NASA and the Settlement of the Solar System (Autonomously….)

Space Mission Challenges in Information Technology
SMC-IT 2011

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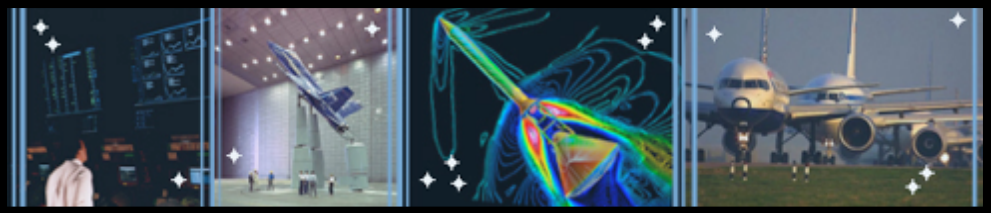
NASA Ames Welcomes SMC-IT 2011

Technical Scope:

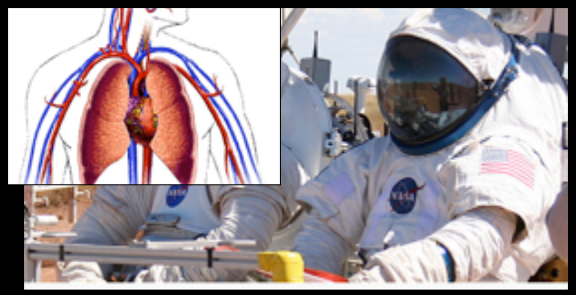
- Intelligent Systems
- High End Computing
- Human System Integration
- Small Satellites
- Science (Earth-Life-Space))
- Astrobiology
- Science Missions
- Aviation and Aeronautics
- Innovative Collaborations

- 2400 Employees
- $700+ M Annual Budget

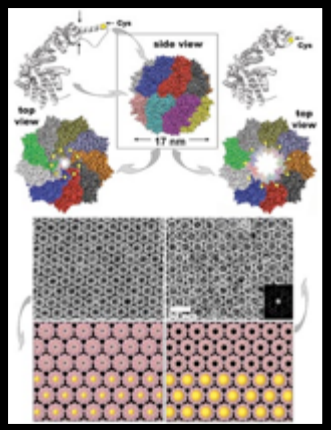
Ames Technology Areas



Aviation and Aeronautics



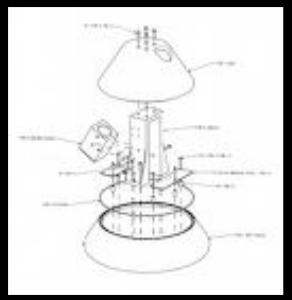
BioTech/Biomedical



Nanotechnology

Integrated Systems Health Management (ISHM)

Small Satellite Systems



Systems Engineering and Design

Robotics and Artificial Intelligence

Materials Science and Entry Systems

Reliable Software and High-end Computing

What Challenges exist in Exploration…?

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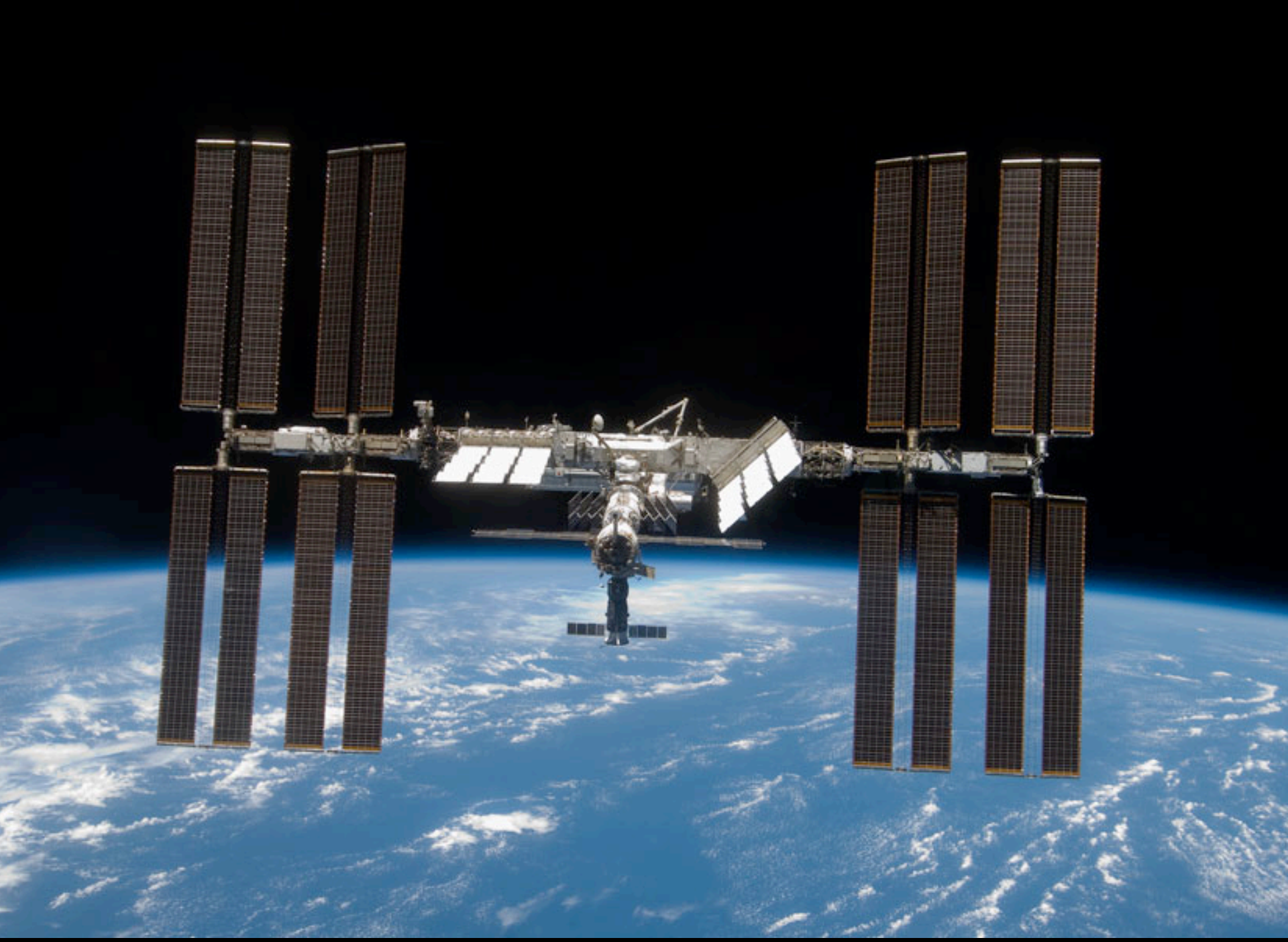
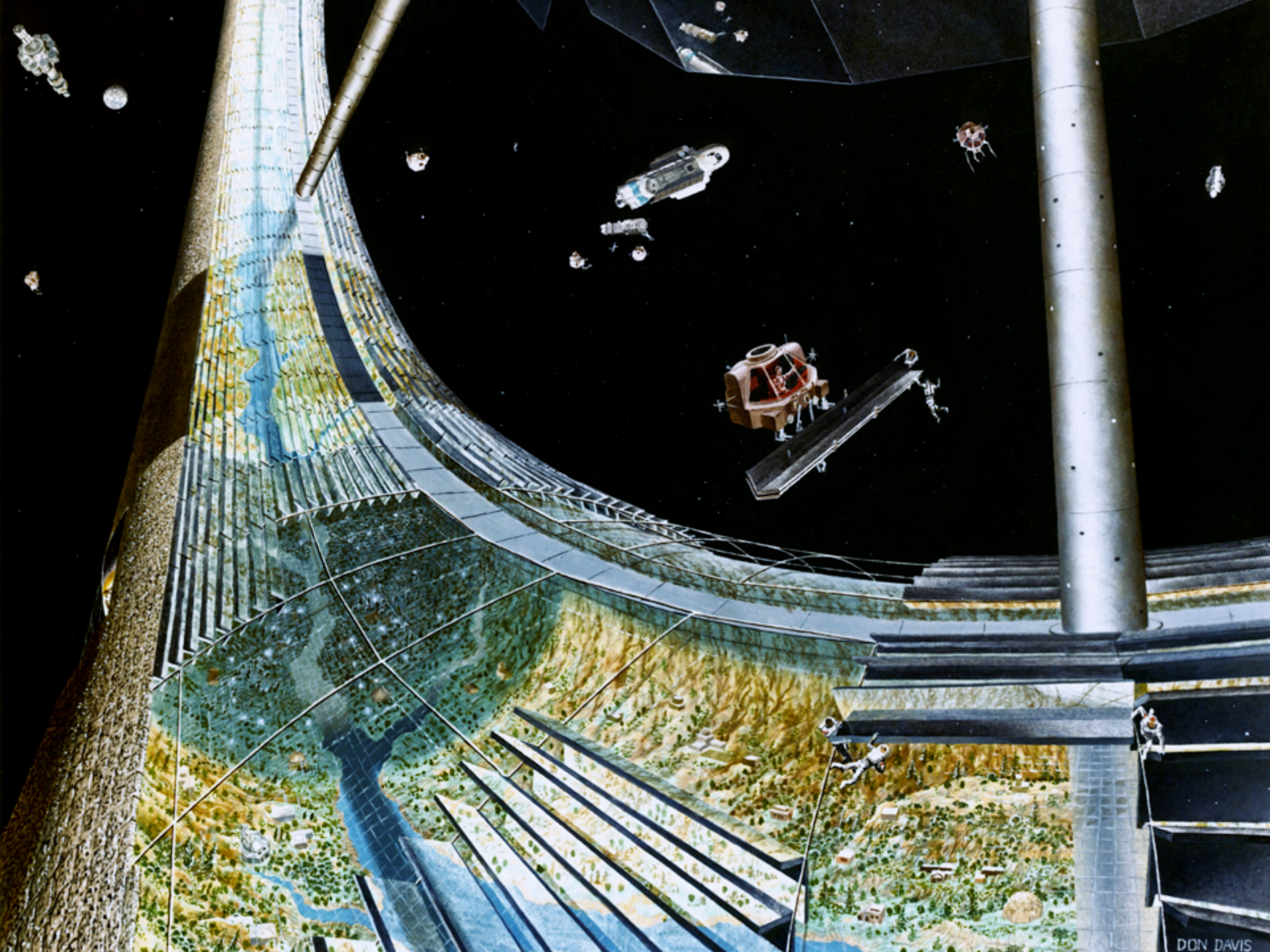
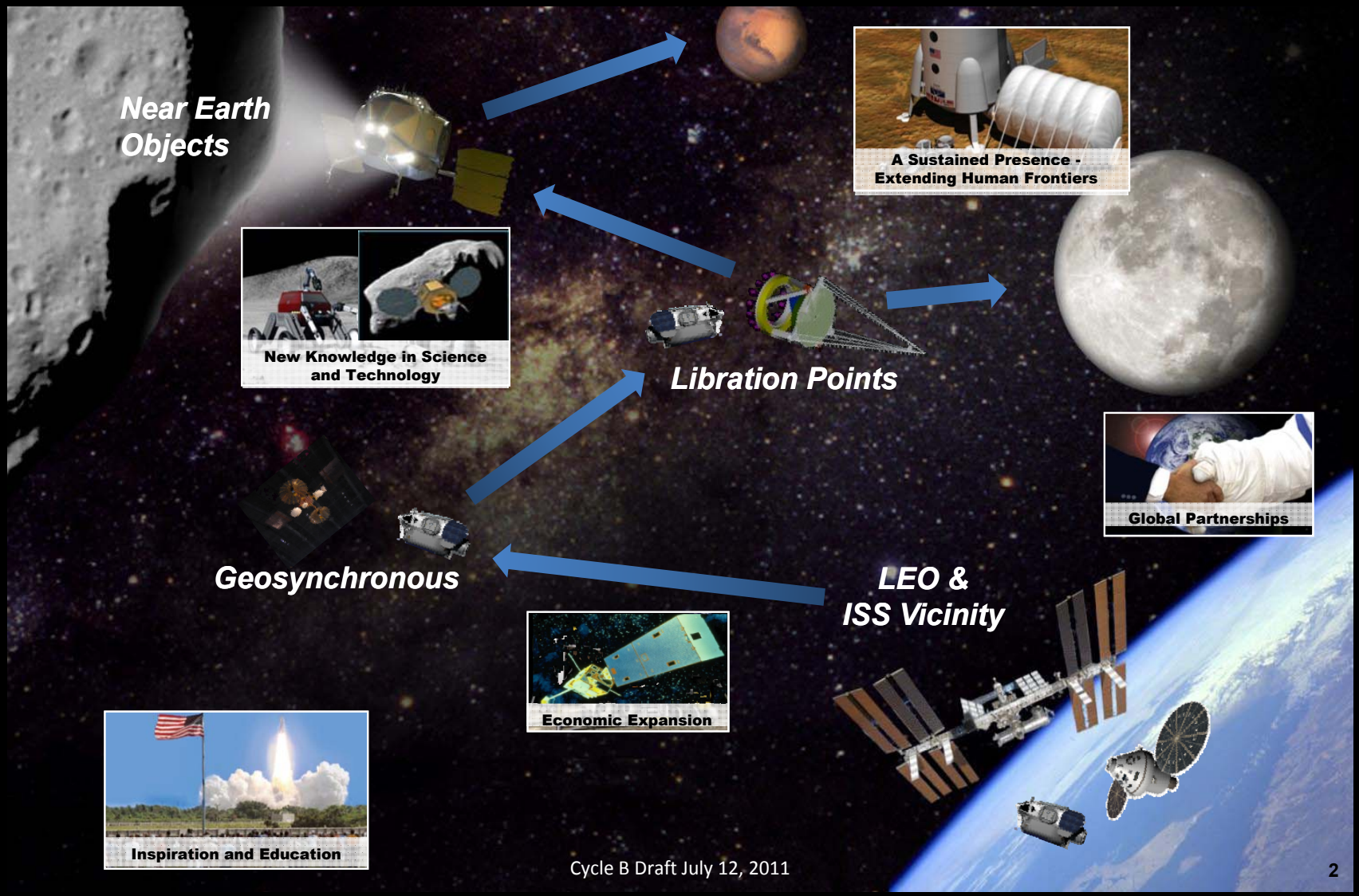



DON DAVIS

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

- NASA will have visited all of the Planets in the Solar System robotically
  - Dawn is visiting Vesta and Ceres in the main Asteroid belt
  - 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, and trips to Near-earth Asteroids, and Mars’ vicinity.

NASA's Human Exploration Destinations



Cycle B Draft July 12, 2011

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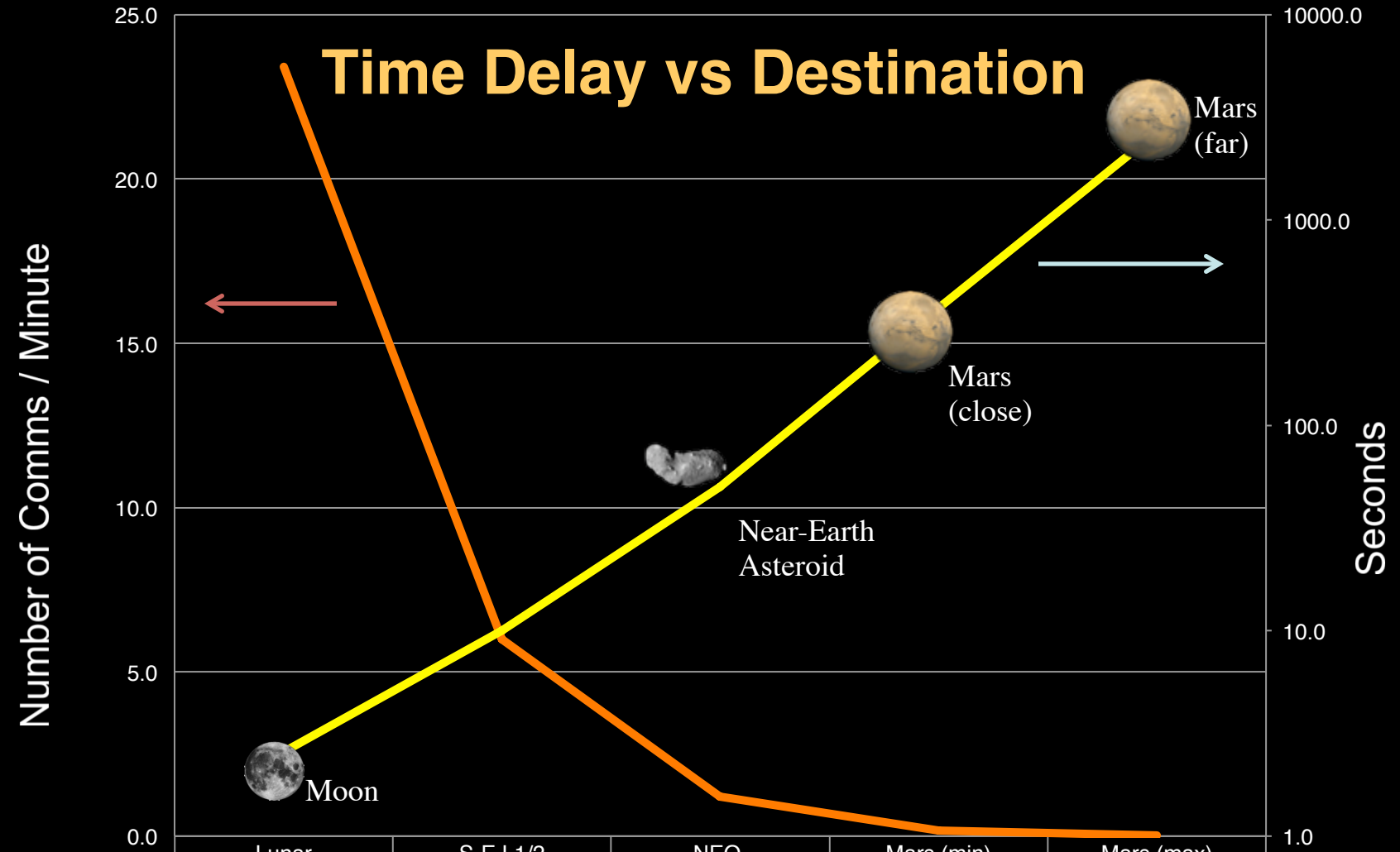
Time Delay vs Destination



	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

What is the Objective for Exploration Operations?

How does the Objective impact what automation and information technology development is needed?

- **<u>Current Objective</u>: Utilize the Earth-based Support systems**
  - Known processes (heritage)
  - Accepted Risk for Apollo, Shuttle, ISS
  - Existing, extensible Infrastructure

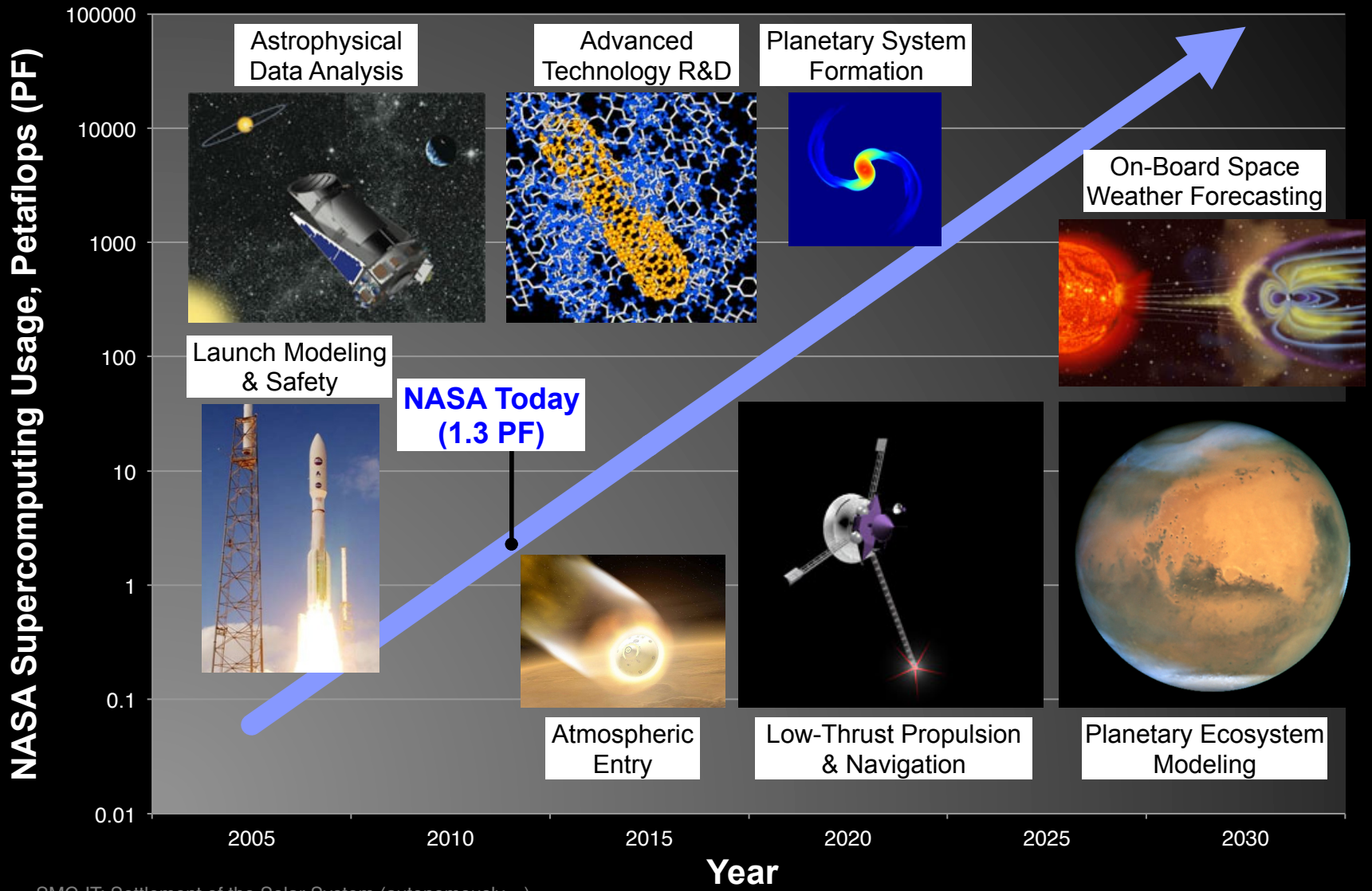
  Key Question 1: Is Communication with Earth feasible?

- **<u>Future Objective</u>: Maximize Crew-System Self-sufficiency**
  - Enable decisions on-board, new processes
  - Prepare for NEO/Mars mission operations models
  - Enhance the number of missions managed by Earth

  Key Question 2: Is an On-board Human Decision feasible?

- **<u>Question</u>: Is an On-board Decision feasible?**
  - "Given the detailed operations phase, is there a person/system available on-board with the required 'expertise' to decide, in a way that fits in the timing constraints and subject to acceptable safety risks?"
  - Factors
    - Crew size
    - Crew roles and skill mix
    - Task focus given detailed operations phase
    - Crew work load
    - Time available for analysis / decision
    - Safety impacts of analysis / decision
- **<u>Constraints</u>: On-board decision and computing power available**
  - "Are the autonomous software / systems capable?
  - "Are the on-board computational resources sufficient for the load?"

Projected Growth in NASA Supercomputing



The Challenge

We **can not** pack the knowledge of today's ground-based Operational Staff of subject matter experts into three or four Astronauts!

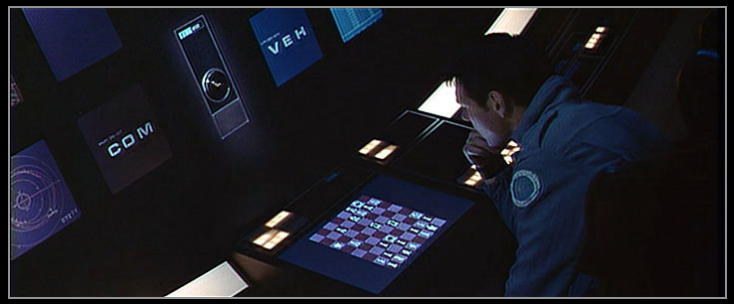
Current Human Spaceflight operations requires Roughly 300,000 commands issued yearly by ISS ground controllers.

SMC-IT Challenge

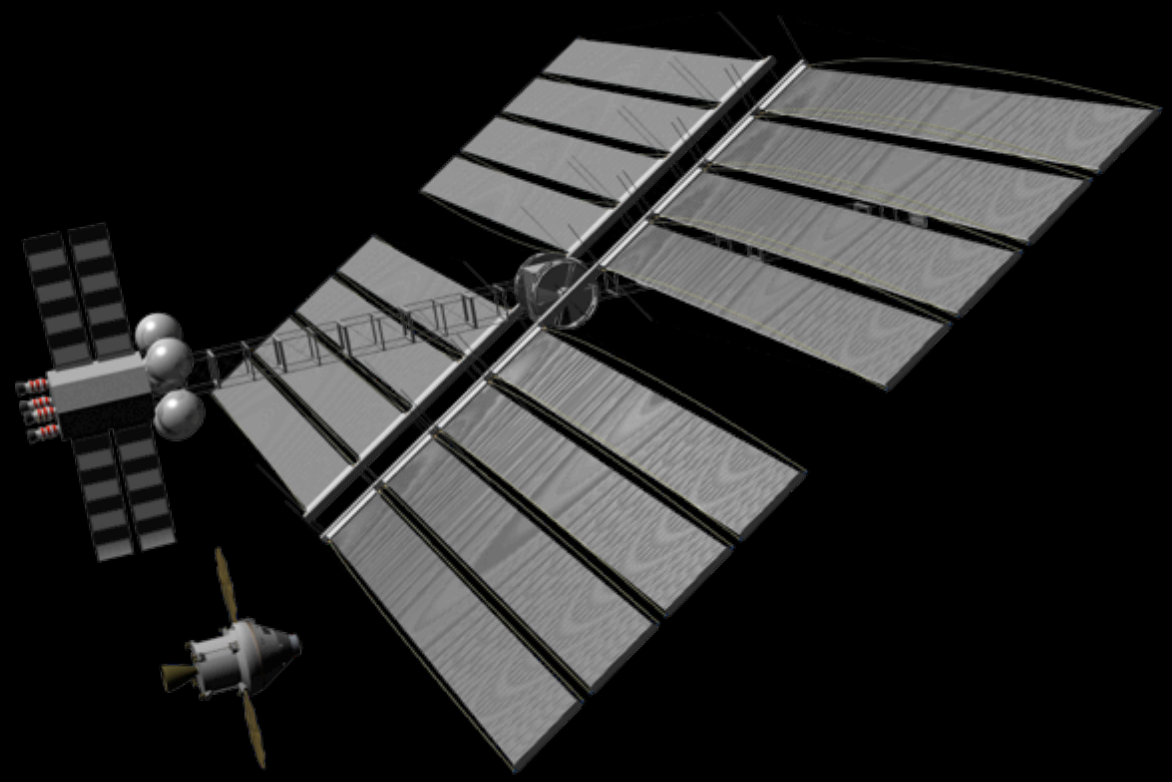
Developing Crew-Centered Mission Operations is one of NASA's <u>most complex tasks</u>

- **Break the moment-to-moment link to ground ops.**
  - 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

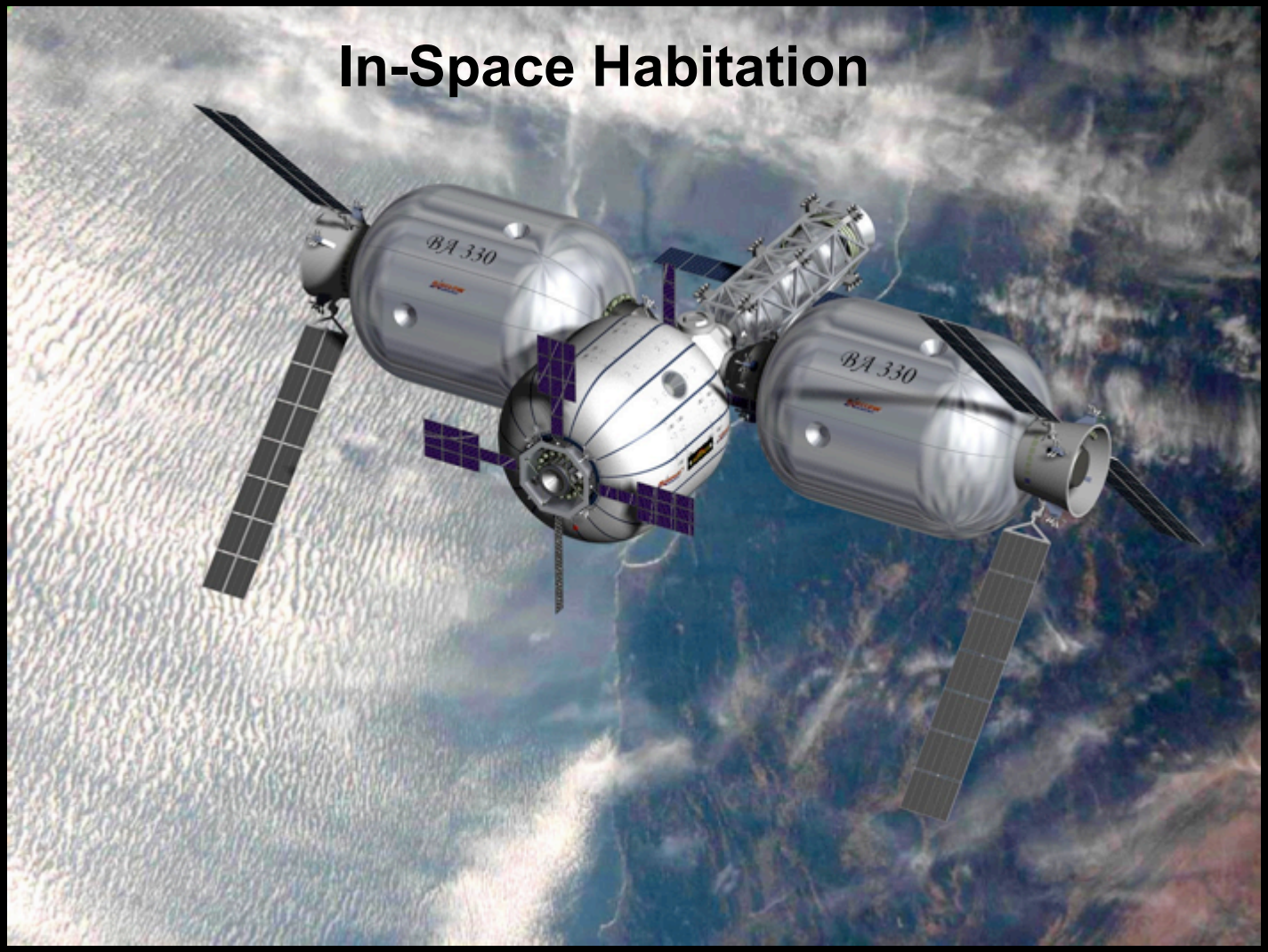
- **Seamless integrate Humans with Data**
  - Blending virtual and real sensory information
- **Provide 'enough' computational capability**
  - Space-based HEC avionics



Solar Electric Propulsion

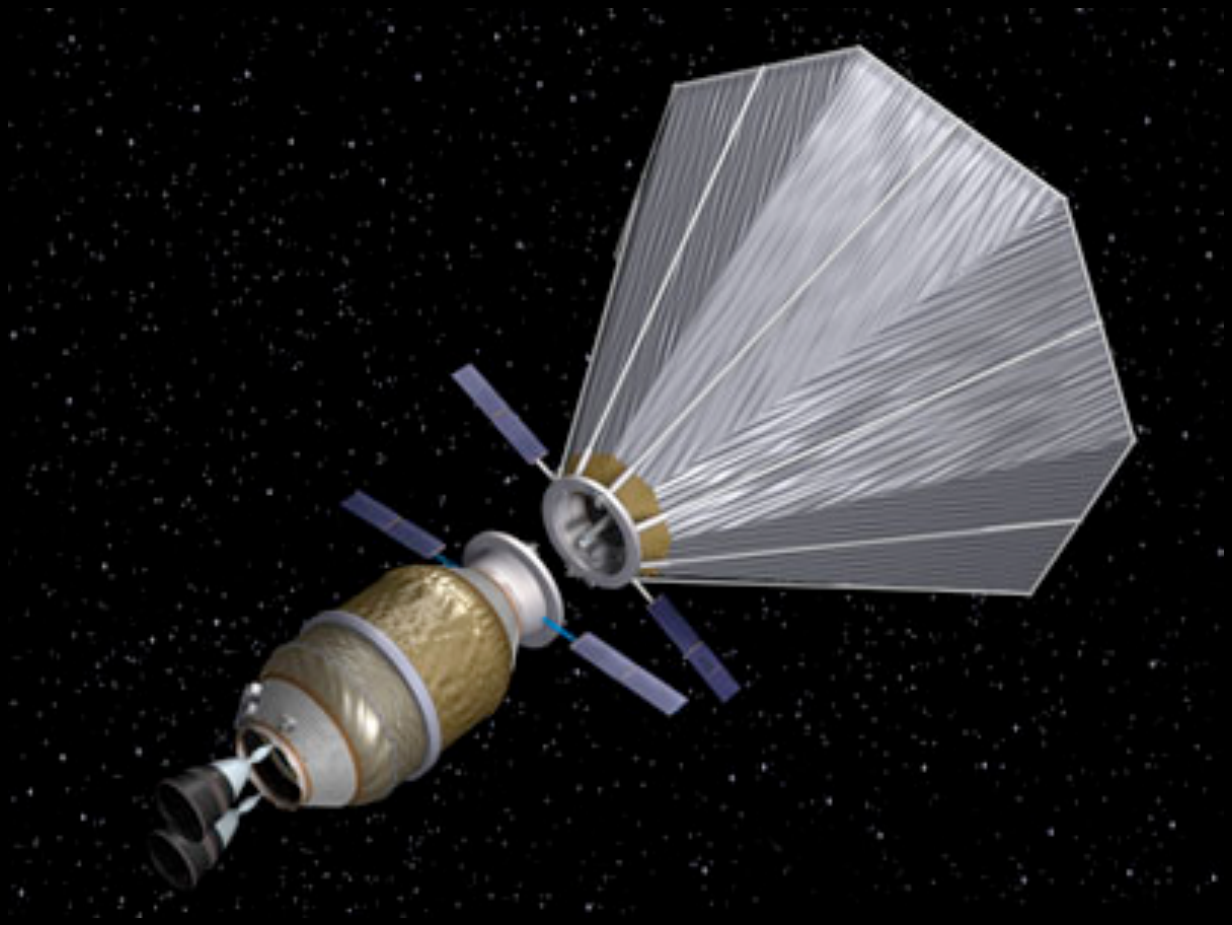


In-Space Habitation



Planetary Transportation System

Propellant Depots



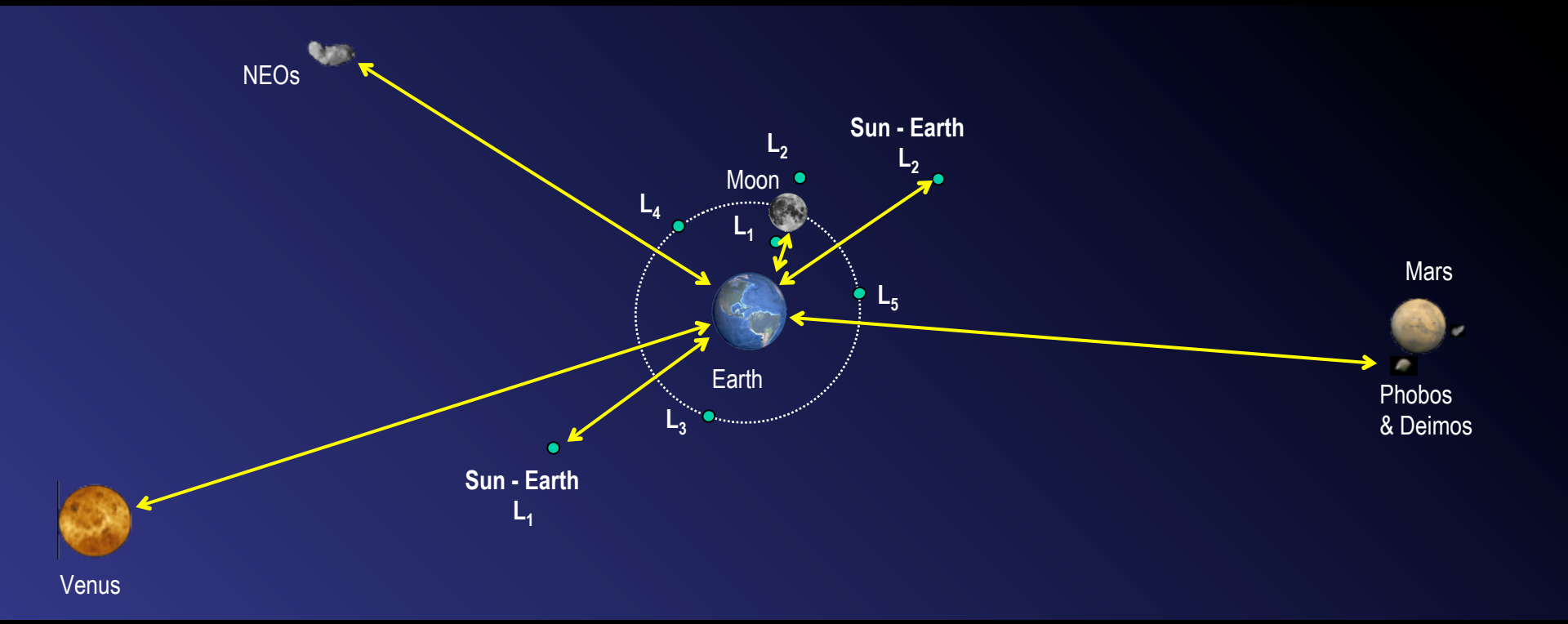
In-situ Processing Technologies

As Exploration Targets change the Challenges remain the same….

- **Constellation Program: (2006-2010)**
  - Avionics and Software were Key Technology needs
- **HSF Augustine Commission: 2009**
  - Crew autonomy and deep space automation were Key Technology Needs
- **HEFT: Human Exploration Framework Team: (2010)**
  - Crew autonomy, ISHM, Reliable Software, High powered Avionics all were Key Technologies
- **HAT: Human Spaceflight Architecture Team: (2011)**
  - Crew autonomy, ISHM, Reliable Software, High powered Avionics all were Key Technologies

Exploration Enabling Technologies

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



New New Amsterdam?