    - Aeronautics,
    - Earth and Space Science

    where Quantum technologies can have the greatest impact.
- **The conference will focus on 3 areas:**
  - Quantum Measurement (QM), Quantum Computing (QC) and Quantum cryptography and key distribution (QK).

Exploration of the Solar System is a long-term investment…

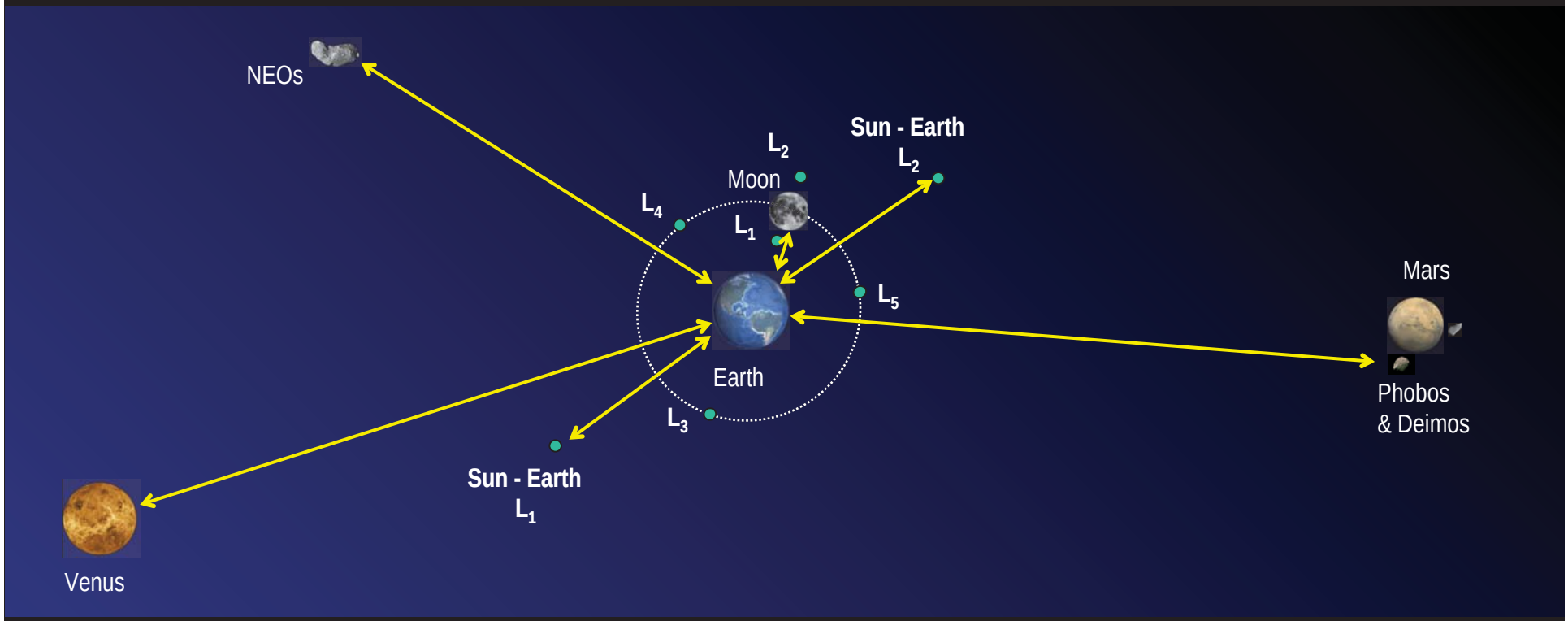
- NASA has visited all of the Planets in the Solar System robotically
  - Dawn is visiting Ceres and Vesta in the Asteroid belt now
  - New Horizons is halfway to Pluto, arriving in 2015
- These robotic missions form the "First Explorers" for Earth to gain understanding of what exists and is of interest for future Human exploration.
- Reasonable future Human destinations include a return to the Moon, Near-earth Asteroids, and Mars vicinity.

NASA's Human Exploration Destinations



Intelligent Systems as an Enabling Technology

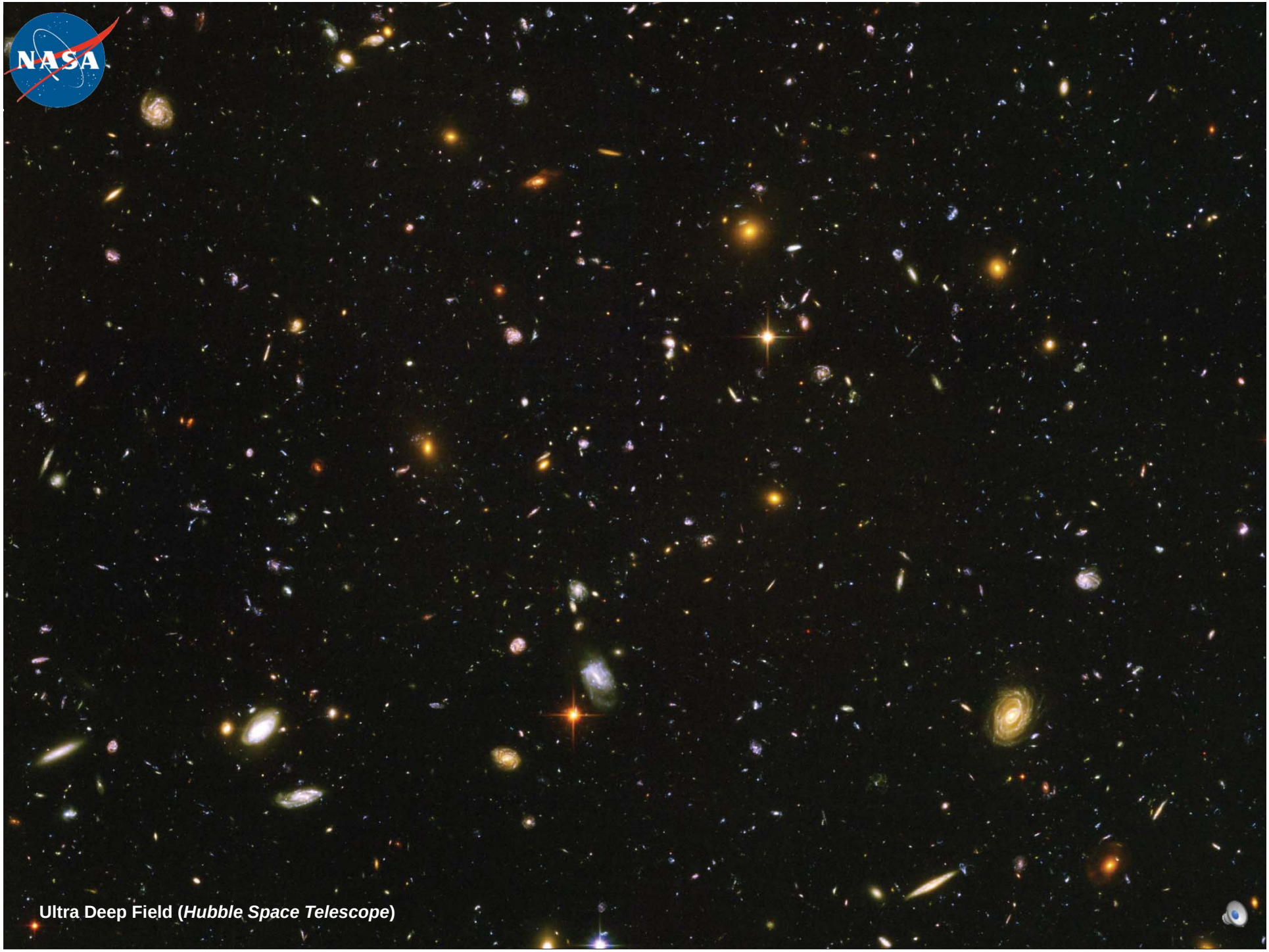
Automation and advanced information technology are key enablers of the Exploration vision, for crewed or robotic explorers.



Automation Challenge

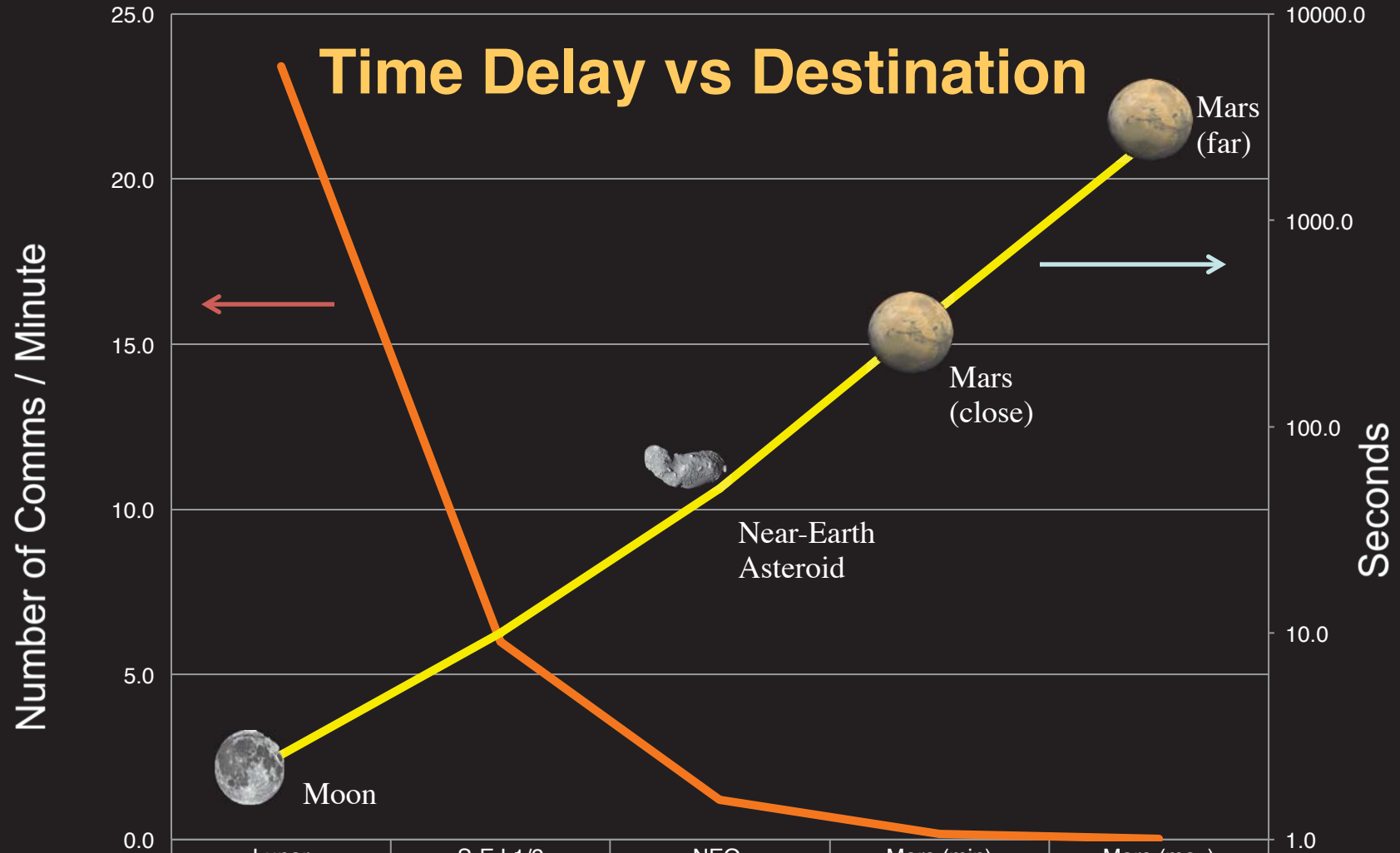
Developing Autonomous Crew-Centered Missions is one of NASA's <u>most complex tasks</u>

- **Break the moment-to-moment link to ground control.**
  - On-board Planning and Scheduling of Crew and robotic activities against constraints
- **Take Care of the Spacecraft and Crew**
  - Repair and Recovery Decisions and Mode identification
- **Seamless integrate Humans with Data**
  - Data Analysis and Data Fusion
- **Human – Robotic Coordination**
  - Task decomposition and collective intelligence



Ultra Deep Field (*Hubble Space Telescope*)

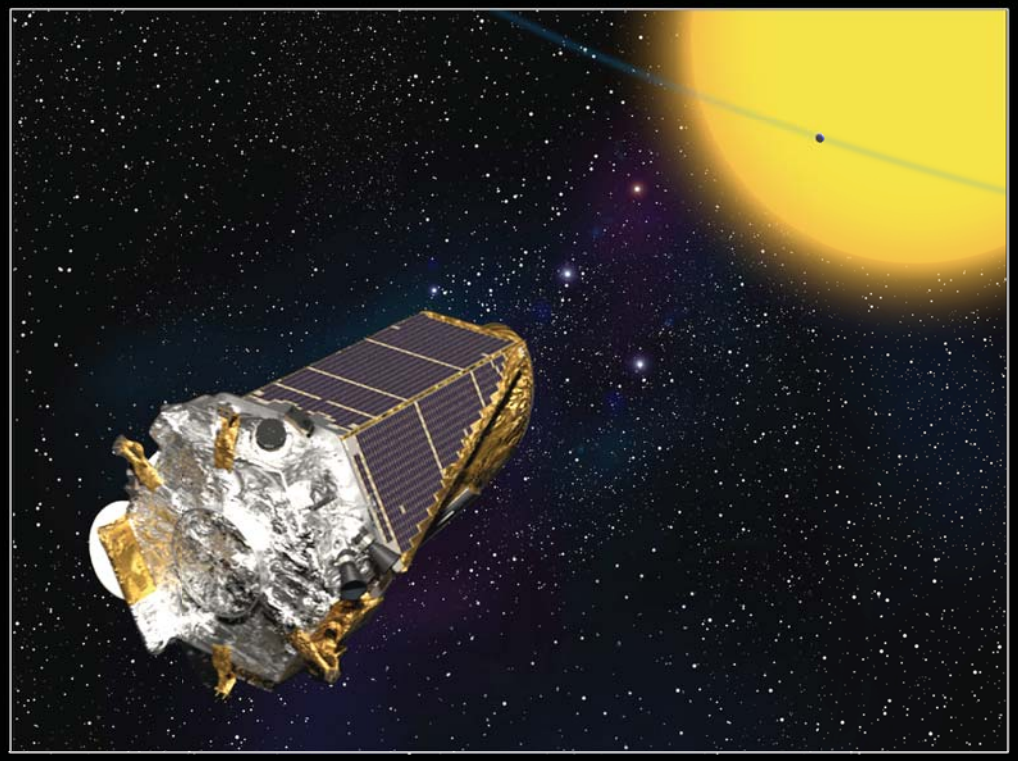
Time Delay vs Destination



	Lunar	S-E L1/2	NEO	Mars (min)	Mars (max)
# Comms per Min	23.4	6	1.20	0.16	0.02
Roundtrip Time (Secs)	2.6	10.0	50.0	373.3	2673.3

NASA's Kepler Mission

- Determine the frequency of Earth-size and larger planets in the habitable zone of sun-like stars
- Determine the size and orbital period distributions of planets



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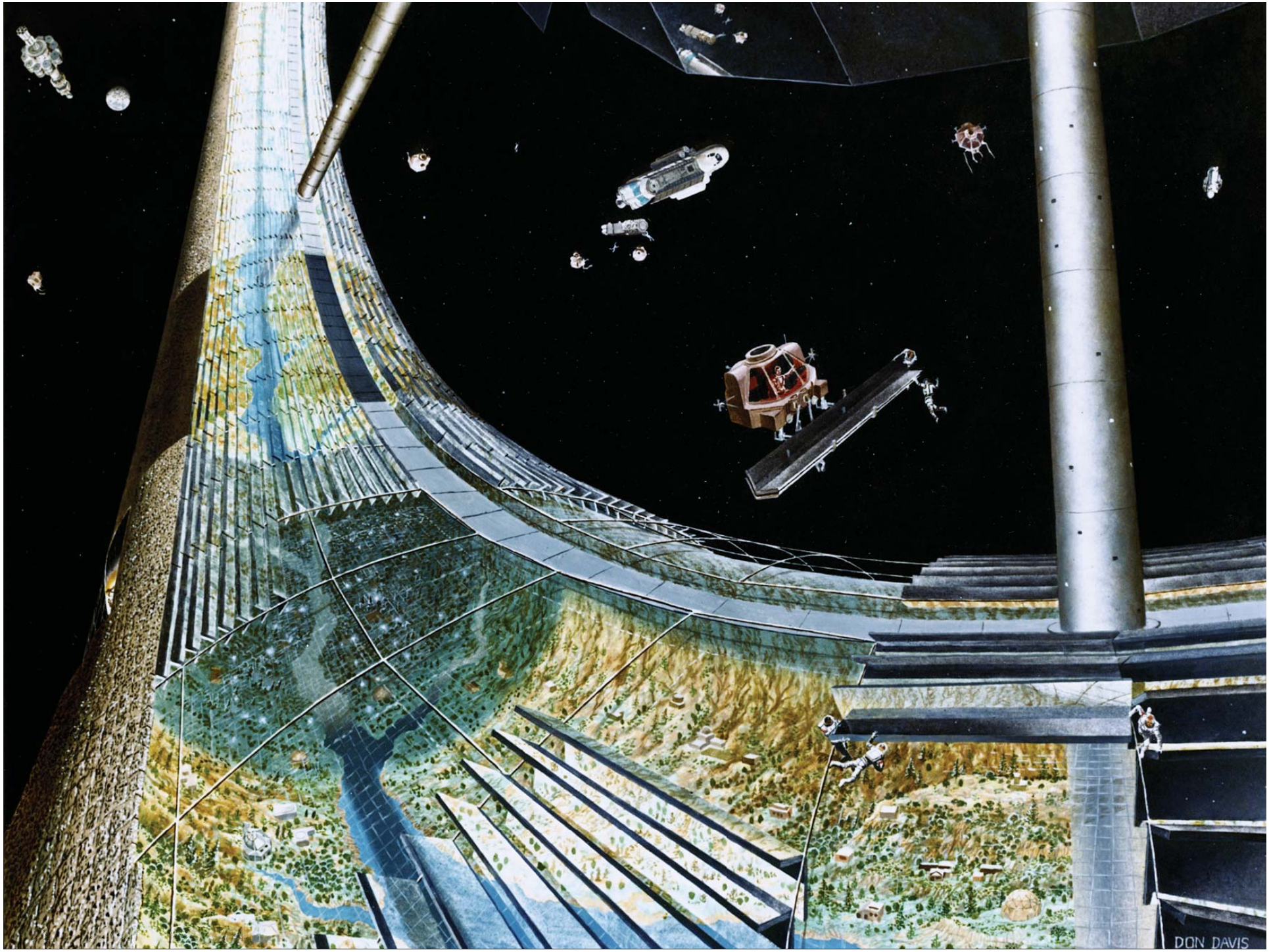

DON DAVIS

The New York Times

Space & Cosmos

Private Spacecraft Returns Safely From Orbit

Scott Audette/Reuters

SpaceX's Falcon 9 rocket lifting off in Cape Canaveral, Fla., on Wednesday.

By KENNETH CHANG
Published: December 8, 2010

SPACE TECHNOLOGY ROADMAPS • STR

FOR THE FOURTEEN TECHNOLOGY AREAS

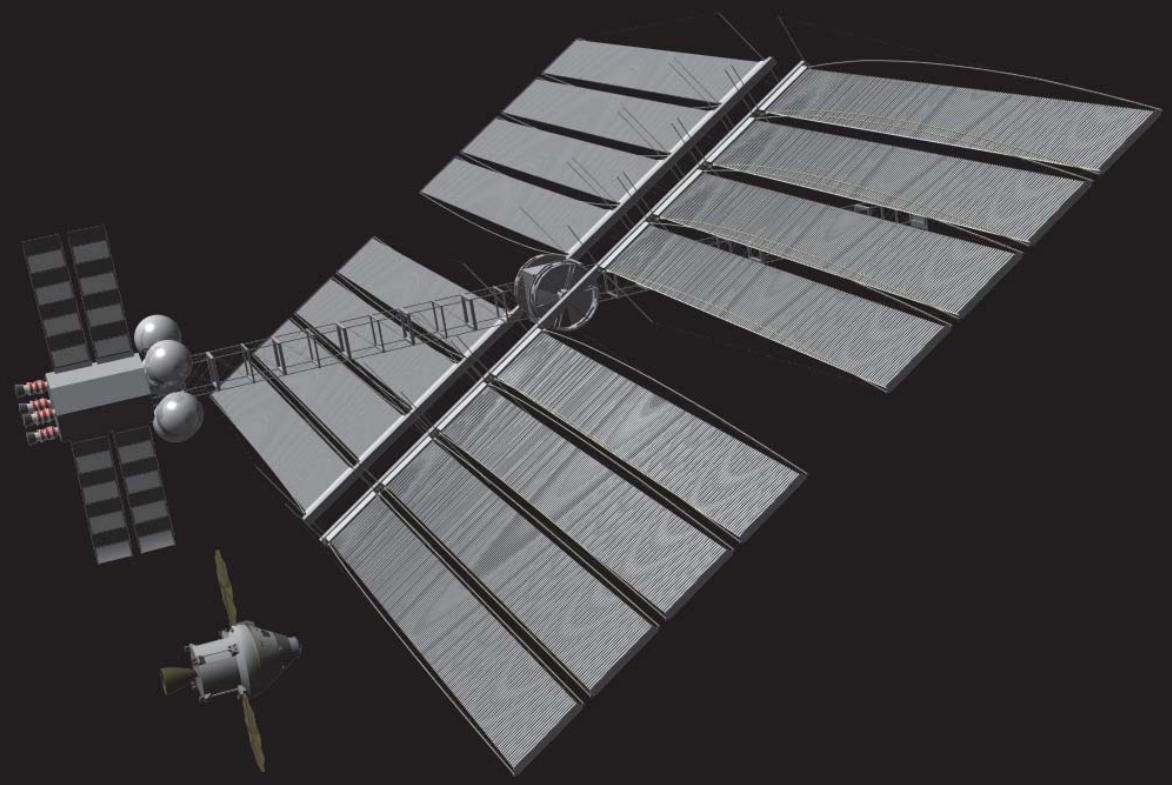
TECHNOLOGY AREA STRATEGIC ROADMAPS (TASR)

TECHNOLOGY AREA BREAKDOWN STRUCTURE (TABS)

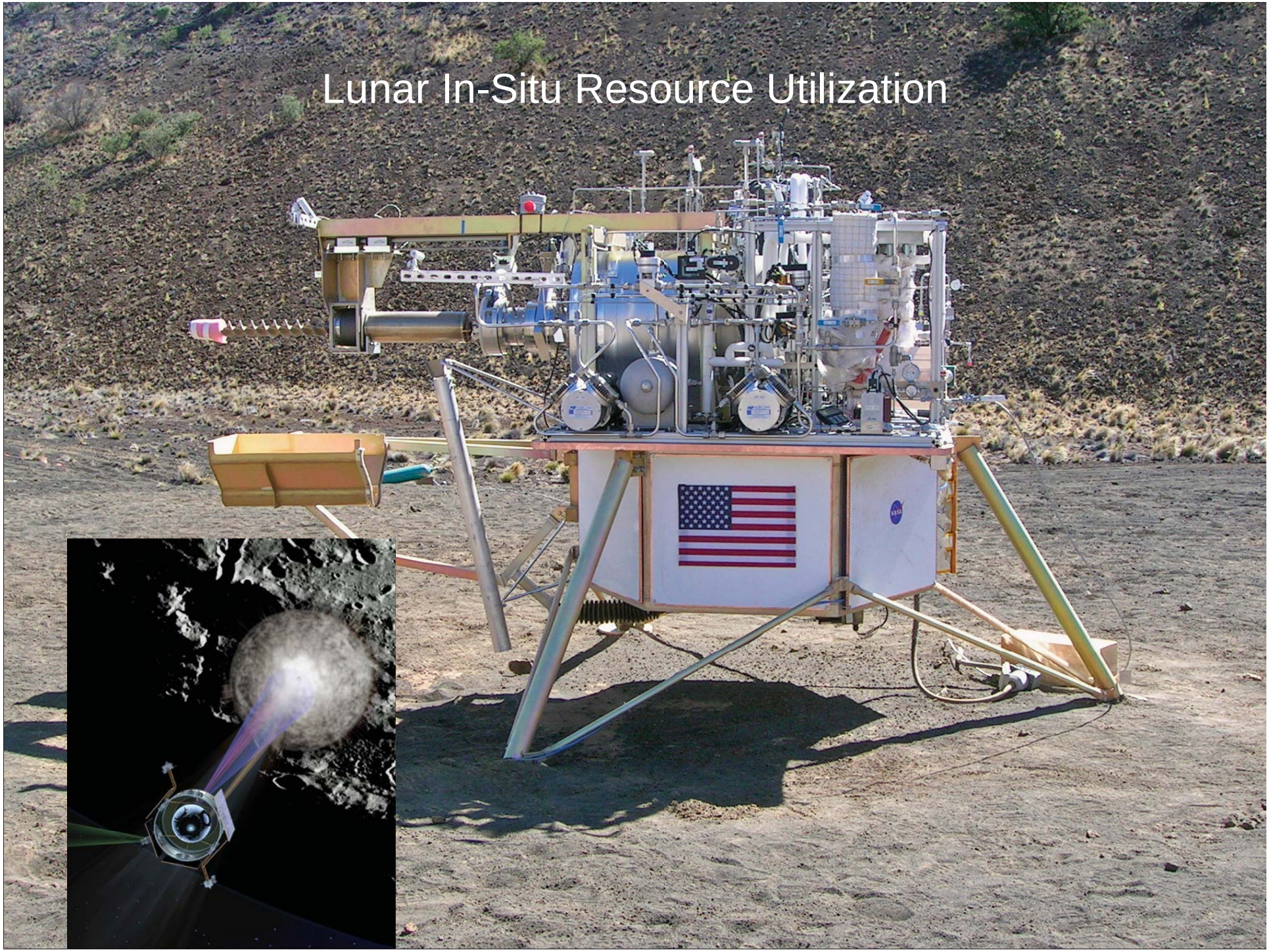
DRAFT

1

Solar Electric Propulsion



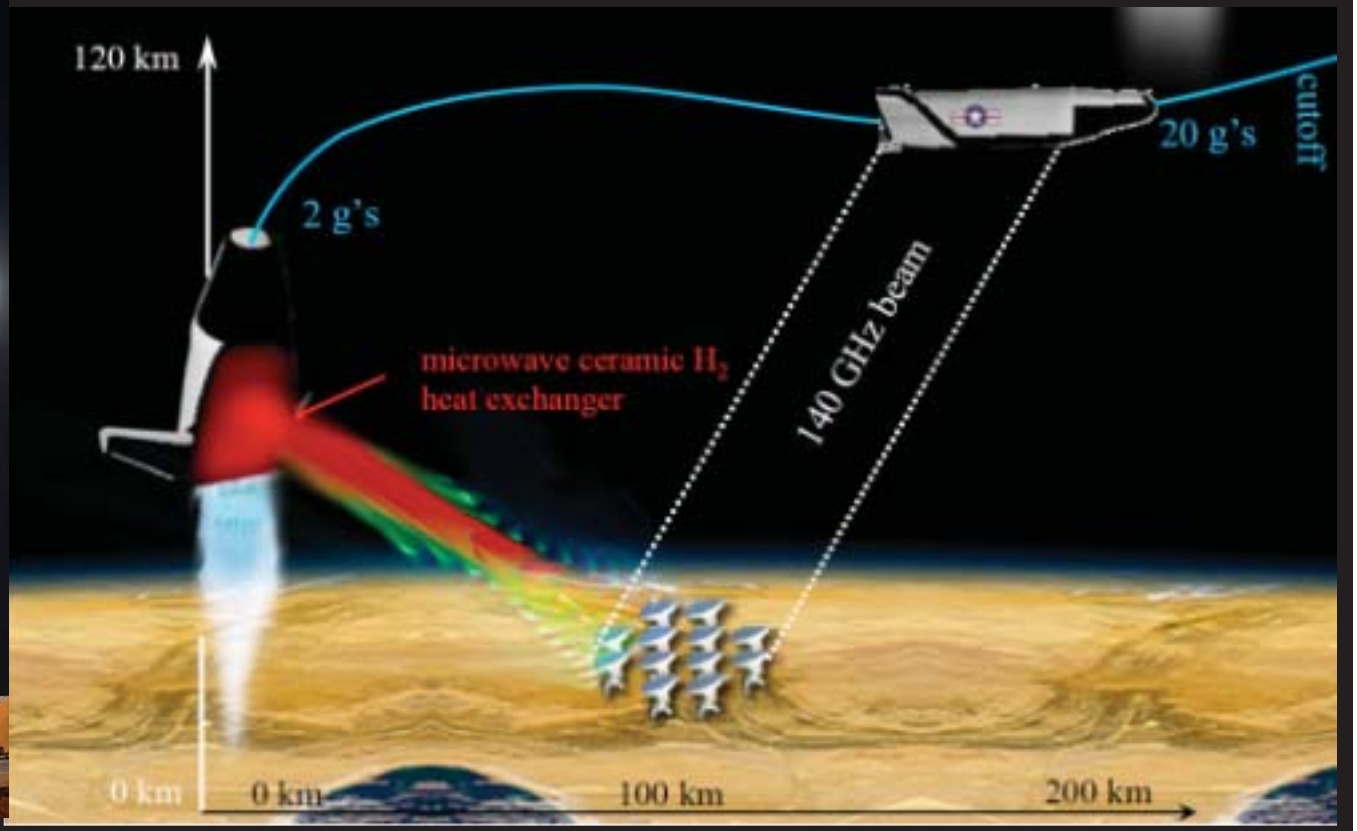
Lunar In-Situ Resource Utilization



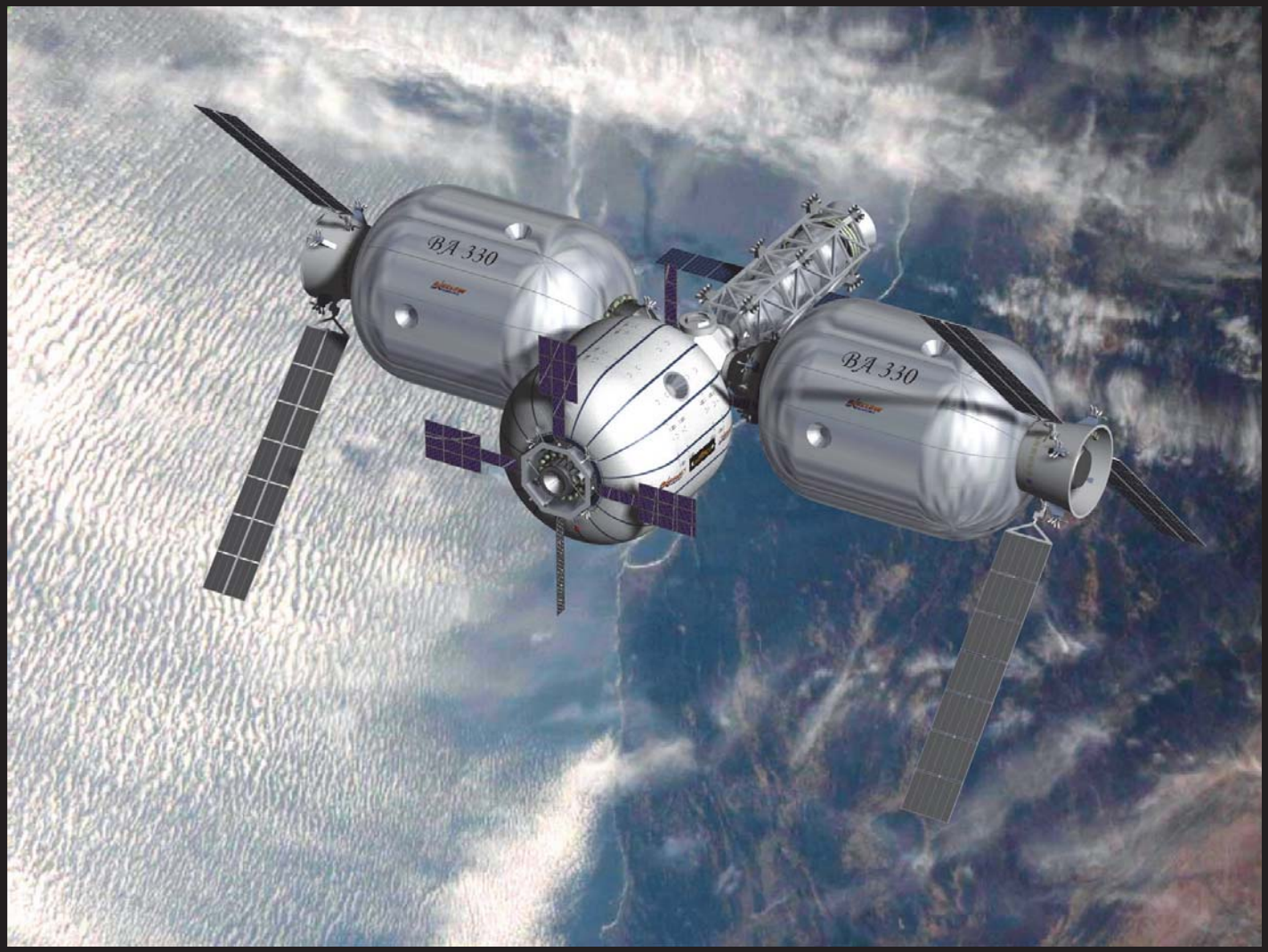
Ames Research Center *in Silicon Valley*

– Synthetic Biology

Re-usable Launch Vehicles



In-Space Habitation



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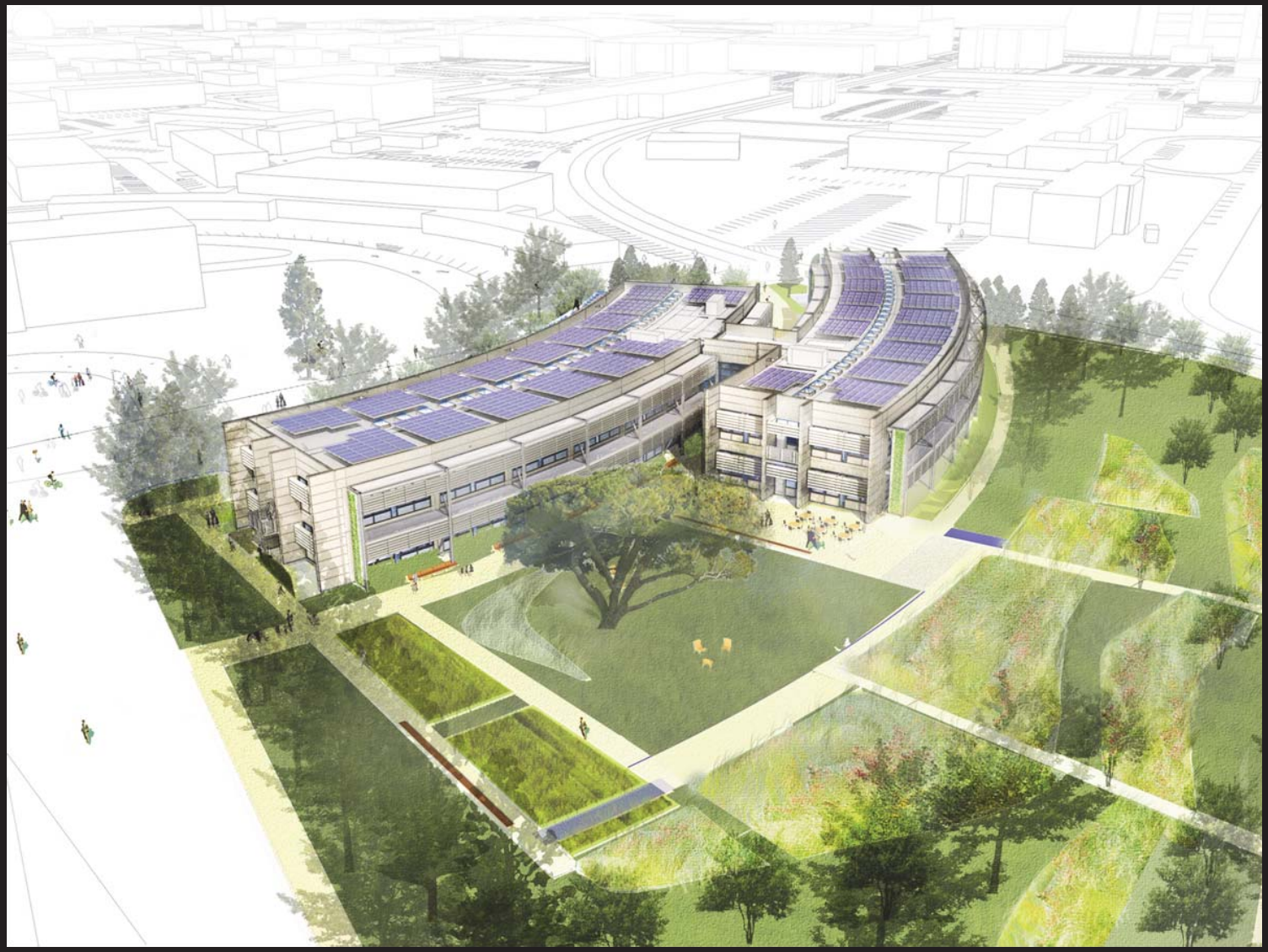
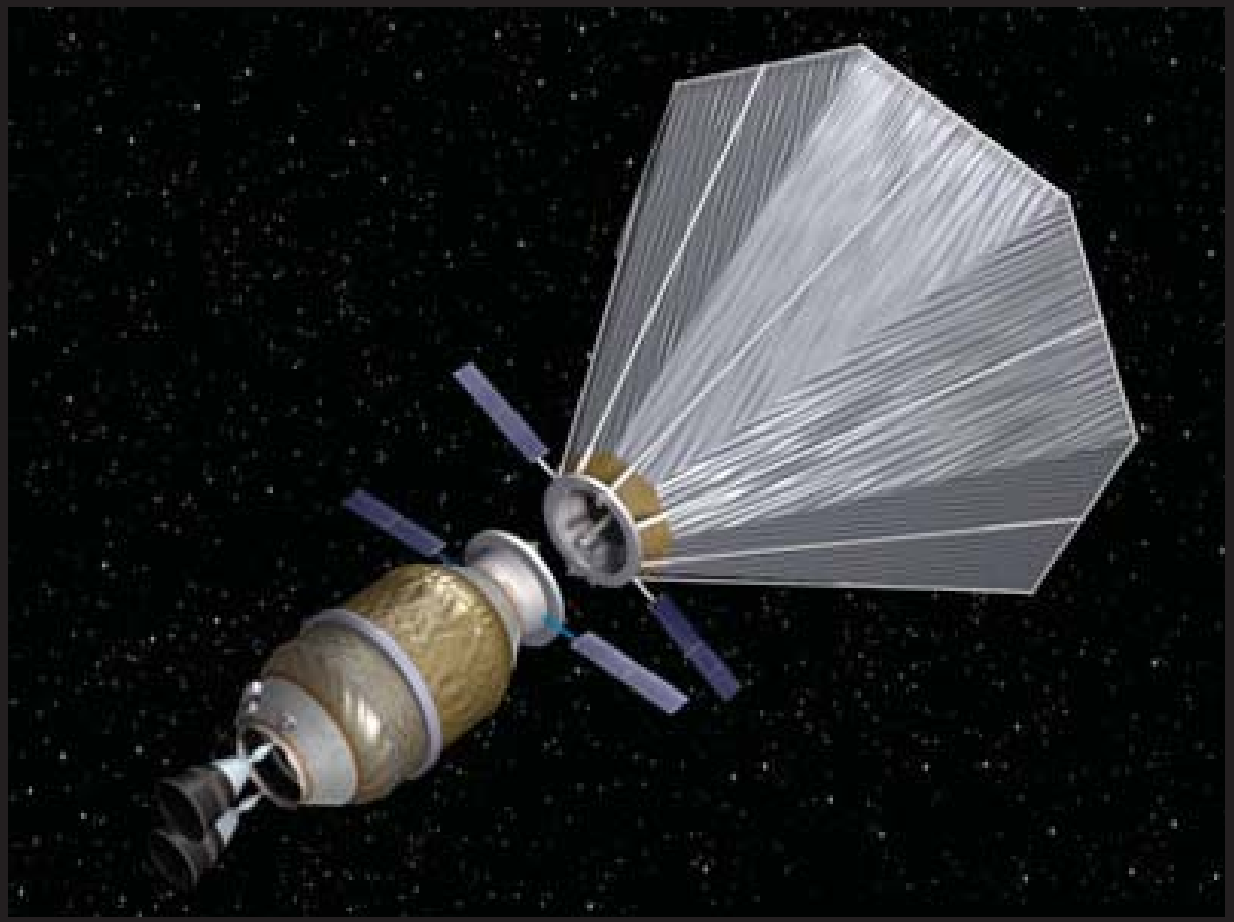
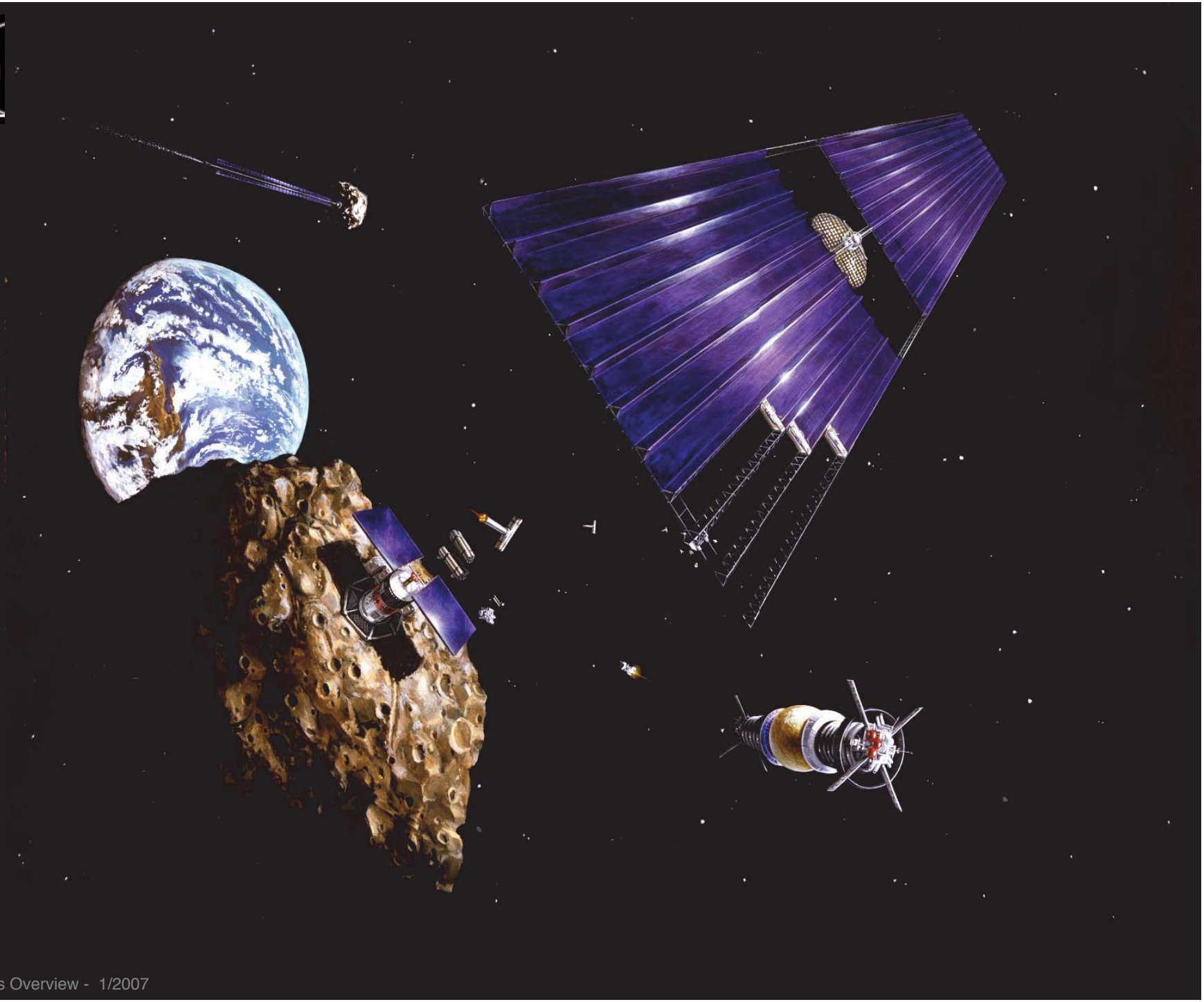
Closed-Loop Environmental Control



Lunar Transportation System

Propellant Depots





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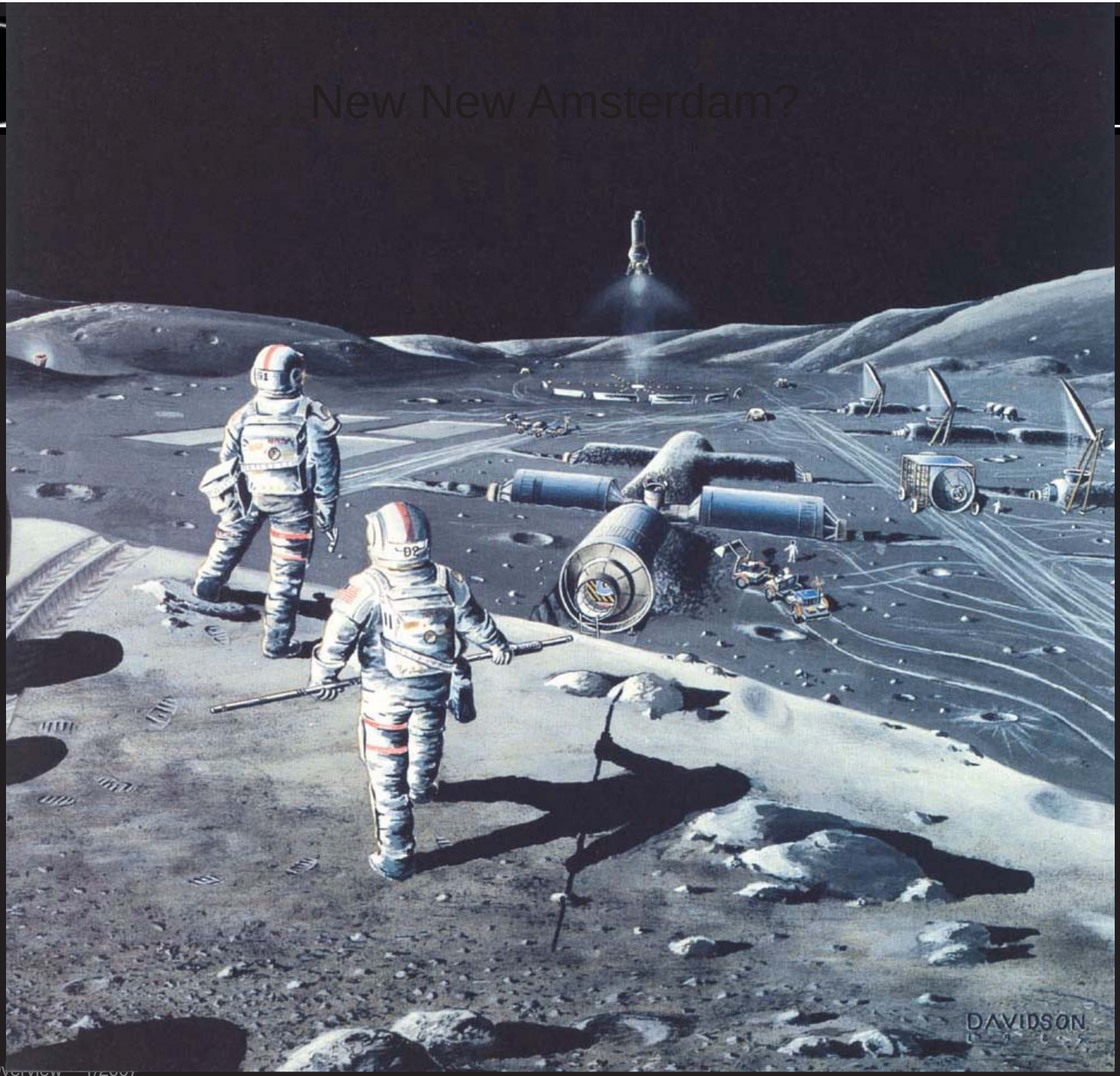
New New Amsterdam?



Automation Challenge

Developing Crew-Centered Mission Operations is one of NASA's <u>most complex tasks</u>

- **Break the moment-to-moment link to ground control.**
  - On-board Command and Control, System Monitoring
- **Take Care of the Spacecraft**
  - Repair and Recovery, Systems Health
- **Enable the Crew to focus on Exploration**
  - Activity Planning and Scheduling
- **Seamless integrate Humans with Data**
  - Blending virtual and real sensory information
- **Provide 'enough' computational capability**
  - Space-based HEC avionics