



NASA Systems Engineering: Challenges and Initiatives

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Systems Engineering Programs

NASA Headquarters, Office of the Chief Engineer



Purpose

- Discuss Challenges Facing NASA's Systems Engineering Community

and

- Addressing those Challenges





NASA's Vision



NASA's Vision

To reach for new heights and
reveal the unknown,
so that what we do and learn
will benefit all humankind.



NASA Resources and Missions

- Budget – FY '13 Plan
 - Total = \$17.7B
 - **Aero** = \$.5B
 - **Science** = \$4.9B
 - **Exploration** = \$3.9B
 - **Space Ops** = \$4B
 - Space Tech = \$.7B
 - Other = \$3.6B
- Workforce
 - Total = 17,813
 - 60% Engineering
 - 5% Scientist
 - 35% Other
 - Ten Field Centers
 - Four Facilities





NASA Centers and Facilities



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NASA Aeronautics



Fundamental Aeronautics Program

Integrated Systems Research Program



Airspace Systems Program



Aviation Safety Program

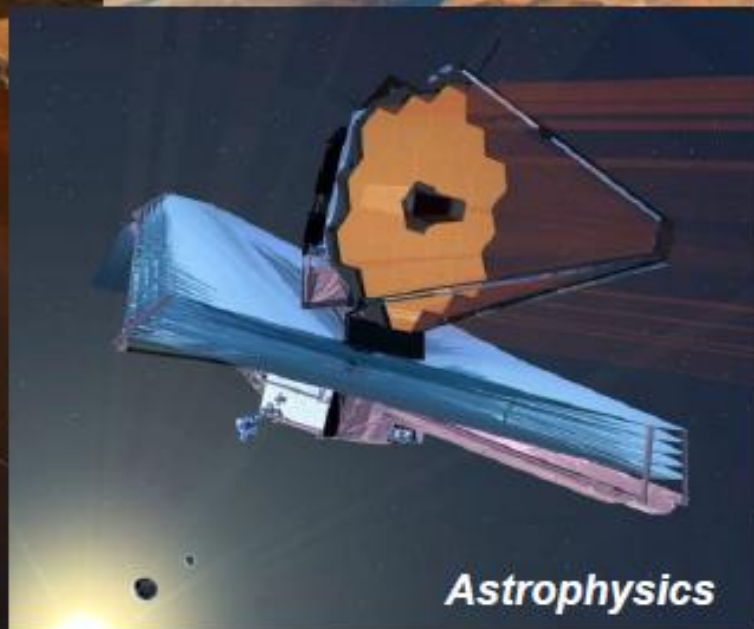
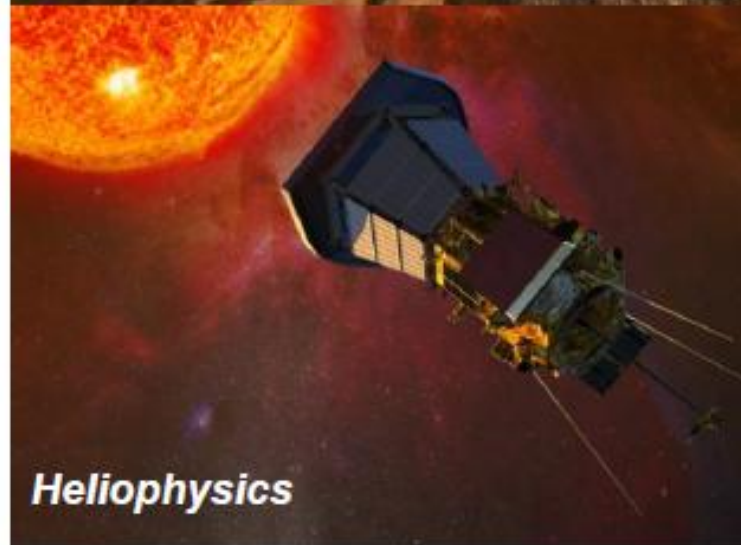
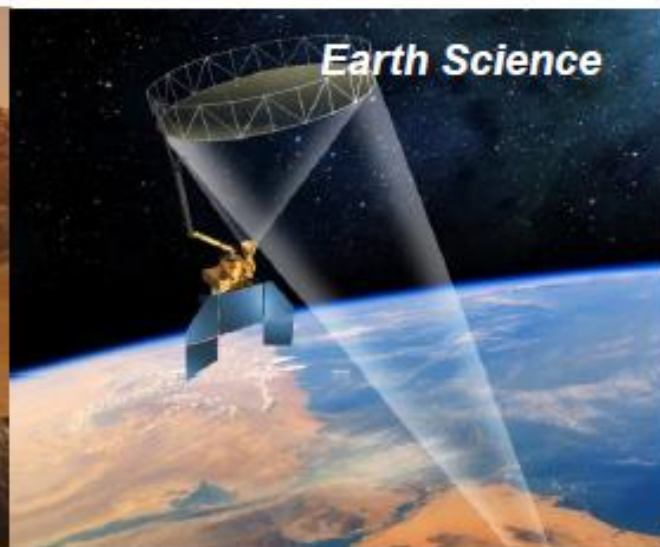


Aeronautics Test Program





NASA Science





Human Explorations & Operations

Space Life & Physical Sciences
Research & Applications Division

Advanced Exploration
Systems

International Space
Station

Launch Services
Program

Commercial Spaceflight
Development

Human Spaceflight
Capabilities

Space Communication &
Navigation

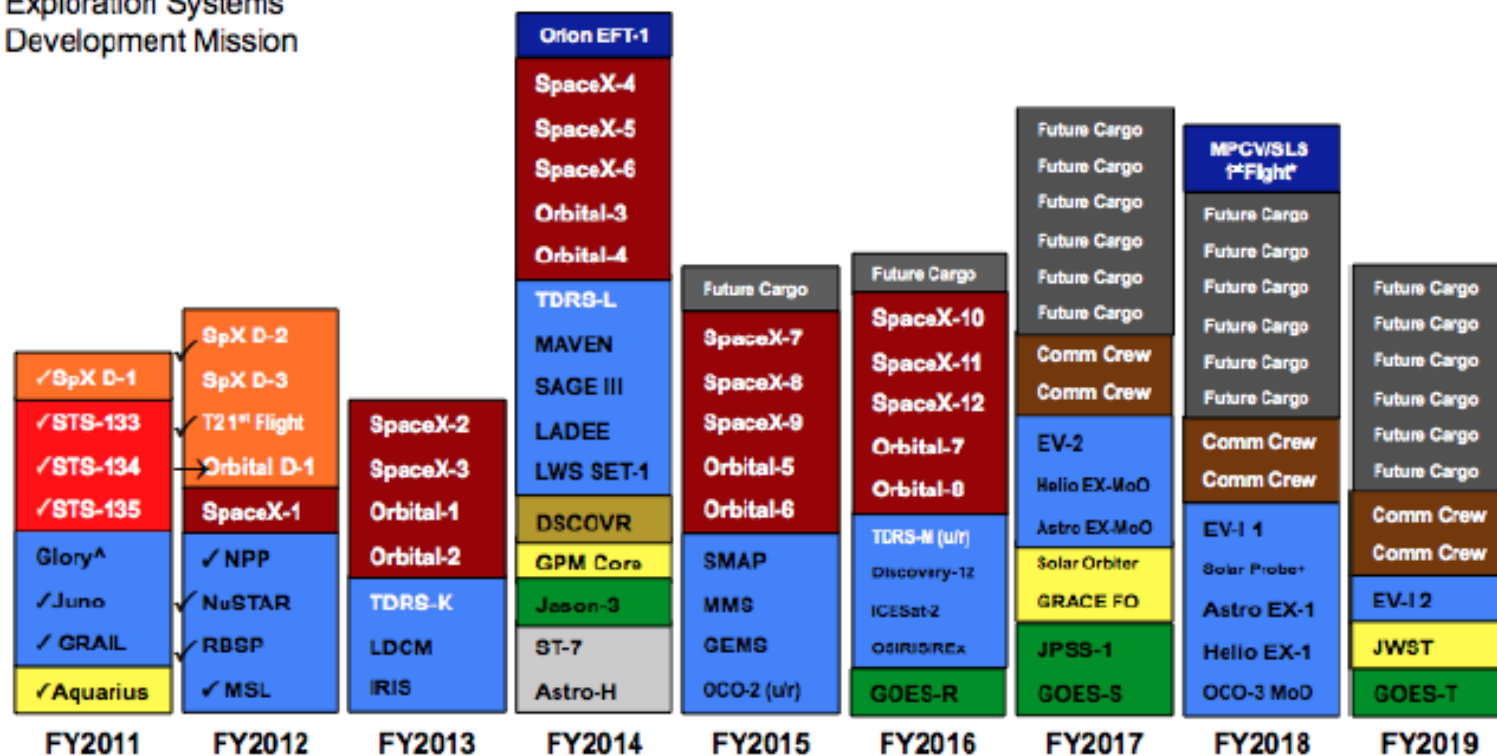
Architecture & Analysis

Exploration Systems





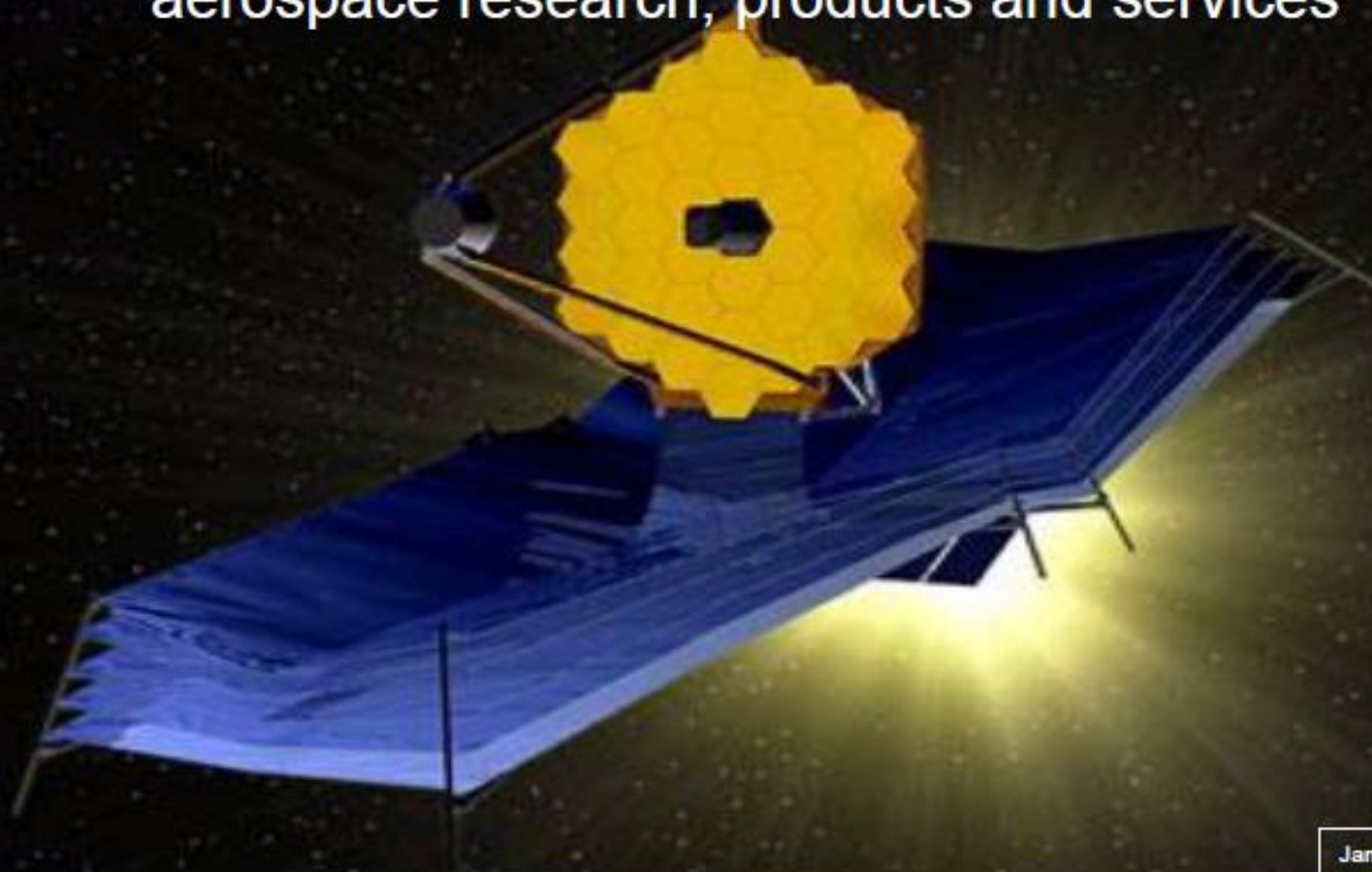
NASA Mission Launches: FYs '11-'19





NASA's Systems Engineering Vision

A premier Systems Engineering capability widely recognized for its leadership and expertise in the engineering of systems and subsystems to enable NASA to provide leading edge aerospace research, products and services



James Webb Space Telescope



Systems Engineering Approach

- NASA has developed and implemented best practices that constitute an updated approach to systems engineering to be used for all NASA missions
- Our approach: Learn from Our and Others' Experience
 - Develop and employ the best SE practices, tools and methods
 - Lessons learned
 - Knowledge capture and transfer
 - Benchmark
 - Systems Engineering Leadership Development Program
 - Mentoring





Engineering of Complex Systems

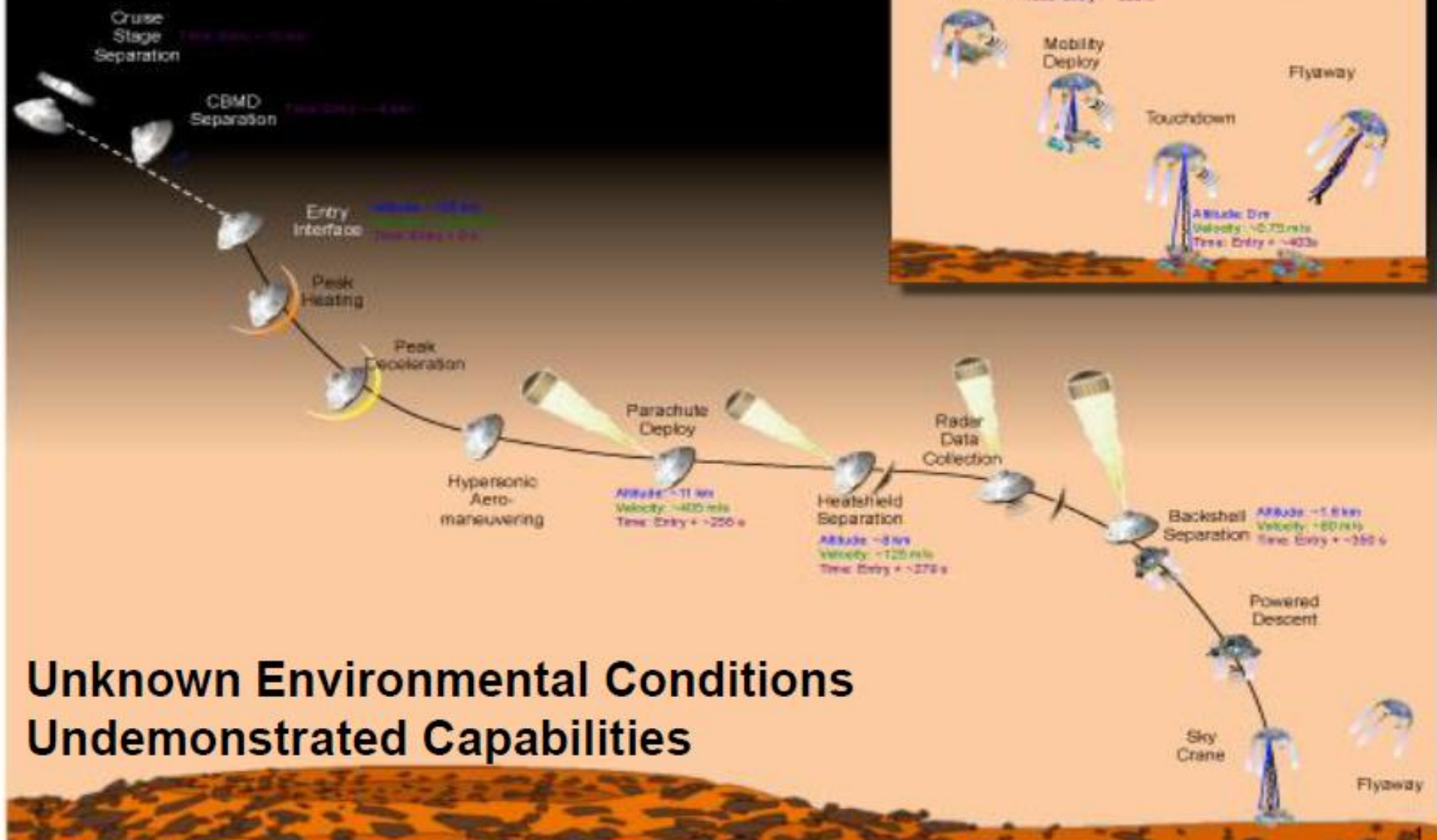


- End-to-End Design Architecture
- Integration
- Man-Machine Interface
- Legacy/Heritage Systems
- Multi-Decadel/Generational Life
- System Monitoring
- Unknown Risks and Second/Third Order Effects
- Collaboration



Example: MSL Entry/Descent/Landing

"7 Minutes of Terror"



Unknown Environmental Conditions
Undemonstrated Capabilities



Example: Earth to Mars

Enabling Capabilities

- Beyond Earth Orbit Crew and Cargo Access
- In-space Propulsion
- Ground Operations
- In-Space Operations
- Long-Duration Habitation
- Mobile Exploration Module
- EVA Systems
- Precursor Robotics
- Human-Robotic Interfaces
- Destination Systems





Engineering Complex Systems: NASA Status

- Current State:
 - Developing Systems with Traditional SE Processes and Tools
 - Some Programs and Projects are Introducing Model-Based Engineering
- Initiatives:
 - NASA Integrated Model-Centric Architecture
 - Model-Based Systems Engineering and PP&C
 - PDLM
 - Training
 - Benchmarking
 - Inter-Agency Working Group
 - Common Understanding of Problems
 - Identified Need to Collaborate, Share Expertise and Resources
 - Early Formation Phase



Summary

- **Systems Engineering is Strong and Pervasive**
- **Future Missions Create BIG Challenges**
- **Collaborative Approach to Tackling the BIG COMPLEX PROBLEM is a MUST**

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