National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

The Future of NASA's Human Spaceflight Program
Presented to the San Gabriel Valley Section - AIAA
September 22, 2011

Kimberly Simpson
Mission Systems Concepts Section
NASA Jet Propulsion Laboratory
California Institute of Technology

Principle to JPL's Involvement in HSF

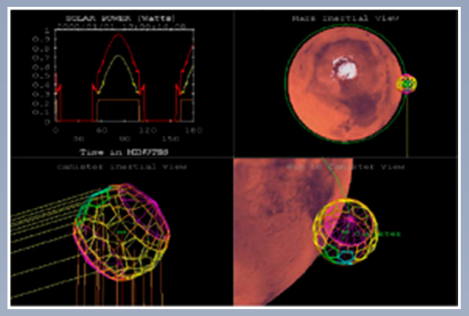
- **Core Driving Principle – JPL will participate as part of the NASA Space Flight community to provide value from JPL's experience in robotic missions and integrate the best of its technical and project/ program skills consistent with the Human Space Flight (HSF) program needs**

National Aeronautics and Space Administration

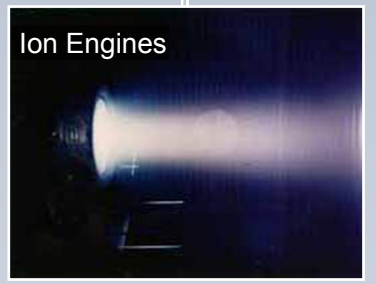
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

JPL has End-to-End Capabilities Needed to Implement Missions

Project Formulation - Team X



Mission Design

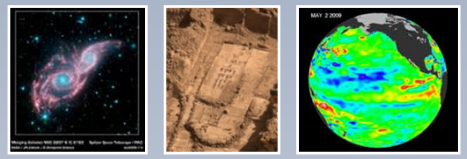


Spacecraft Development

Integration and Test

Environmental Test

Real Time Operations

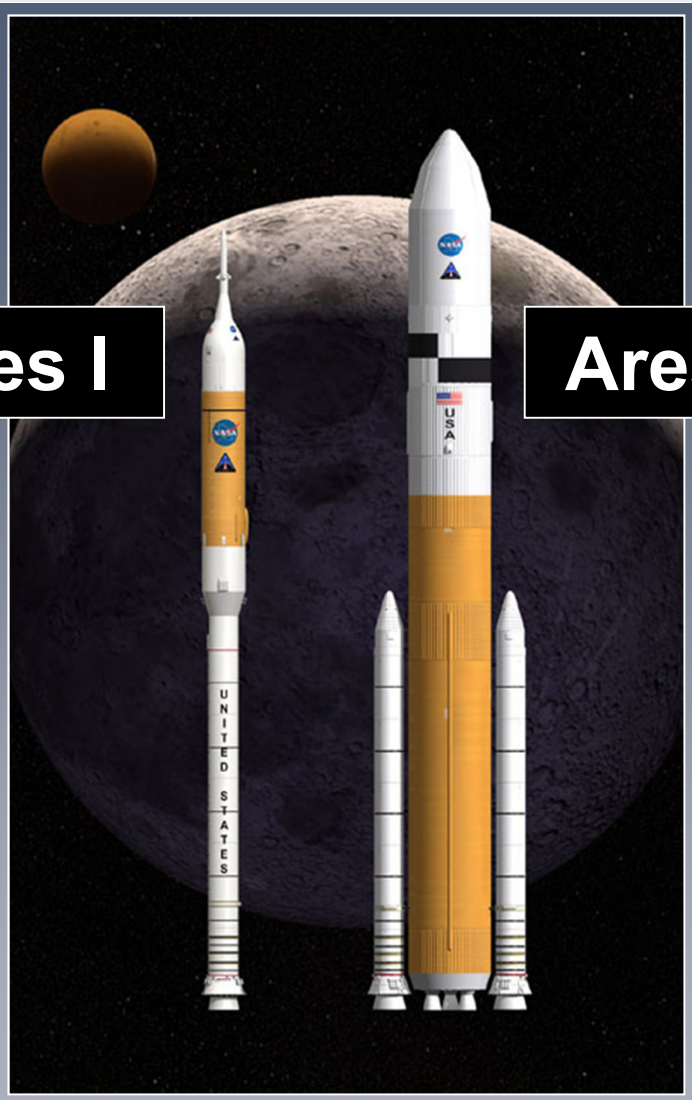


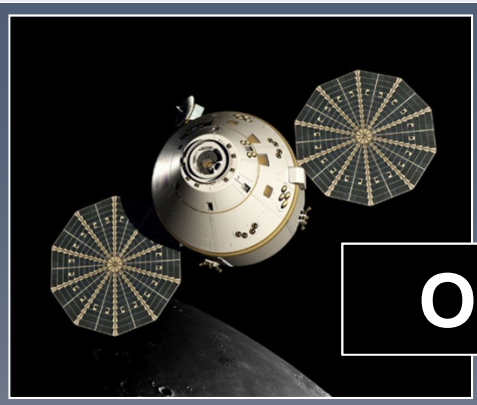
Scientific Research

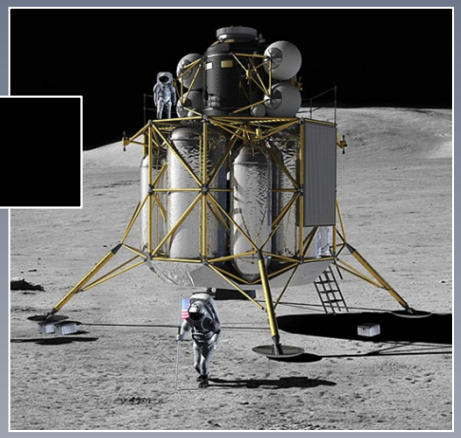
FY09-FY11 JPL ESMD engagement

- **Constellation Program**
  - Level 2 system engineering - small group primarily in Software, Avionics Integration Office
  - Program System Engineer- B. Muirhead
  - Altair Lunar Lander- Flight system engineering and GN&C staffing
  - Orion- International Space Station (ISS) Communication Adaptor (teamed with JSC) GFE
  - Ares 1 Launch Vehicle- support for PDR and propulsion
  - Mission Operations- System engineering support
  - Human Exploration Framework Team (HEFT) 1 and HEFT 2 support
- **Technology Program**
  - Advanced Environmental Monitor and Control - Project lead and two ISS demonstration instruments
  - 15 other projects
    - Human-Robotics: development of ATHLETE concept and test bed
- **Lunar Robotics Precursor Program**
  - Goldstone Radar upgrade, Lunar Modeling and Mapping Project support
- **Directorate Integration Office - Modeling support**

History of Constellation

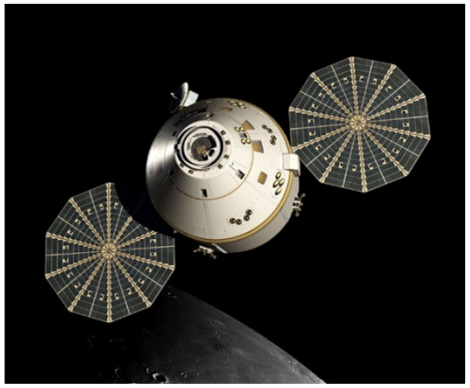






Future of HEOMD's Exploration Systems Development

- **Constellation Program cancelled Feb 1st, 2010**
- **Human Exploration and Operations Mission Directorate (HEOMD) created July, 2011**
  - Defined Exploration Systems Development Office
  - Responsible for developing integrated flight/ground system consisting of
    - Multi-Purpose Crew Vehicle (aka Orion)
    - Space Launch System (SLS)
    - 21st Century Ground Systems



National Aeronautics and Space Administration

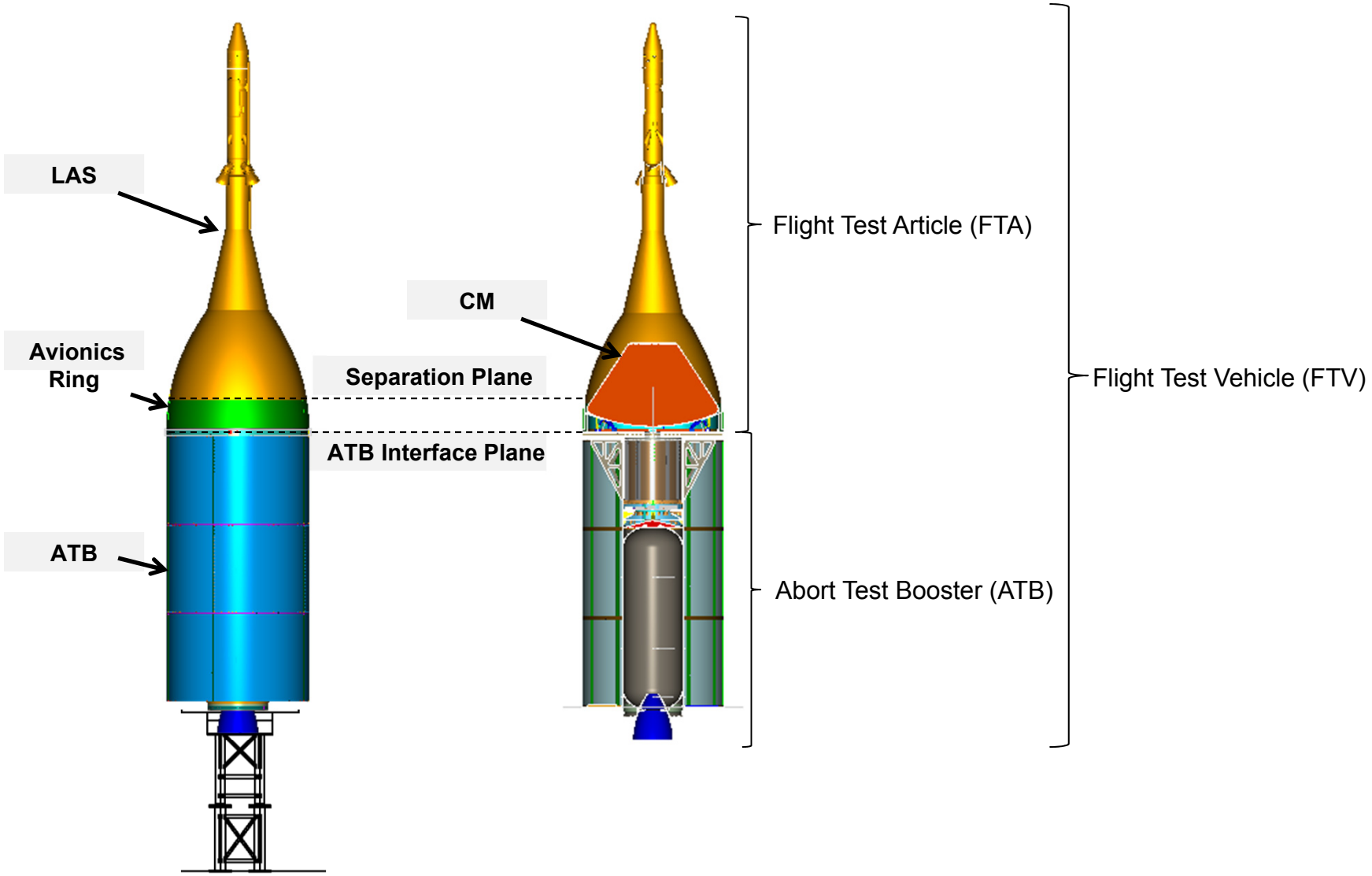
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

First Flight Test
OFT-1 or AA-2

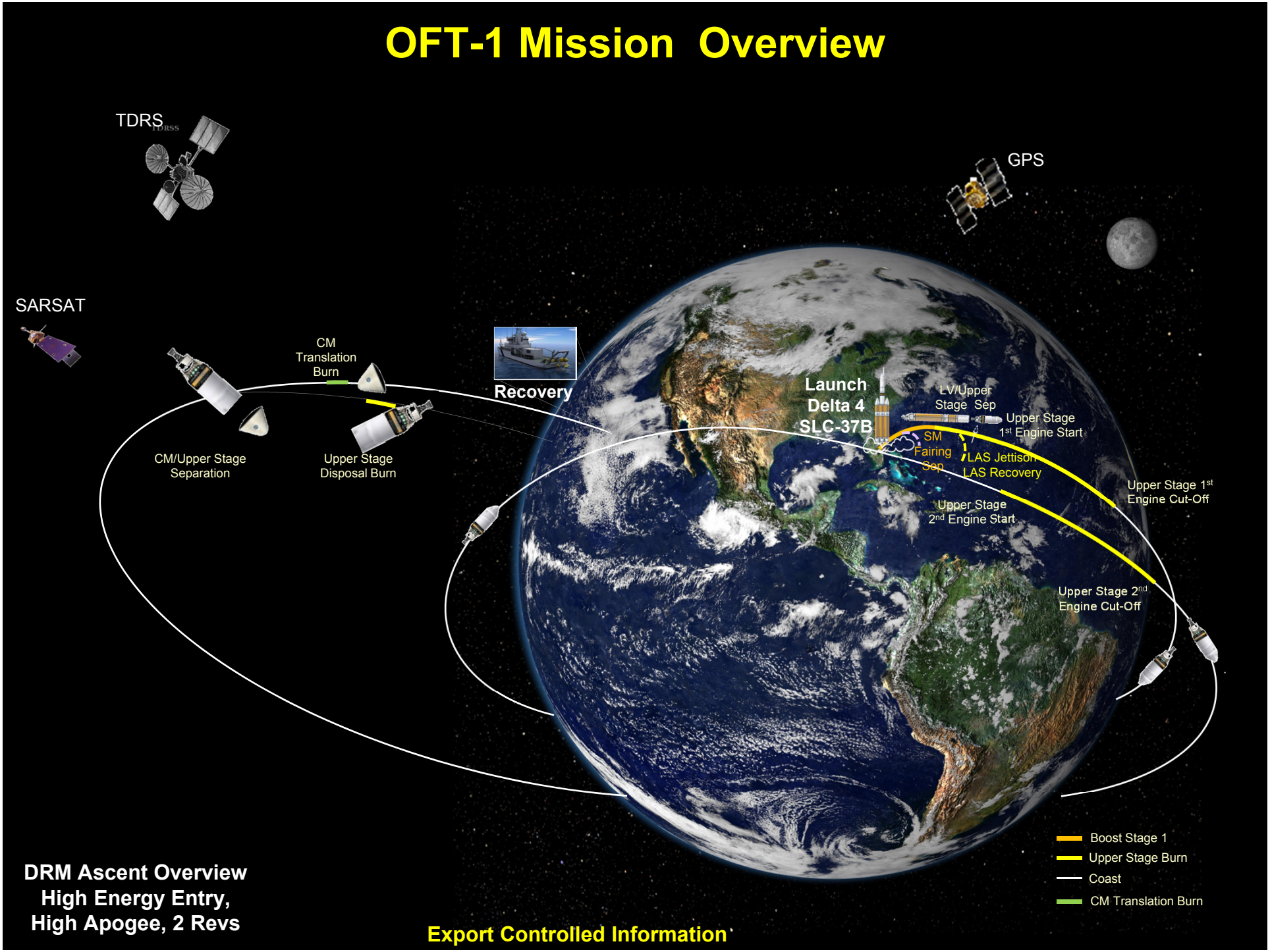
- **Working an Orion Flight Test (OFT-1) baseline since Oct, 2011**
  - Follows successful execution of Pad Abort 1 (PA-1)
  - Planning to Oct 22nd, 2013 launch

- **Alternative is Ascent Abort-2 (AA-2)**

AA-2 Vehicle Configuration

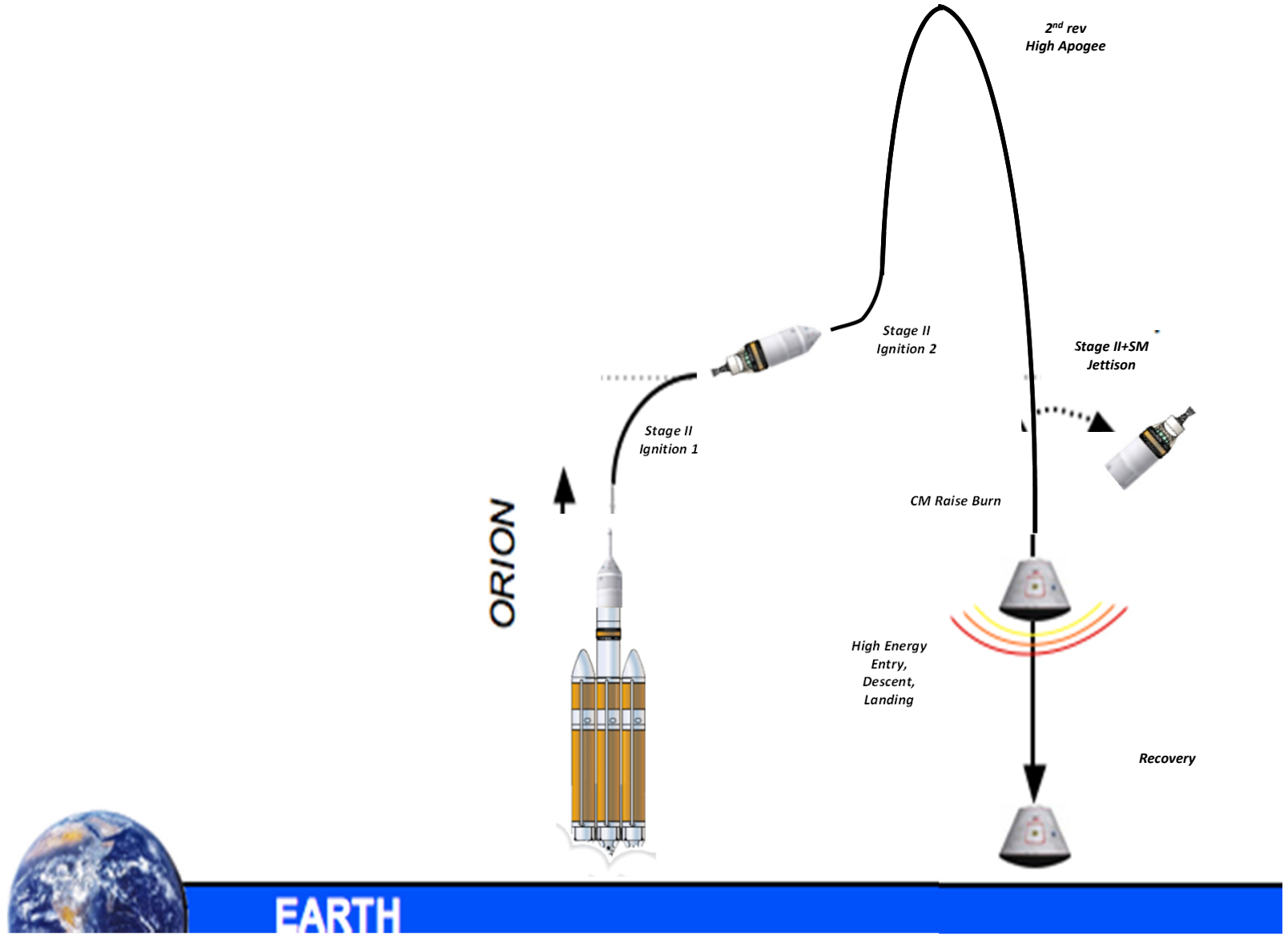


OFT-1 Mission Overview



DRM Ascent Overview
High Energy Entry,
High Apogee, 2 Revs

OFT-1 Mission Overview (cont.)

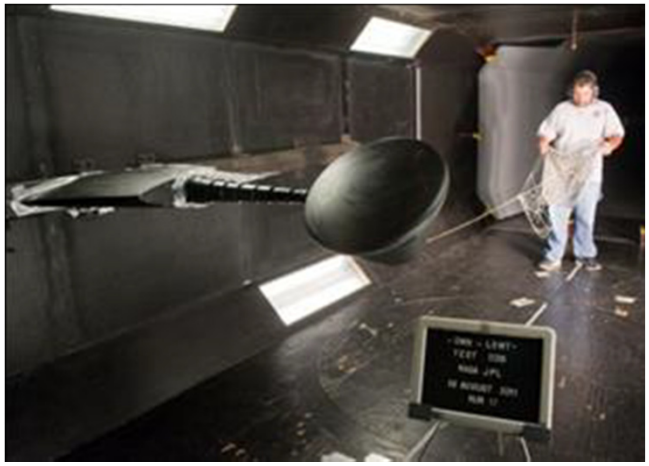


National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Recent MPCV Accomplishments

The Ground Test Article Launch Abort System stacked onto Crew Module at the Lockheed Martin facility in Denver, Co.



Conducted low-speed wind tunnel test at Texas A&M University subsonic wind tunnel

MPCV water landings tests in the Hydro Impact Basin at Langley

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Human Space Flight Building Blocks

DRM TITLE	MINIMUM ELEMENTS									
	Commercial LV	SLS - HLLV	MPCV	CPS	REM/SEV	EVA Suit	Lunar Lander & Elements	DSH	SEP	Mars Elements
LEO missions	R	B	B			R				
HEO/GEO vicinity without pre-deploy		D	D	D	D	R				
HEO/GEO vicinity with pre-deploy	R	R	R	R	D	R				
Lunar vicinity missions		R	R	R		R				
Low lunar orbital mission		R	R	R		R				
Lunar surface mission		R	R	D		D	D			
Minimum capability NEA		R	R*	D	D	R		R		
Full capability NEA		D	D*	D	D	D		D	D	
Martian moons: Phobos/Deimos		R	R*	R		D		R	R	
Mars landing		D	R*	R		D		R	D	D

* MPCV entry velocity could be driven by these missions for certain targets, if selected.

- LV=Launch Vehicle
- SLS=Space Launch System
- MPCV=Multi-person Crew Vehicle
- CPS=Cryogenic Propulsion Stage
- REM=Robotics & EVA Module
- EVA=Extravehicular Activity
- DSH=Deep Space Hab
- SEP=Solar Electric Propulsion

D	Driving Case
R	Required Elements
B	Back-Up Capability

D/R/B Element allocations based on Authorization Act and other conditions. Different constraint basis would result in different element allocations/options.

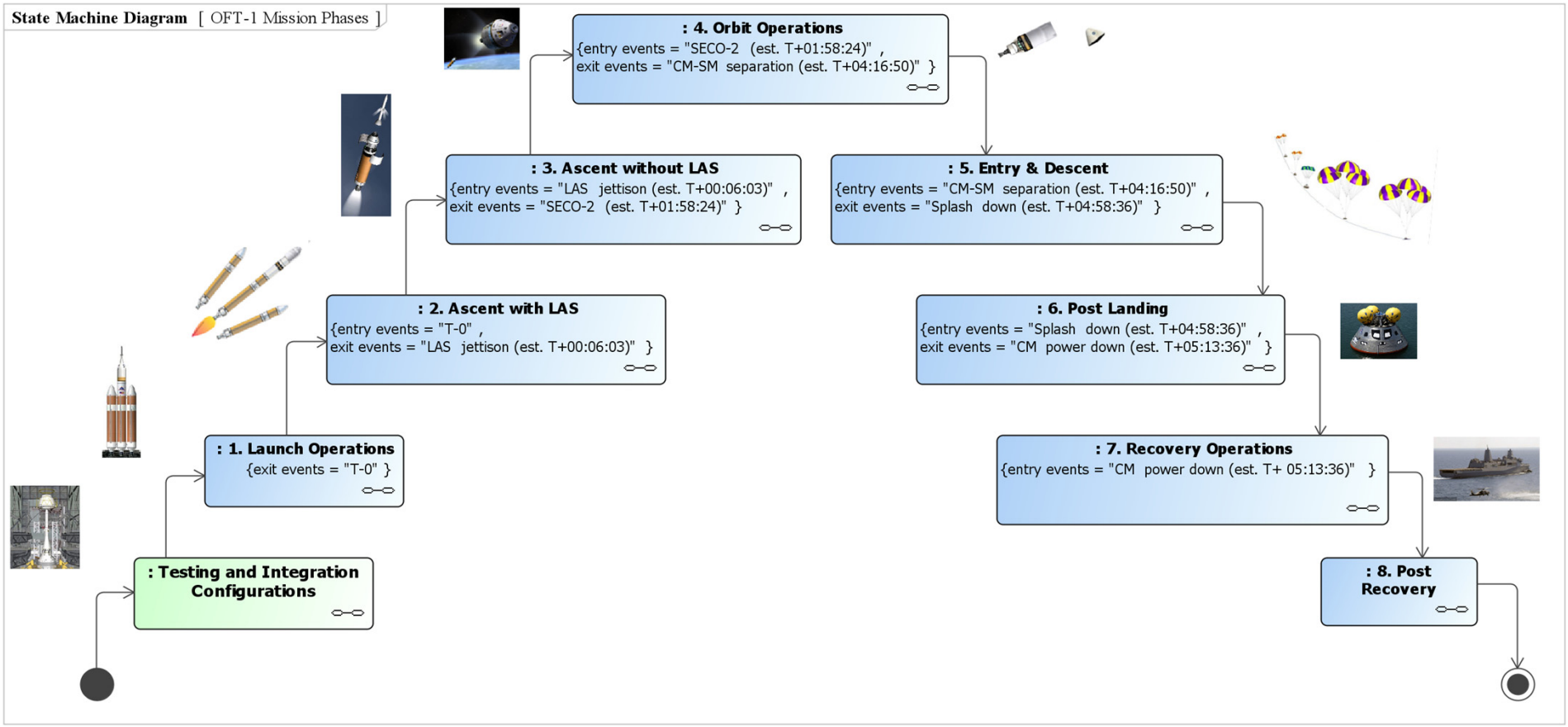
Driving: There is something in this DRM that is "driving" the performance requirement of the element.
Example : Entry speeds for MPCV driven by NEO DRM.

Required: This element must be present to accomplish this DRM.
Example : SEV required for Full Capability NEO, but not for other DRMs

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

OFT-1 End-to-End Information System Architecture



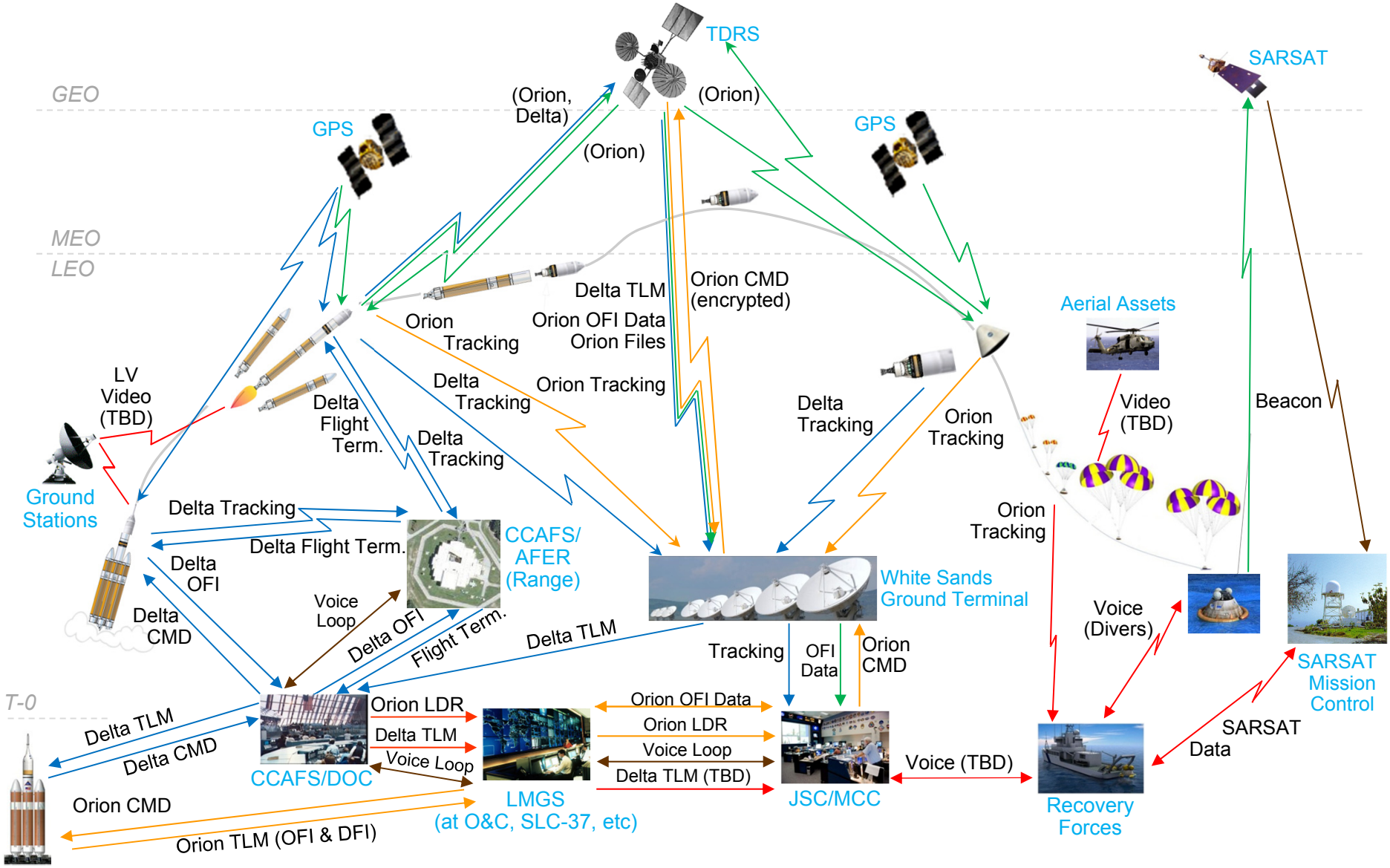
JPL specializes in the system engineering of end-to-end information systems, enabling breakthroughs for multi-element interoperability

National Aeronautics and Space Administration

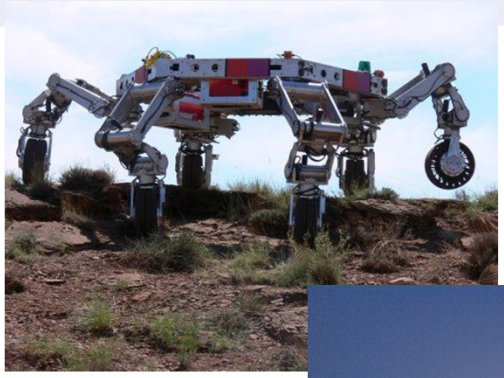
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

OFT-1 High-Level Mission View

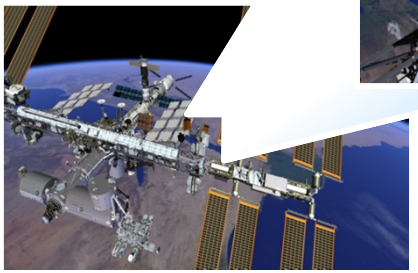
(notional 8/15/2011 version)



FY11-12 JPL HEOMD engagement



- **HSF Architecture**
  - Mars Destination Co-Lead
  - Solar Electric Propulsion Element Lead
  - Robotic Systems Support
- **Program to Program Integration**
  - Development of systems-of-system data architecture
- **MPCV**
  - Development of OFT-1 EEIS architecture
  - Engineering of Thermal Protection System
  - Parachute System drogue chute wind tunnel testing
- **ISS Payloads**
  - Optical Testbed and Integration on ISS eXperiment (OpTIIX)
  - Materials on ISS Experiment X (MISSE-X)
  - ISS Vehicle Cabin Atmosphere Monitor
  - Electronic Nose (ENOSE) - contamination detector

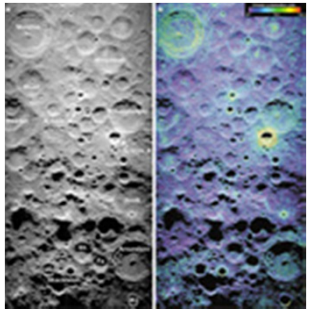


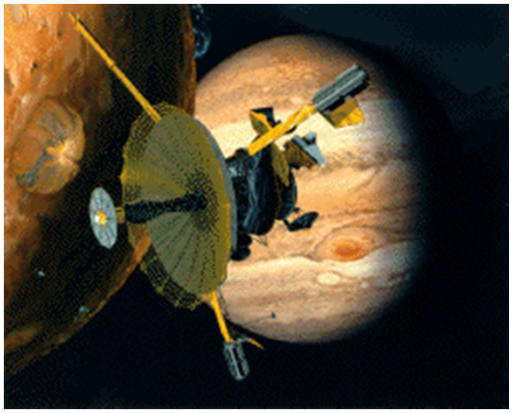
FY11-12 JPL HEOMD engagement

- **Potential ISS Payloads**
  - Evolvable HD Imaging Testbed
  - GigaBit Laser Communications Testbed
  - OCO-3 (in preformulation with JSC as a partner)
  - Scatterometer Testbed
- **Advanced Exploration Systems**
  - Atmosphere Resource Recovery for Long Duration Exploration
  - Spacecraft Fire Safety Demonstrations
  - Autonomous Landing and Hazard Avoidance (ALHAT)
  - Multi-Mission Space Exploration Vehicle Crew Mobility for In-Space and Surface Applications
  - Deep Space Habitat Definition and Subsystem Maturation
  - Logistics Reduction and Repurposing
  - AES / 4-m Resolution Goldstone Radar Imaging of NEOs
- **Mission Operations Directorate (MOD)**
  - Core Trajectory System
  - Next Generation Planning System

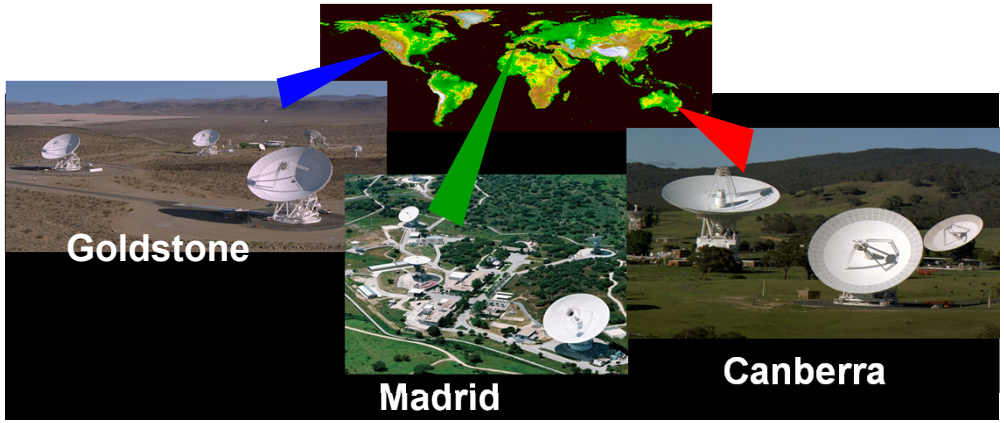
JPL Career Path

- **Started career at JPL as an Academic Part Time (APT)**
- **Developed software for Deep Space Network (DSN) telecommunications systems**
  - Planetary Radar





  - DSN Galileo Telemetry Processor



JPL Career Path

- **Performed ground data system engineering for multiple flight projects in various stages of the project life cycle (phases A – E)**
  - Mars Global Surveyor (flight operations)
  - Mars Climate Orbiter/ Mars Polar Lander (devel.)
  - Stardust (development and flight operations)
  - Genesis (development)
  - Europa Orbiter (concept)
  - Space Interferometry Mission (preliminary design)
  - Mars Volcanic Emission Life Scout (MARVEL - proposal Step 2)

Essentials to Success

- **…then transitioned to the Constellation Program**
  - Throughout the past six years have held a handful of exciting positions

- **Essentials to success**
  - Build a solid experience base in area of expertise
    - Find a system in development and stick with it until the end (if you can…at least once)
    - Patience is definitely a virtue
    - Not only do you learn a technical area well, but you learn how to deal with people and issues (not everything goes as planned)
  - Be willing to work outside your comfort zone
    - Transitioning to the Human Space Flight program is a perfect example
    - There have been many times where I've asked myself "what did I just sign up for"
      - But I have no regrets
    - Every new task is a learning opportunity

Essentials to Success

- **Essentials to success**
  - Human Space Flight is affected by many factors
    - Politics
    - Budget
    - Public opinion
    - …and individuals who just want to do the right thing
    - Remain flexible and open to change (take opportunities when they present themselves)
  - Respect the talent at each of the NASA centers
    - Diverse experience base makes NASA, as a whole, stronger
    - Partnerships enable teams capable of addressing future challenges

JPL and HSF Recap

- **JPL is working with HEOMD to create the "Next Era" of its engagement with HSF:**
  - Innovative ideas, approaches and solutions to human space flight challenges
    - From mission formulation through hardware development to flight operations
  - An experienced cadre with multiple life cycles of both hands on/in house and contractor product delivery
  - A cadre that now has been engaged in the current HSF "community with staff familiar with HSF challenges
- **JPL brings a cadre with multiple missions, full life cycle experience to the table**
  - Concept to final shut down of operations
  - "System contract" and "hands on" modes