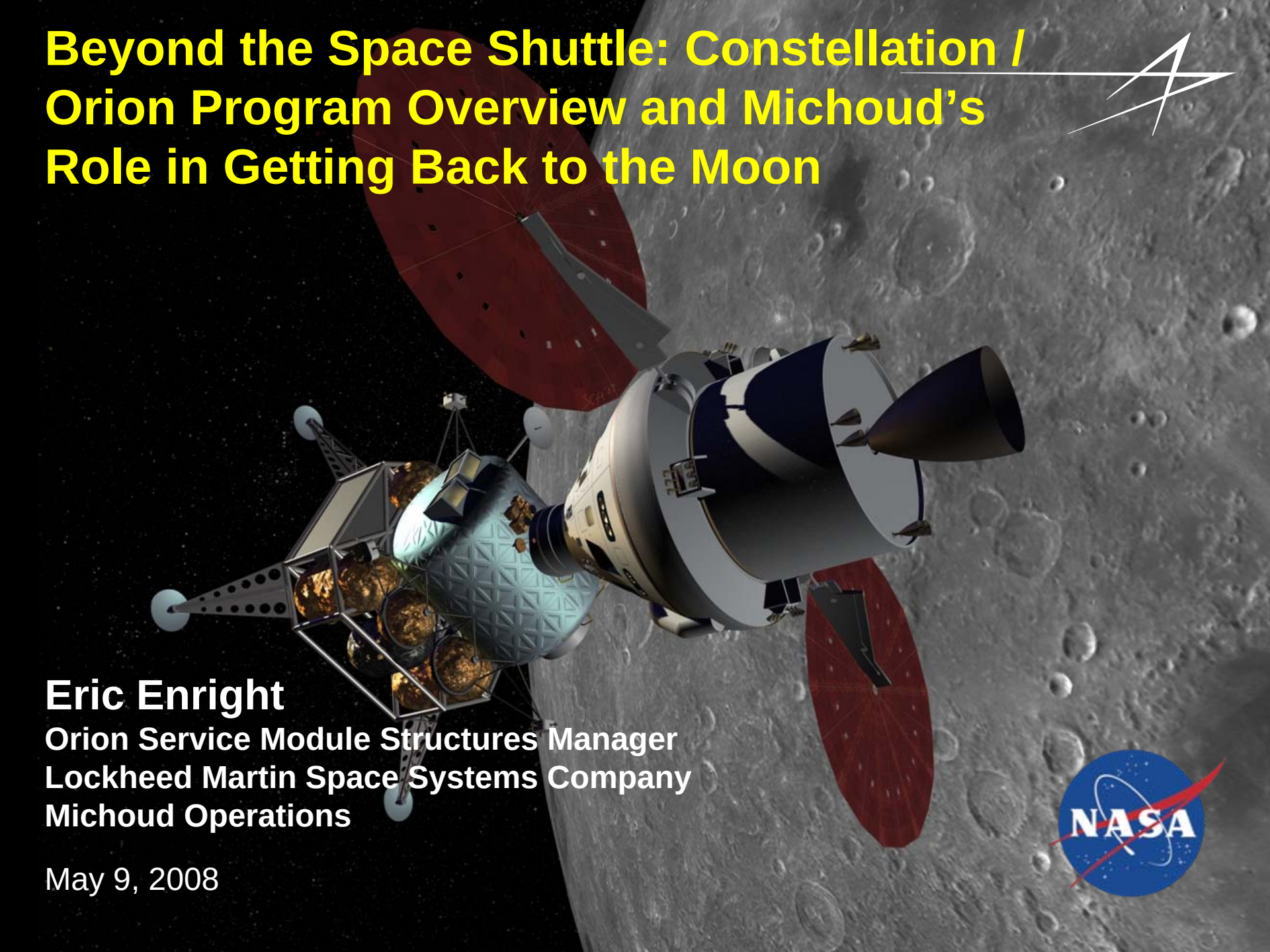
Beyond the Space Shuttle: Constellation / Orion Program Overview and Michoud's Role in Getting Back to the Moon



Eric Enright
Orion Service Module Structures Manager
Lockheed Martin Space Systems Company
Michoud Operations

May 9, 2008

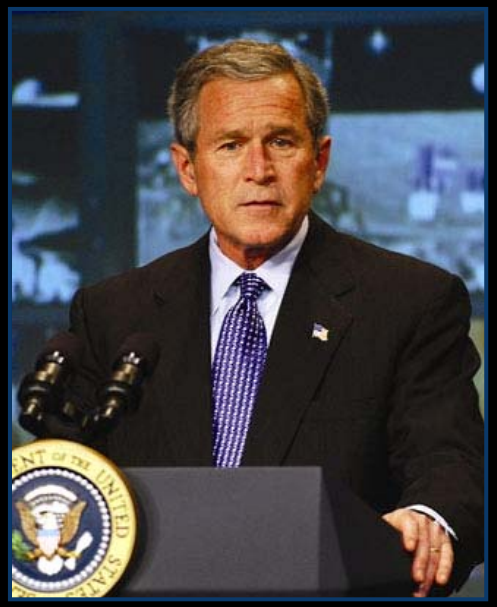
Vision… the Future of Space Exploration

- ***A Renewed Spirit of Discovery: The Vision for Space Exploration***

- **Announced January 14, 2004**
  - **To advance scientific, security, and economic interests through a robust space exploration program.**

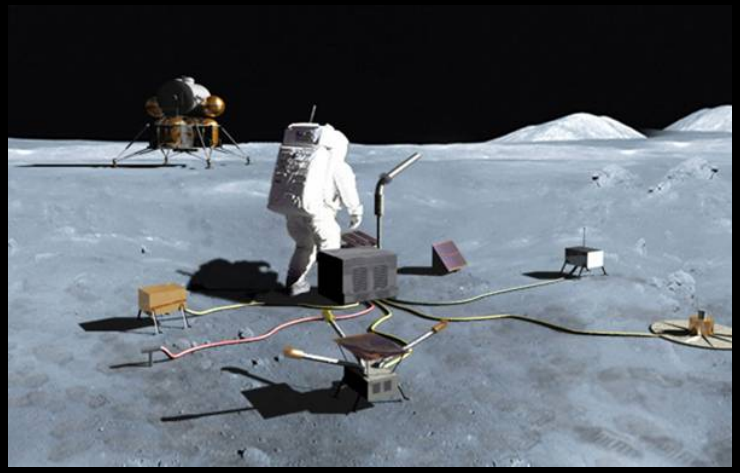
- **NASA's Constellation Program established to implement sustained and affordable human exploration of the moon and Mars**

CONSTELLATION



Direction… the Future of Space Exploration

- **Complete the International Space Station**
- **Safely fly the Space Shuttle until 2010**
- **Develop and fly the Crew Exploration Vehicle no later than 2014**
- **Return to the Moon no later than 2020**
- **Extend human presence across the solar system and beyond**
- **Implement a sustained and affordable human and robotic program**
- **Develop supporting innovative technologies, knowledge, and infrastructures**
- **Promote international and commercial participation in exploration**



NASA Authorization Act of 2005

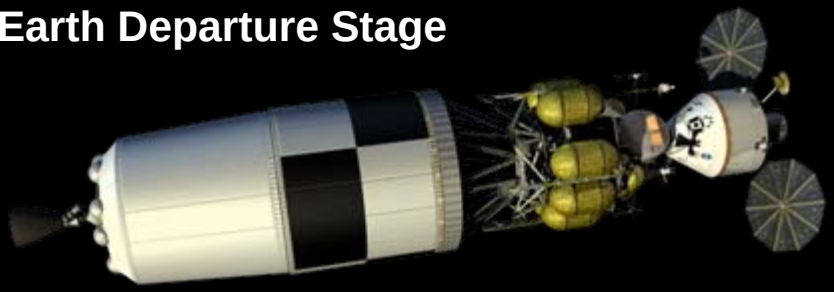
The Administrator shall establish a program to develop a sustained human presence on the Moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations.

Themes… the Future of Space Exploration

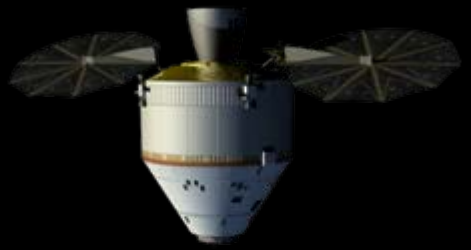
- Use the Moon to prepare for future human and robotic missions to Mars and other destinations
- Project sustained human influence to the moon to enable eventual settlement
- Expand Earth's economic sphere to encompass the Moon and pursue lunar activities with direct benefits to life on Earth
- Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them
- Strengthen existing and create new global partnerships
- Engage, inspire, and educate the public

Components… the Future of Space Exploration

Earth Departure Stage

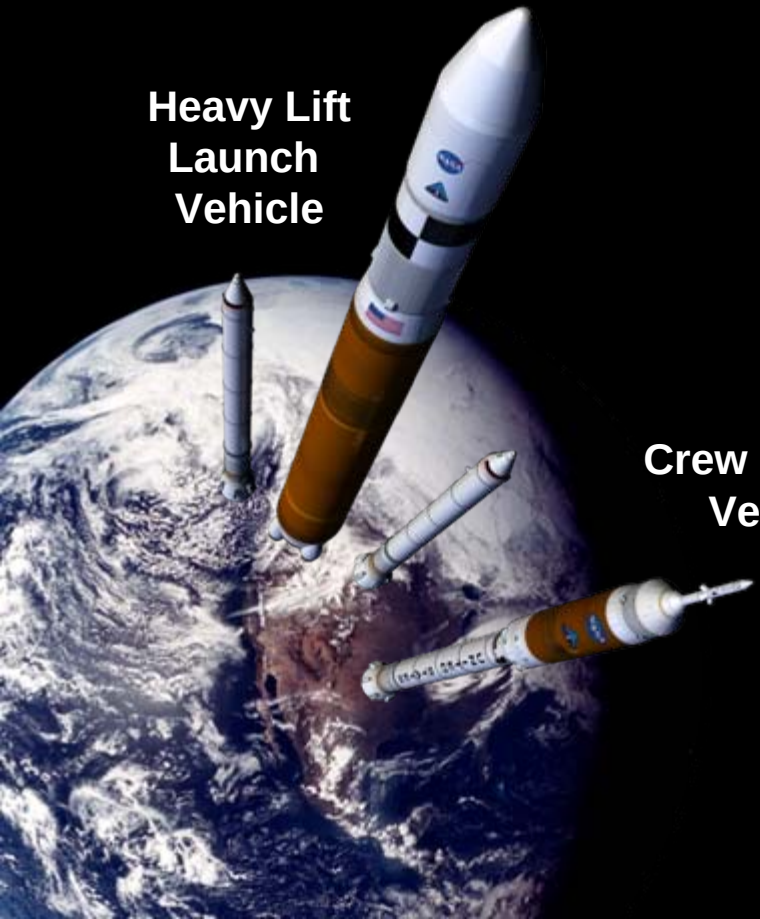


Orion - Crew Exploration Vehicle



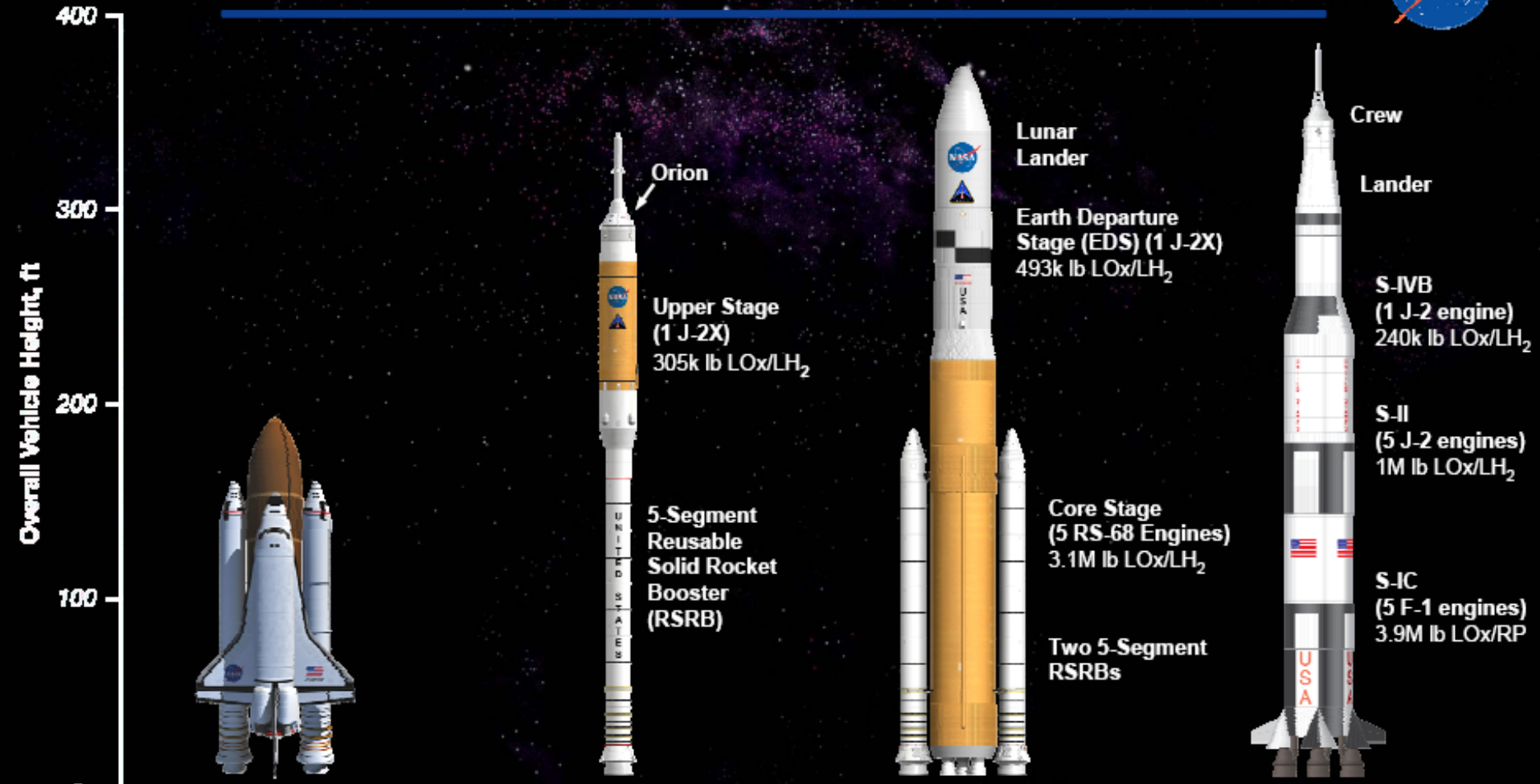
Heavy Lift Launch Vehicle

Crew Launch Vehicle



Lunar Lander

Building on a Foundation of Proven Technologies
– Launch Vehicle Comparisons –



Space Shuttle
Height: 184.2 ft
Gross Liftoff Mass: 4.5M lb

55k lbm to LEO

Ares I
Height: 328 ft
Gross Liftoff Mass: 2.0M lb

52k lbm to LEO
(effective)

Ares V
Height: 362 ft
Gross Liftoff Mass: 7.3M lb

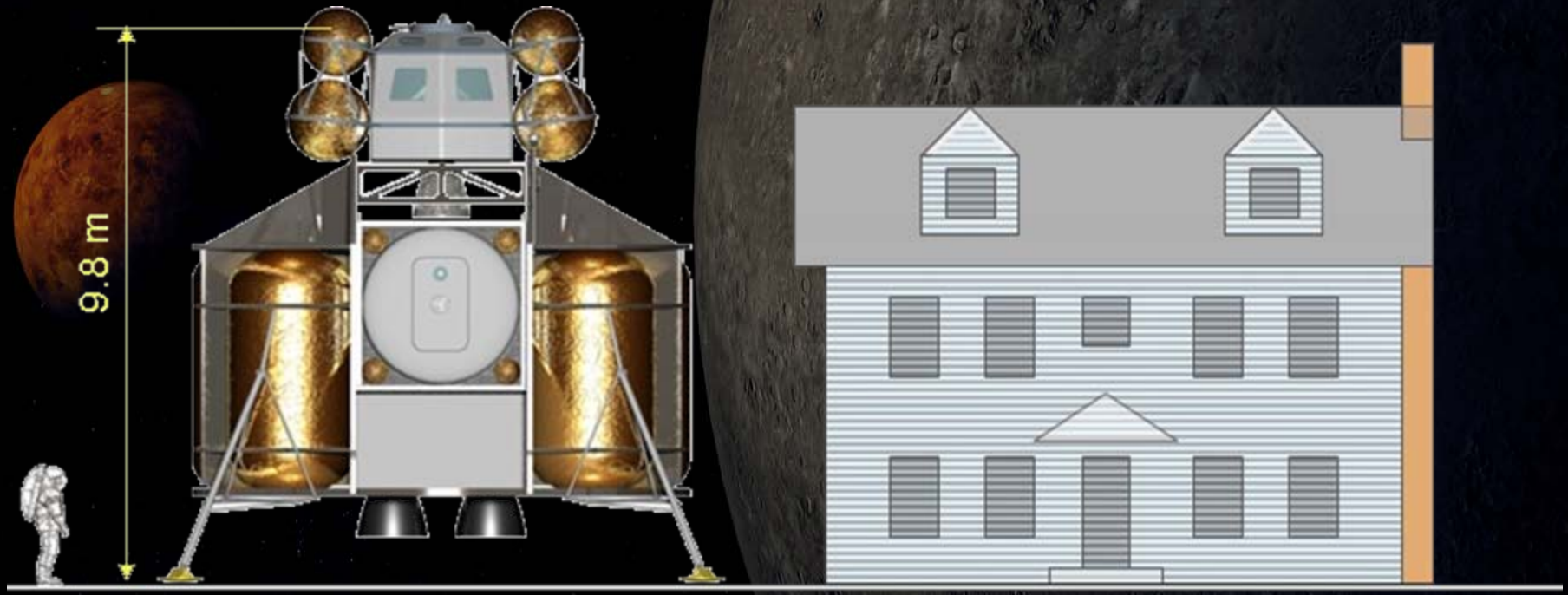
133-144k lbm* to TLI in Dual-Launch Mode with Ares

Saturn V
Height: 364 ft
Gross Liftoff Mass: 6.5M lb

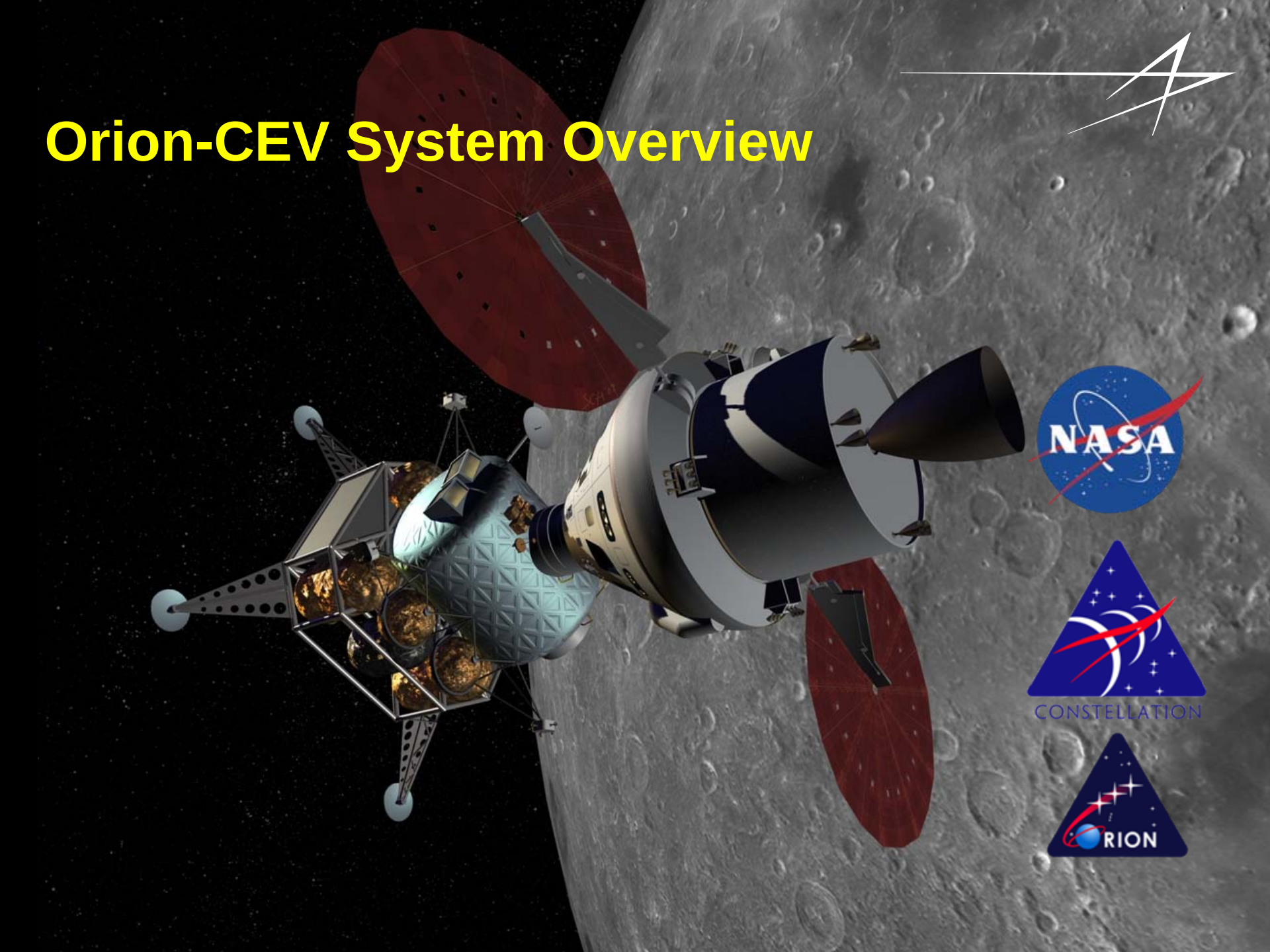
99k lbm to TLI
262k lbm to LEO

**Note: Depending on length of on-orbit LEO loiter time*

Perspective
This is not Apollo

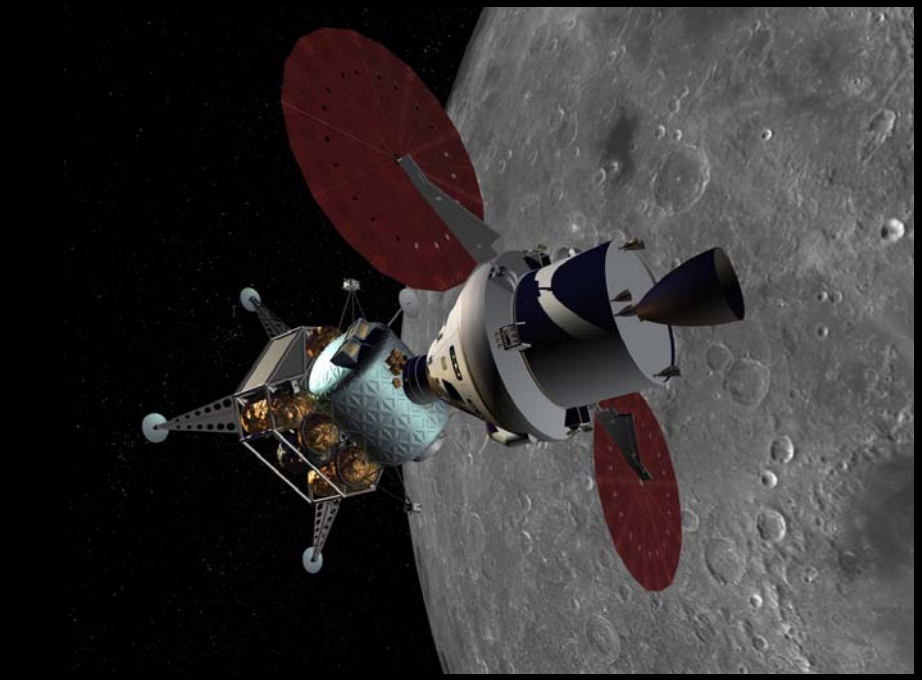


Orion-CEV System Overview



Orion … the Future of Space Exploration

- Orion is the next generation crew piloted spacecraft
  - Human access to Low Earth Orbit …
  - … and to the Moon and Mars



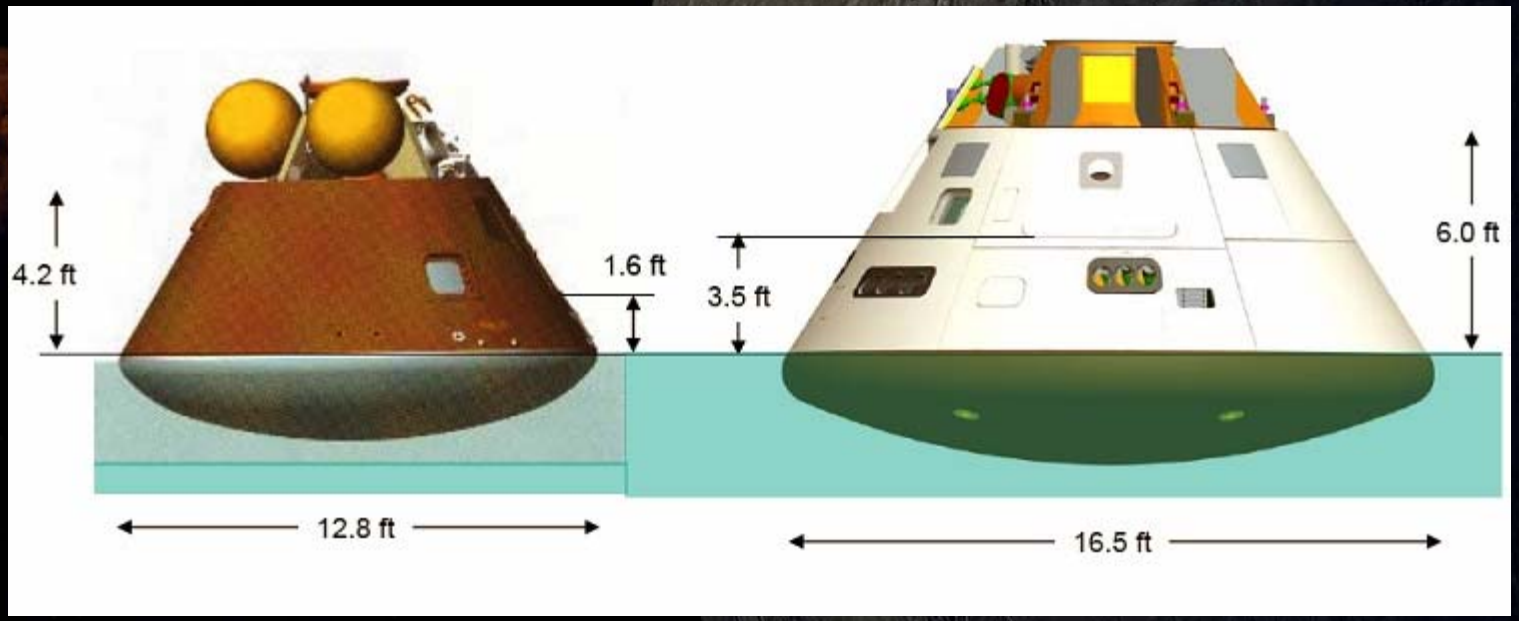
- We have an exciting path to bring Orion to meet the mission
  - Finalize requirements
  - Mature the technology
  - Design the Systems and Modules
  - Produce the hardware and software
  - Test the Systems
  - Prepare for first flight operations

Orion - Crew Exploration Vehicle

- **A blunt body capsule is the safest, most affordable and fastest approach**
  - Separate Crew Module and Service Module configuration
  - Vehicle designed for lunar missions with 4 crew
    - Can accommodate up to 6 crew for Mars and Space Station missions
  - System also has the potential to deliver pressurized and unpressurized cargo to the Space Station if needed

- **5 meter diameter capsule scaled up from Apollo**
  - Significant increase in volume
  - Reduced development time and risk
  - Likely increased landing stability

Capsule Comparison

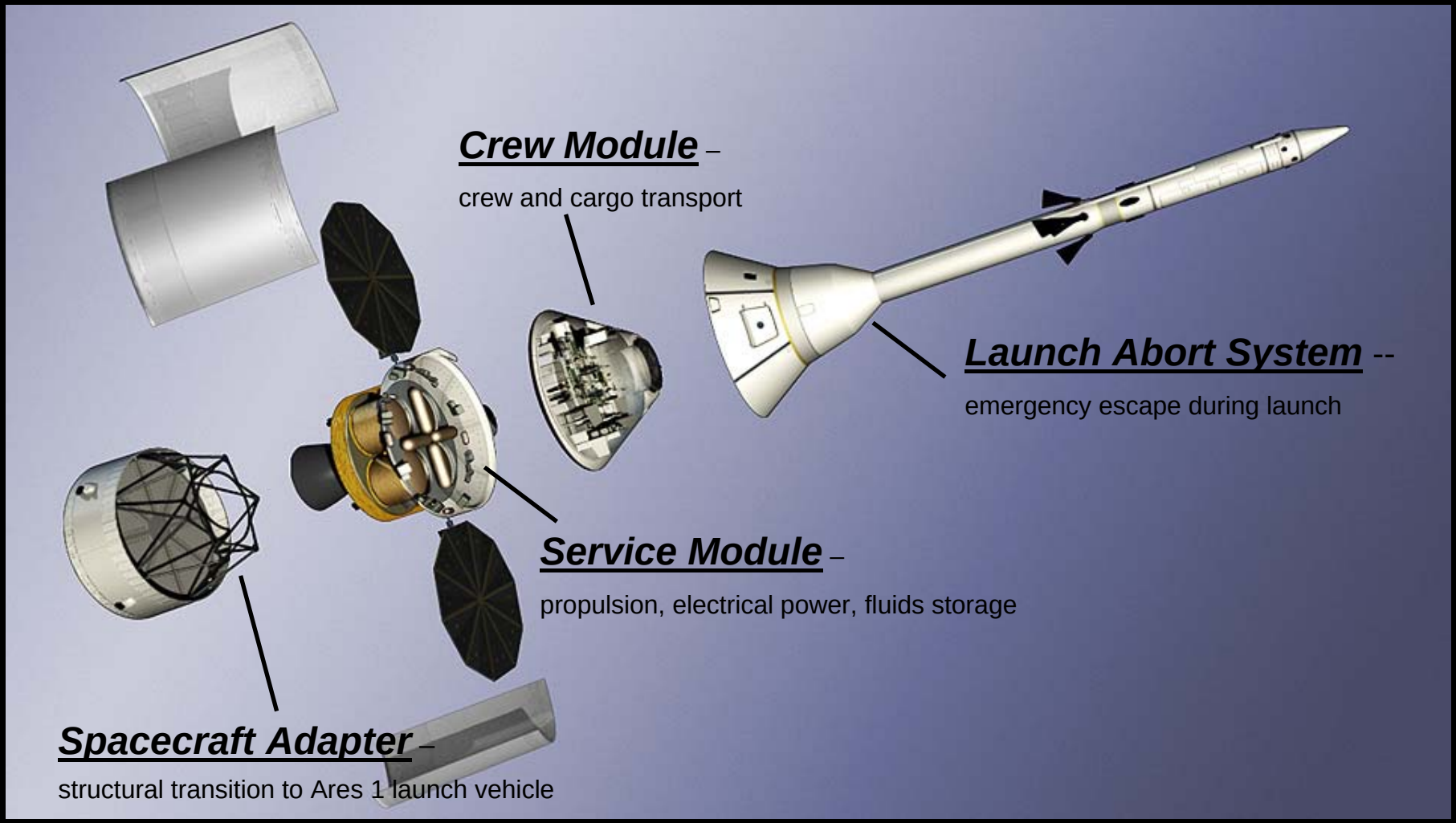


Apollo Diameter: 3.9M

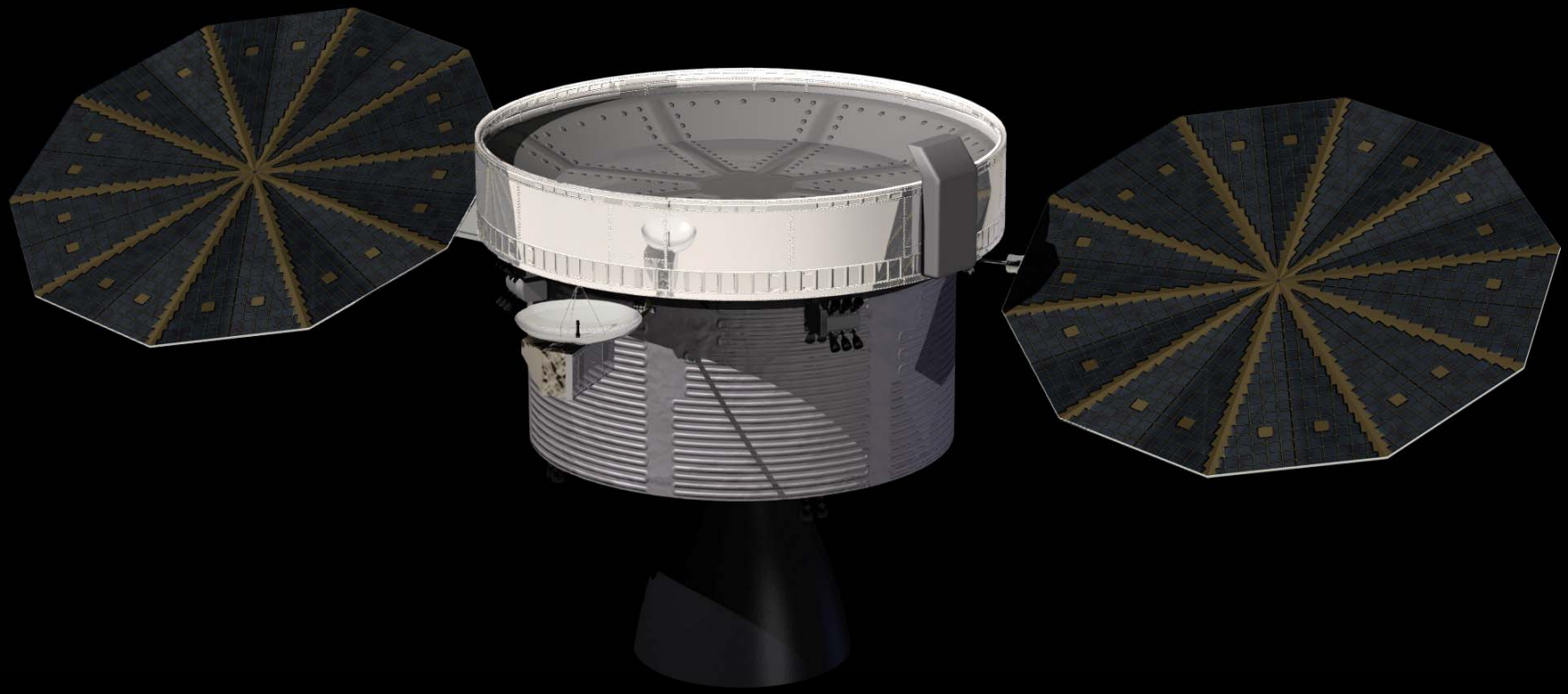
Orion Diameter: 5.0M

Orion Stack Configuration

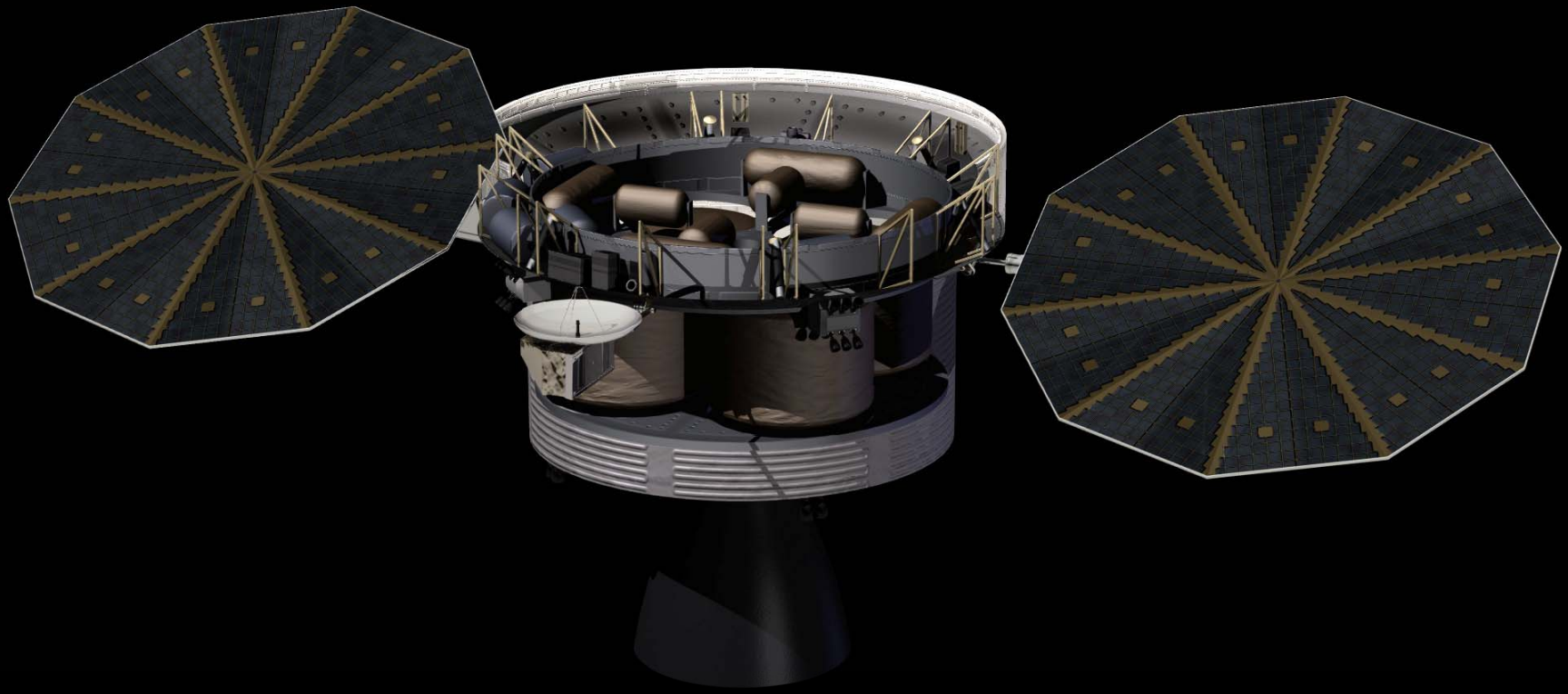
Orion-CEV Expanded View



Service Module



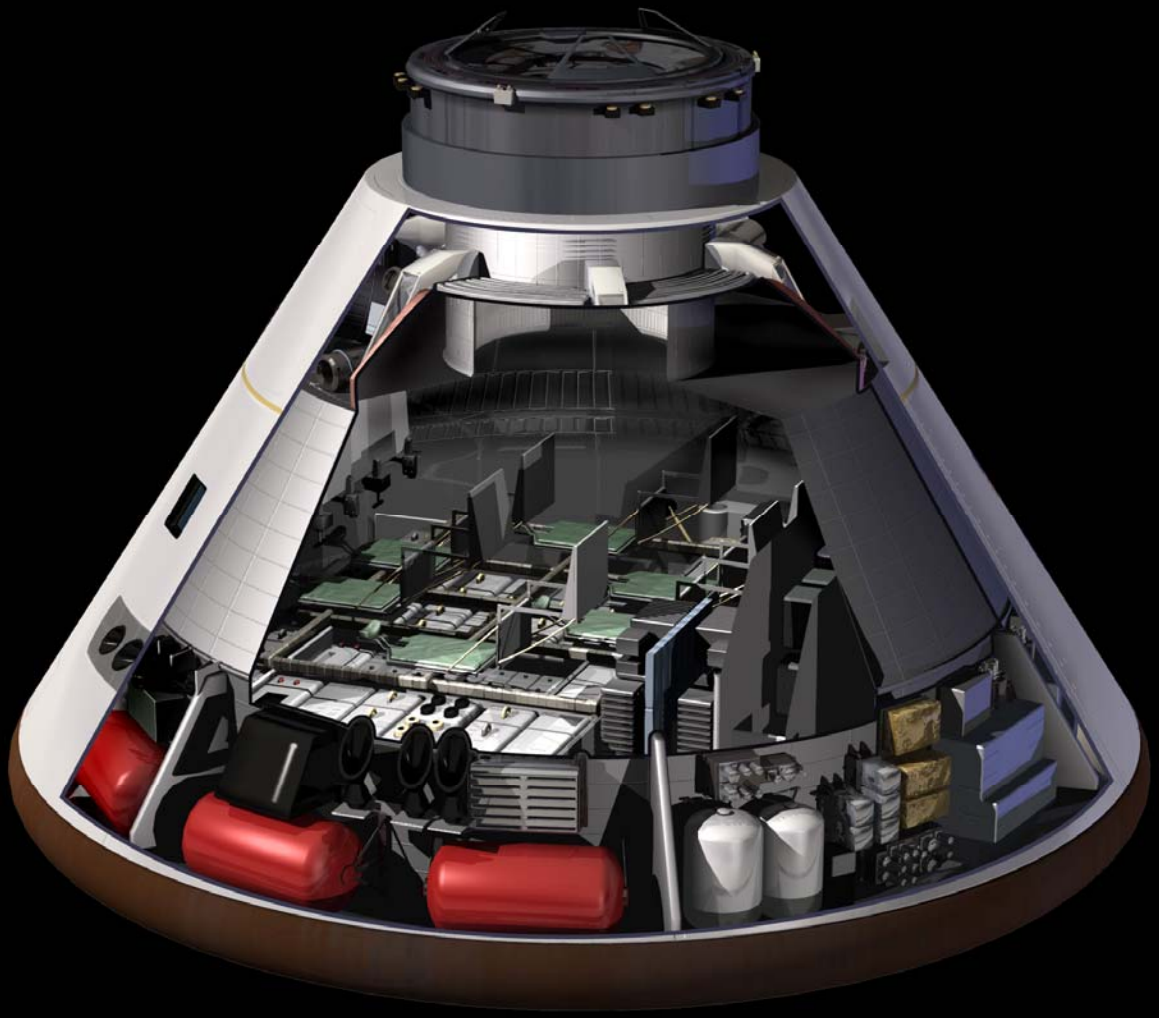
Service Module



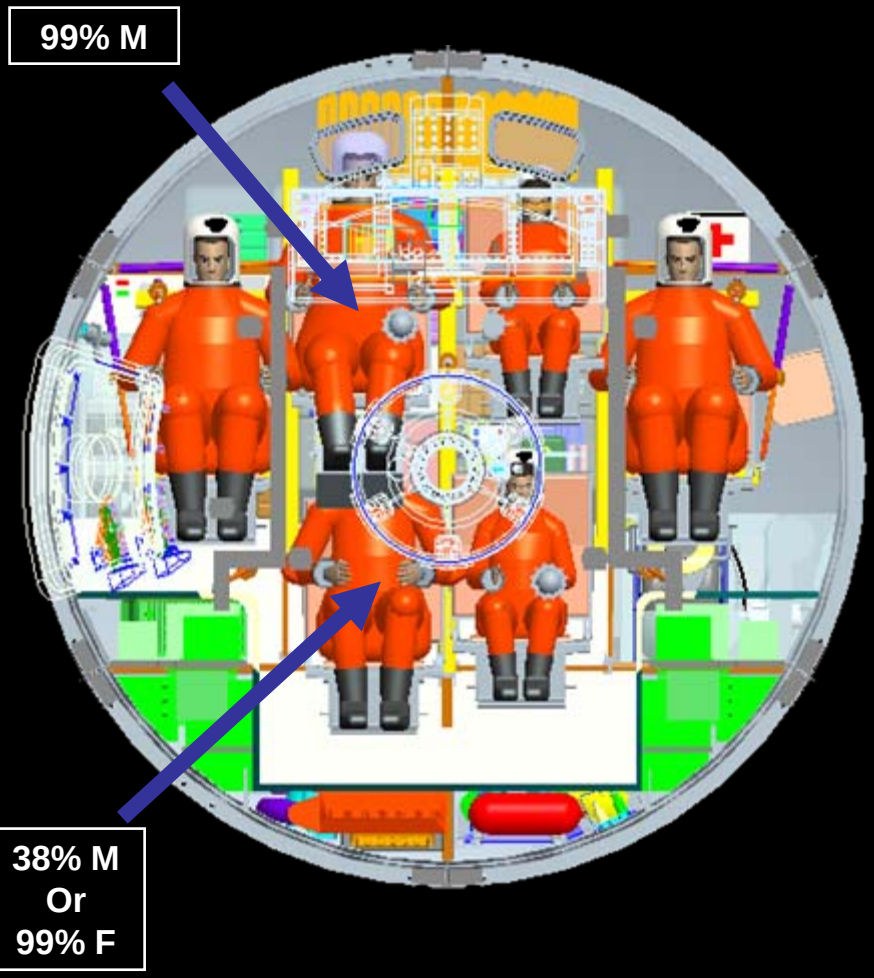
Crew Module

Crew Module

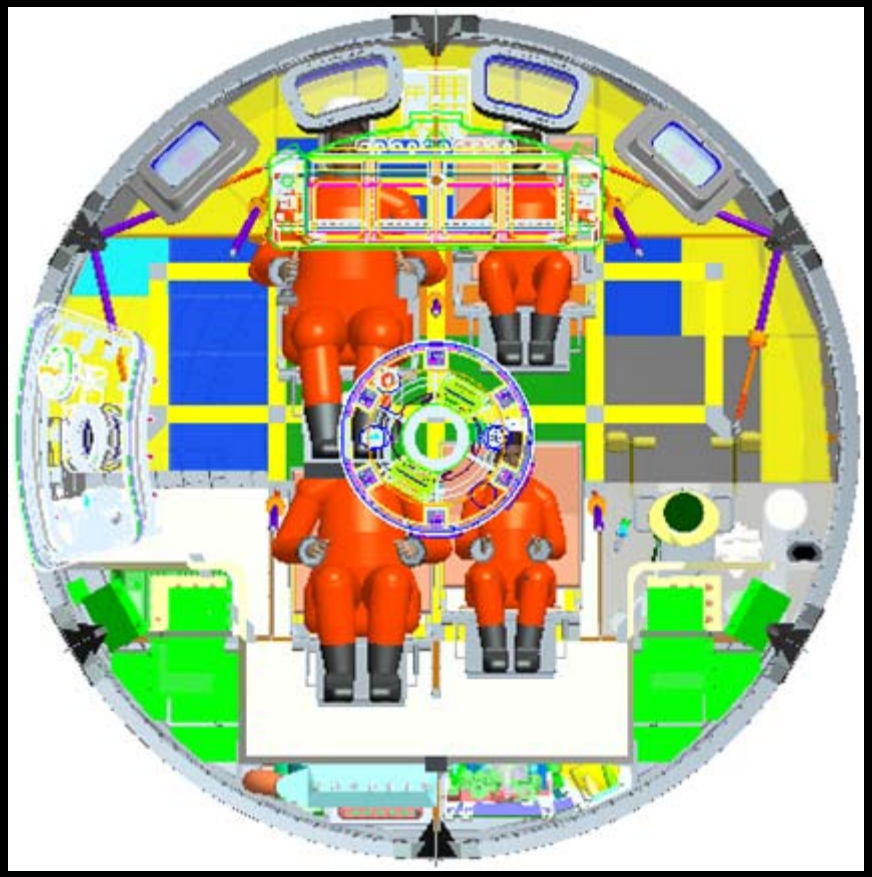
Crew Module



Crew Orientation for ISS

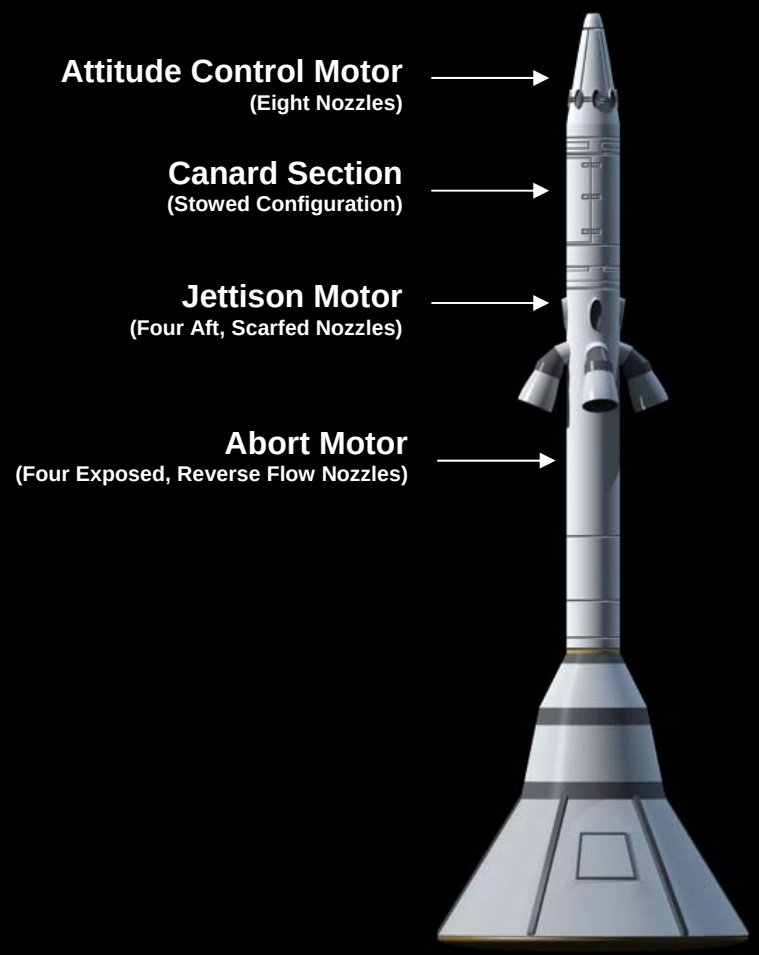


Block 1 -- ISS



Block 2 -- Lunar

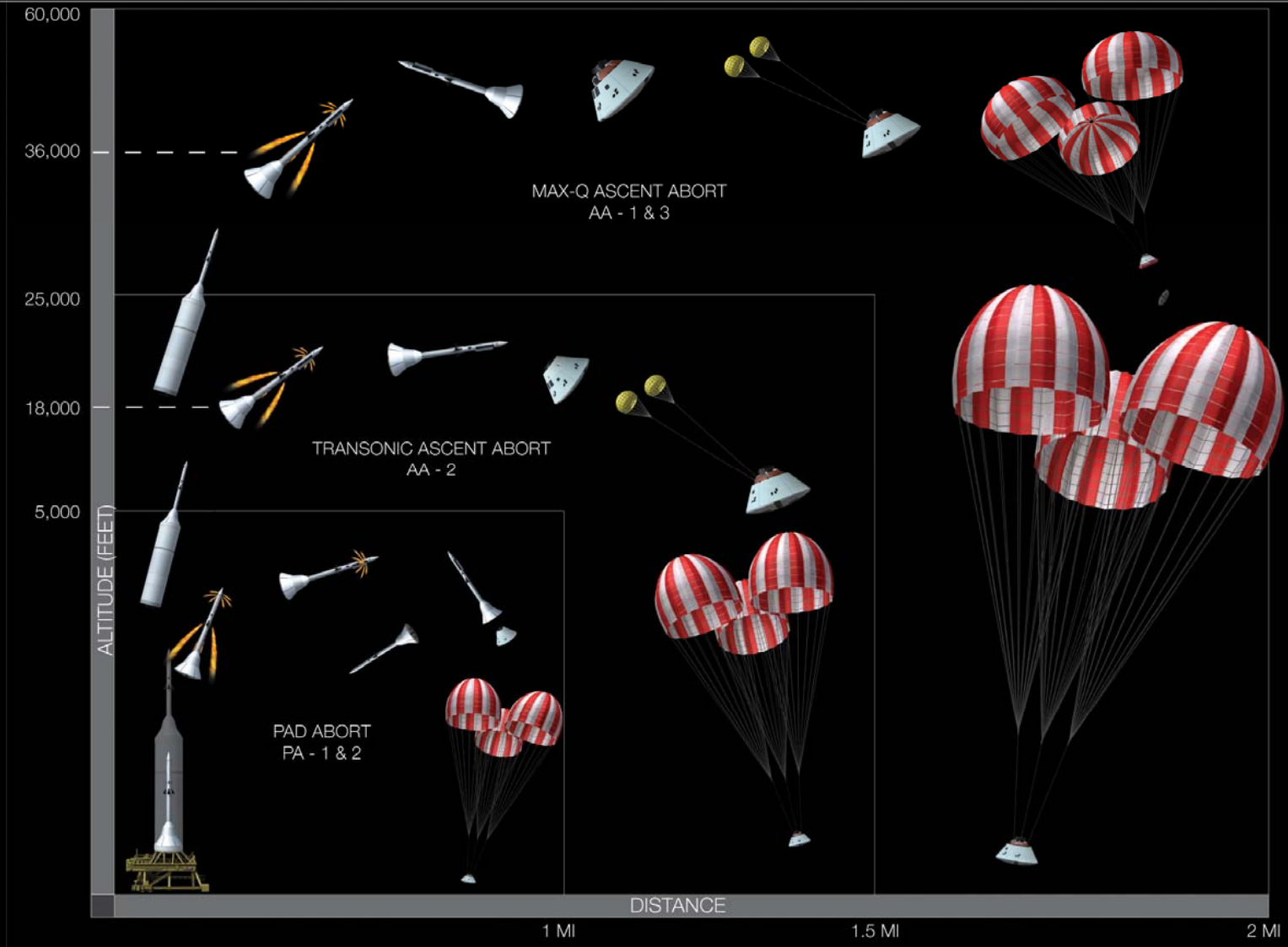
Launch Abort System Evolution



Current
Launch Abort System

Alternate Design
Launch Abort System

Orion Abort Flight Test Program Overview



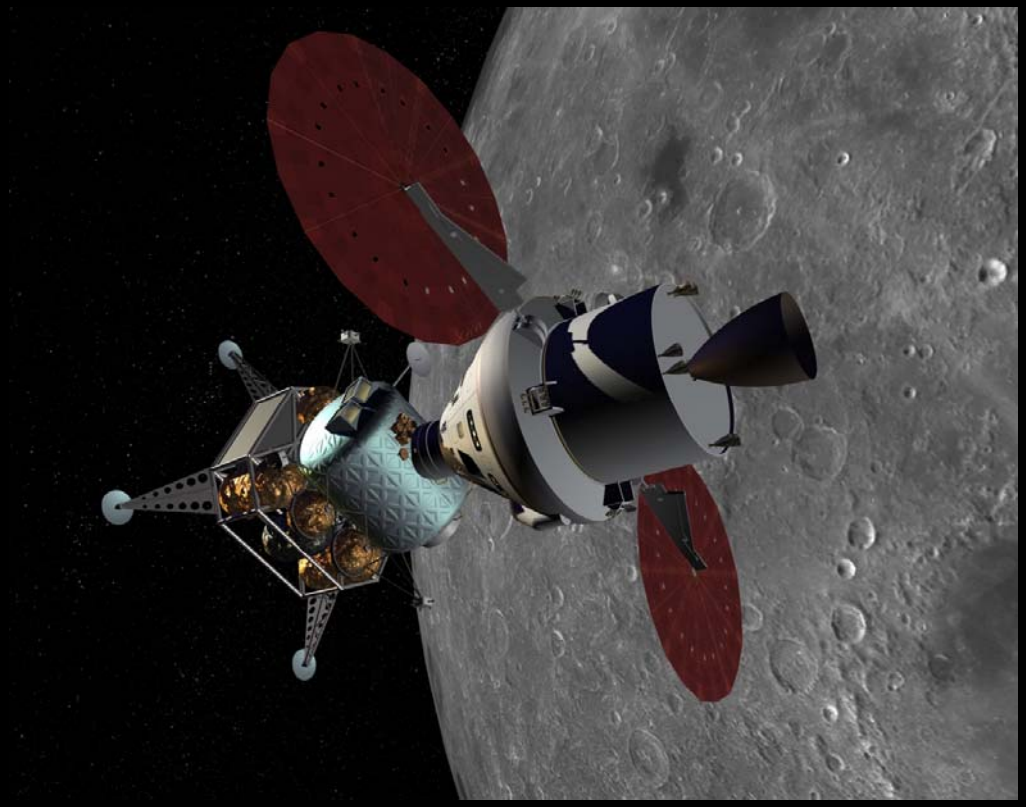
Orion Pad Abort #1 (PA-1) Flight Plan

Orion Earth Orbital Mission

- Capable of supporting ISS missions
- Transport up to 6 crew members on Orion for crew rotation
- 210 day stay time
- Emergency lifeboat for entire ISS crew
- Deliver limited pressurized cargo for ISS resupply

International Space Station Mission

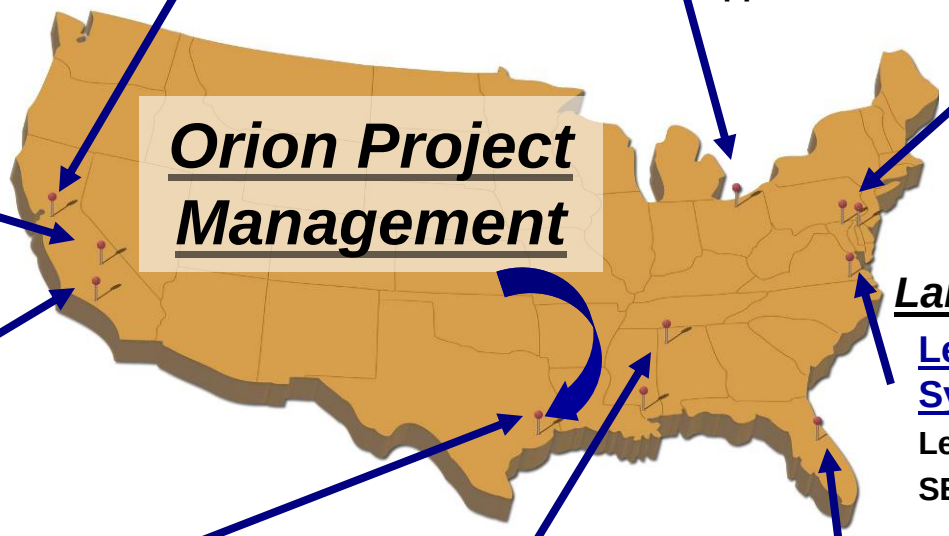
Orion Lunar Mission



- **Orion and Lunar Lander boosted to lunar orbit**
  - Up to 4 crew onboard
- **Lander descends to lunar surface**
- **Orion is uninhabited during lunar surface operations**
- **Lander upper stage returns to Orion in lunar orbit**
- **Orion returns crew to Earth**

Lunar Sortie Mission

Project Orion NASA Team



Ames

Lead Thermal Protection System ADP

Aero-Aerothermal database

Software and GN&C support

Glenn

Lead Service Module and Spacecraft Adapter integration

Flight Test Article "Pathfinder" fabrication

SE&I Support

Dryden

Lead Abort Flight Test Integ/Ops

Abort Test Booster procurement

Flight Test Article Devt/Integ

Goddard

Communications Support

JPL

Thermal Protection System support

Langley

Lead Launch Abort System integration

Lead landing system ADP

SE&I Support

Johnson

Lead Crew Module integration

Orion Spacecraft Integration

GFE projects management

Flight Test Program

Marshall

LAS and SM SE&I Support

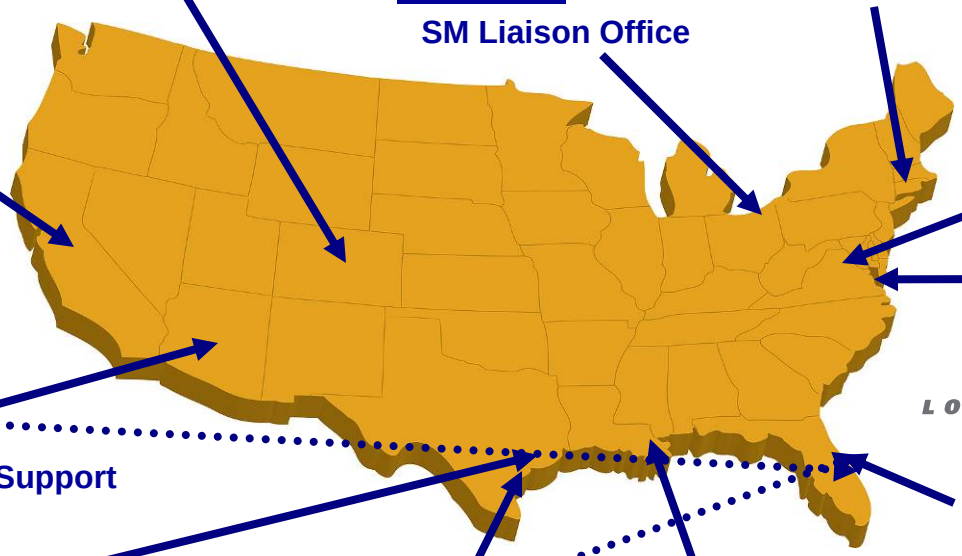
Kennedy

Ground processing

Launch operations

Recovery operations

Orion Lockheed Martin Industry Team



LOCKHEED MARTIN
Systems & Design Engineering Support

Hamilton Sundstrand
A United Technologies Company
Environmental Control & Life Support
Active Thermal Control
System Power Management

AEROJET
Propulsion

LM GRC
SM Liaison Office

Orbital
Launch Abort System
Safety & Mission Assurance

Honeywell
Avionics
Integrated System Health Management
Crew Interface
Mission Ground Ops Support

LM LaRC
LAS Liaison Office

LOCKHEED MARTIN
KSC
Final Assembly
Checkout
Acceptance Test
Sustaining Engineering
Spacecraft Refurbishment

LOCKHEED MARTIN
Program Management
Systems Integration
Crew Module Development
Service Module Development
Qualification Test
Software Development

USA
United Space Alliance
Operator Interfaces
Ground Processing
Mission Flight Planning
Software Development

LOCKHEED MARTIN
Michoud
CM and SM Structures

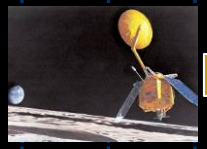
NASA's Exploration Roadmap

1st Human
Orion Flight

05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Initial Orion Capability

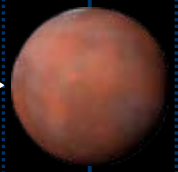
Lunar Outpost Buildup



Lunar Robotic Missions

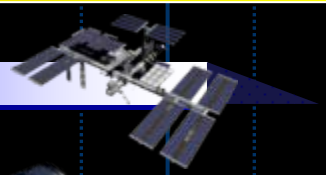
7th Human
Lunar
Landing

Science Robotic Missions

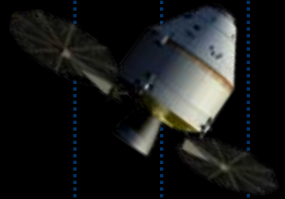


Mars Expedition Design

Commercial Crew/Cargo for ISS

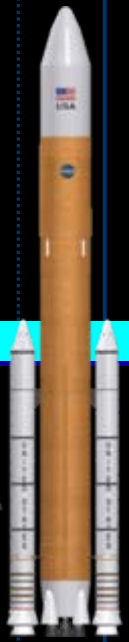


Space Shuttle Ops

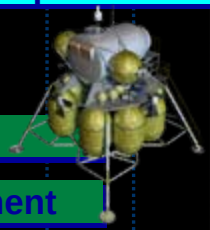


Orion Development

Ares Development



Orion Production and Operations



Early Design Activity

Lunar Lander Development

Lunar Heavy Launch Development

Earth Departure Stage Development

Surface Systems Development

Questions?