Constellation Program Overview

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Constellation Program Office

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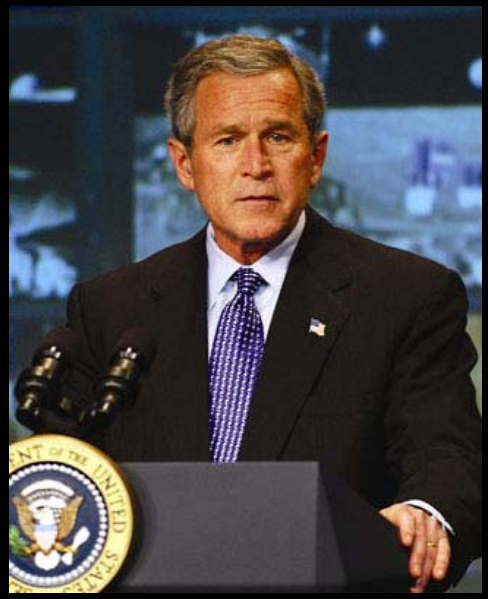
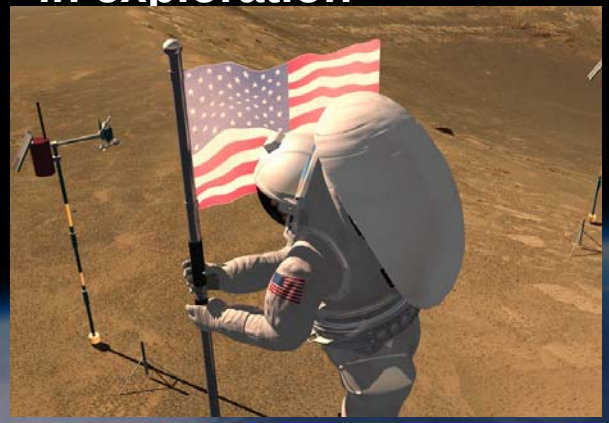
A Bold Vision for Space Exploration, Authorized by Congress

- **Complete the International Space Station**
- **Safely fly the Space Shuttle until 2010**
- **Develop and fly the Crew Exploration Vehicle (Orion) 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.

Exploration Strategy Themes

- Use the Moon to prepare for future human and robotic missions to Mars and other destinations
- Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them
- Extend sustained human presence 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
- Strengthen existing and create new global partnerships
- Engage, inspire, and educate the public

NASA's Exploration Roadmap

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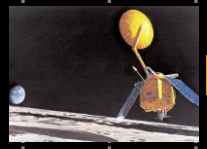
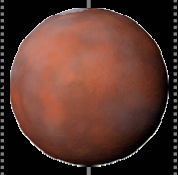
Initial Orion Capability

Lunar Outpost Buildup



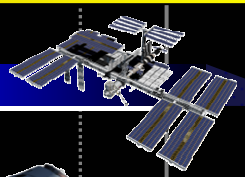
Lunar Robotic Missions

Science Robotic Missions



Mars Expedition Design

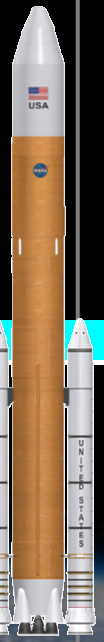
Commercial Crew/Cargo for ISS



Space Shuttle Ops

Orion Development

Ares I Development



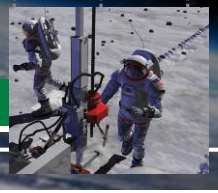
Orion Production and Operations

Lunar Lander Development

Ares V Development

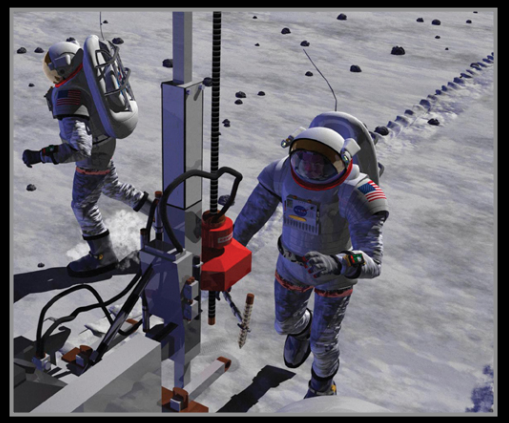
Earth Departure Stage Development

Surface Systems Development



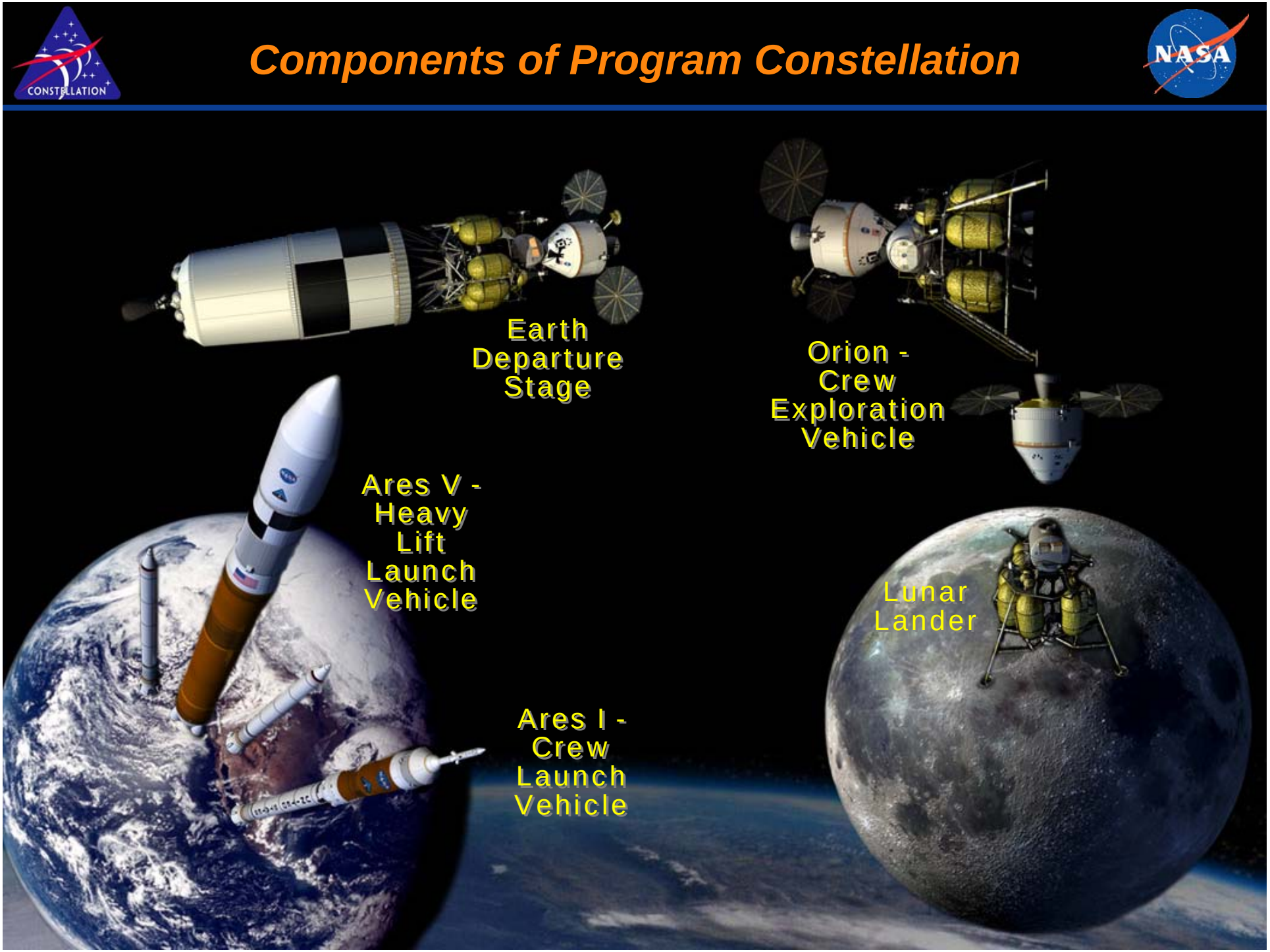
The Moon – the First Step to Mars and Beyond….

- **Gaining significant experience in operating away from Earth's environment**
  - Space will no longer be a destination visited briefly and tentatively
  - "Living off the land"
  - Human support systems
- **Developing technologies needed for opening the space frontier**
  - Crew and cargo launch vehicles (125 metric ton class)
  - Earth ascent/entry system – Orion
- **Conduct fundamental science**
  - Astronomy, physics, astrobiology, historical geology, exobiology



Next Step in Fulfilling Our Destiny As Explorers

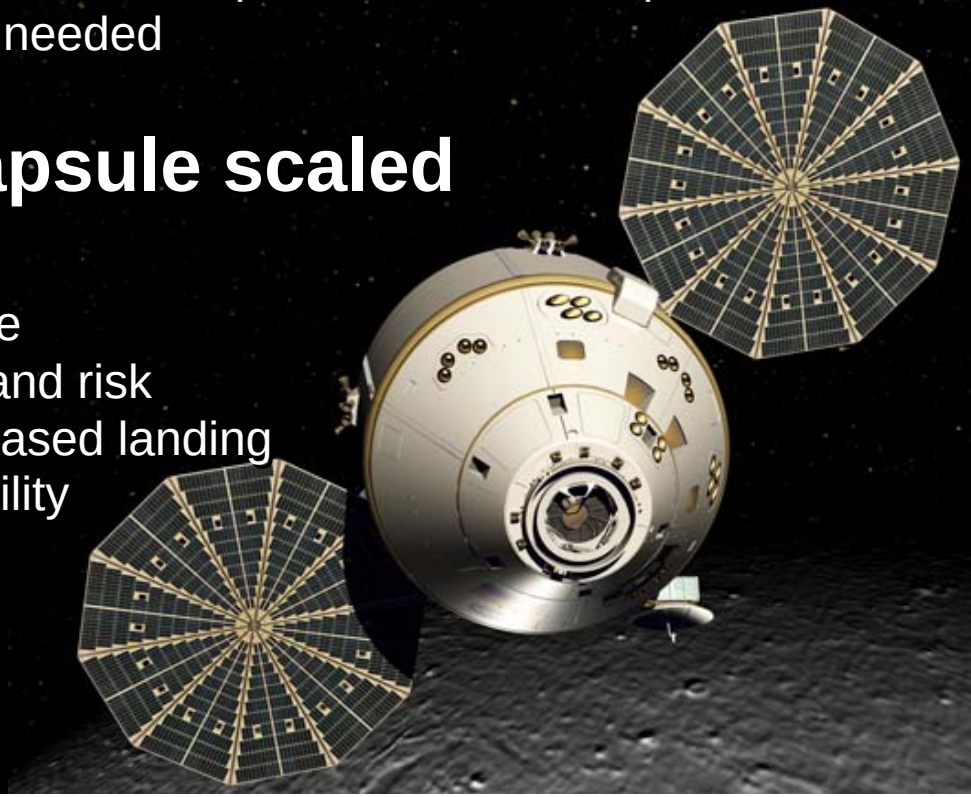
Components of Program Constellation



How We Plan to Return to the Moon

Orion

- **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 from Apollo**
  - Significant increase in volume
  - Reduced development time and risk
  - Reduced reentry loads, increased landing stability and better crew visibility

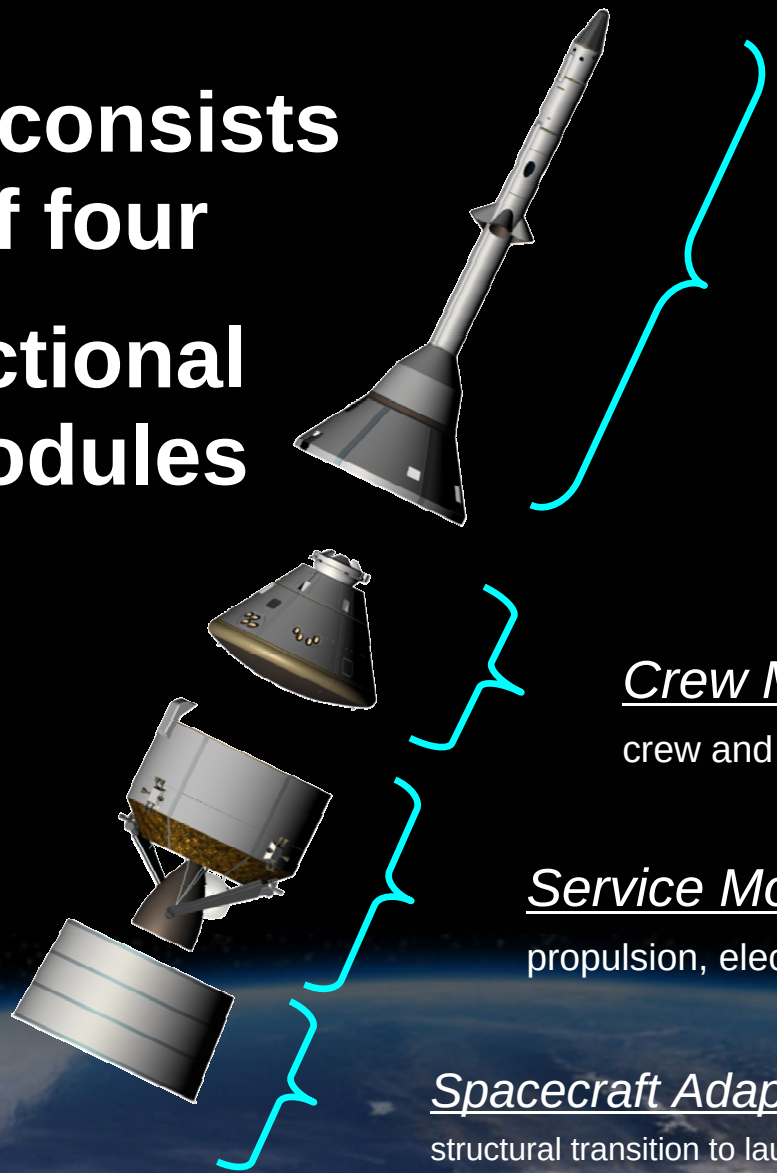


Orion is Capable of Supporting International Space Station Missions

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

Orion System Elements

Orion consists of four functional modules



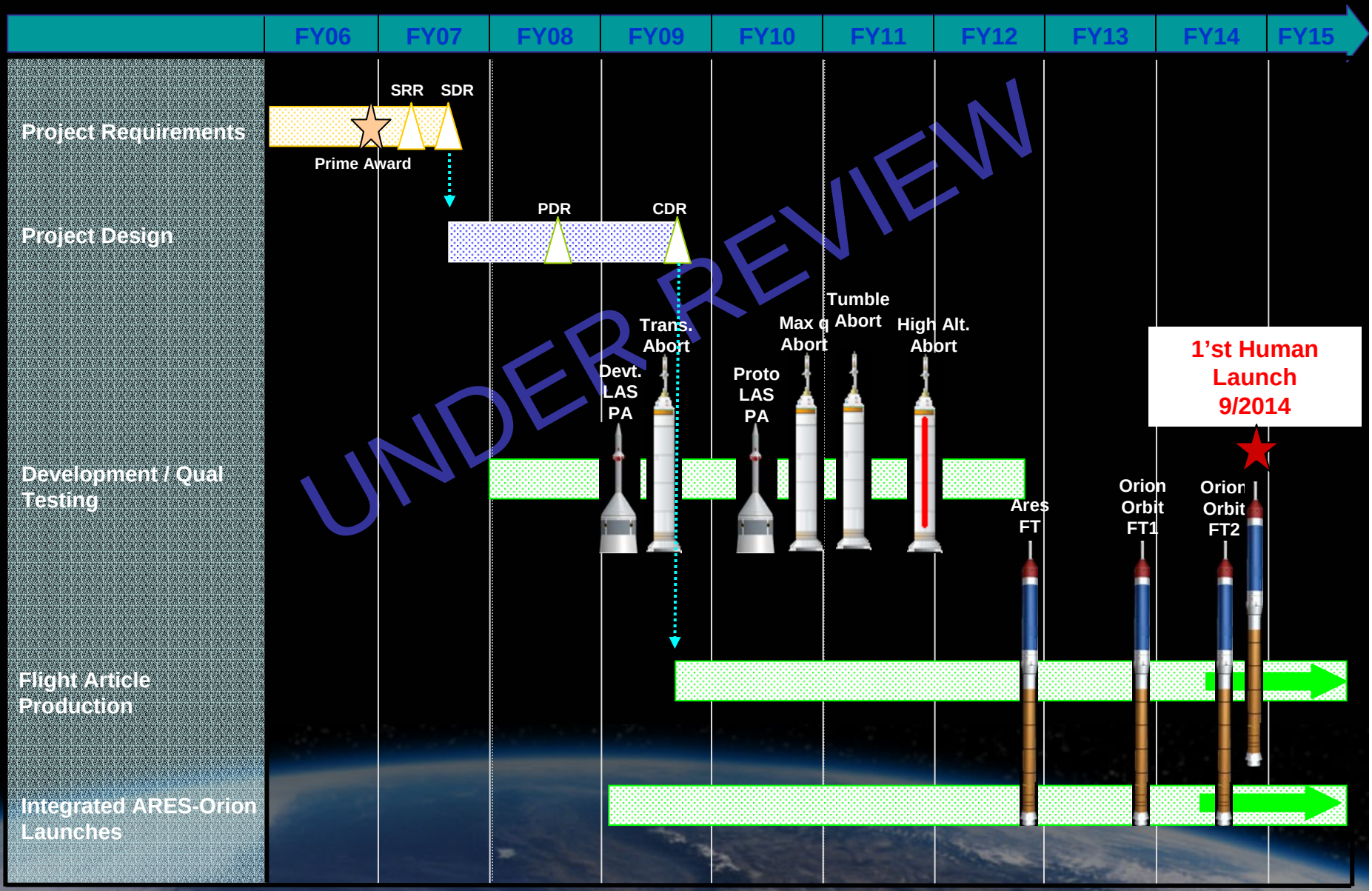
Launch Abort System --
emergency escape during launch

Crew Module –
crew and cargo transport

Service Module –
propulsion, electrical power, fluids storage

Spacecraft Adapter –
structural transition to launch vehicle

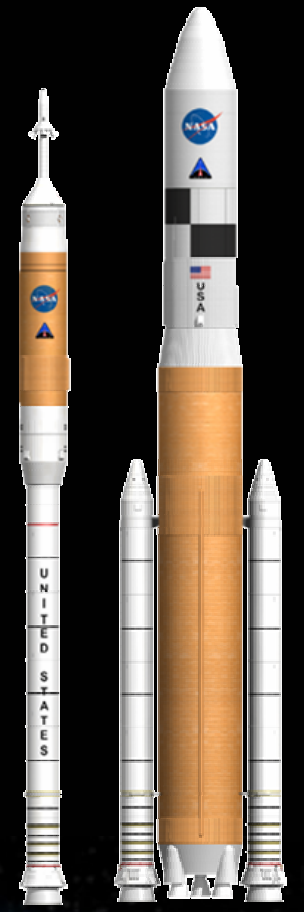
Orion Project Schedule Overview



How We Plan to Return to the Moon

Project Ares

- **The safest, most reliable and most affordable means of meeting crew requirements is a system derived from Space Shuttle components**
  - Capitalizes on human rated systems and existing facilities
  - The most straightforward growth path to later exploration launch needs
- **131 metric ton lift capacity required to minimize on-orbit assembly and complexity – increasing mission success**
  - A clean-sheet-of-paper design is too expensive and risky
  - The current Shuttle system lifts 100 metric tons to orbit on every launch – but 80 metric tons is the Orbiter



Ares I *Ares V*

Ares Launch Vehicle Elements

LAS

Orion
(Crew Module / Service Module)

Spacecraft Adapter

Instrument Unit

Forward Skirt

Upper Stage

J-2X Upper Stage Engine

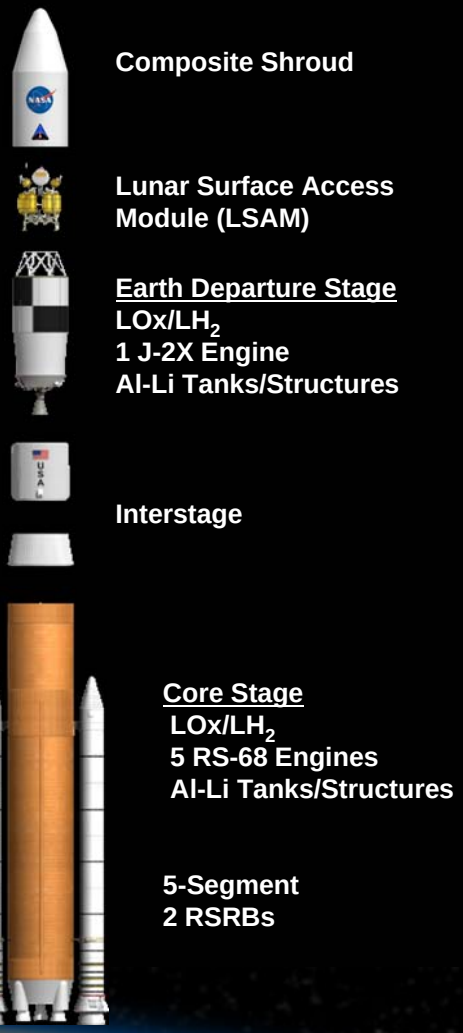
Forward Frustum

Interstage

First Stage
(5-Segment RSRB)

Ares I

22 Mt to LEO



Composite Shroud

Lunar Surface Access Module (LSAM)

Earth Departure Stage
LOx/LH_2
1 J-2X Engine
Al-Li Tanks/Structures

Interstage

Core Stage
LOx/LH_2
5 RS-68 Engines
Al-Li Tanks/Structures

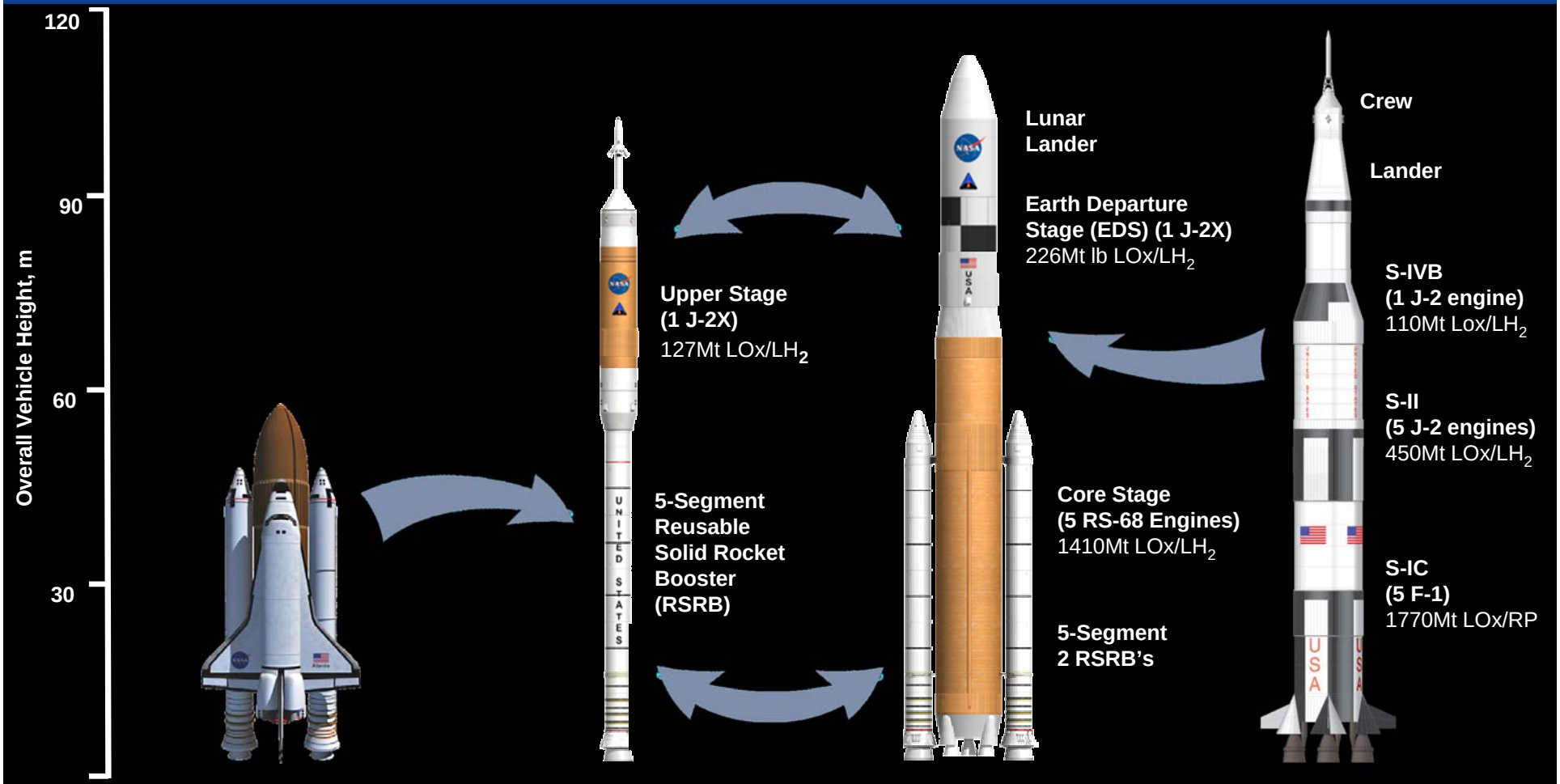
5-Segment
2 RSRBs

Ares V

53Mt to TLI
65Mt to TLI in Dual- launch Mode with Ares I
131Mt to LEO

Building on a Foundation of Proven Technologies

- Launch Vehicle Comparisons -



Space Shuttle

Height: 56m
Gross Liftoff Mass: 2040Mt

25Mt to LEO

Ares I

Height: 98m
Gross Liftoff Mass: 910Mt

22Mt to LEO

Ares V

Height: 109m
Gross Liftoff Mass: 3310Mt

53Mt to TLI
65Mt to TLI in Dual-Launch Mode with Ares I
131Mt to LEO

Saturn V

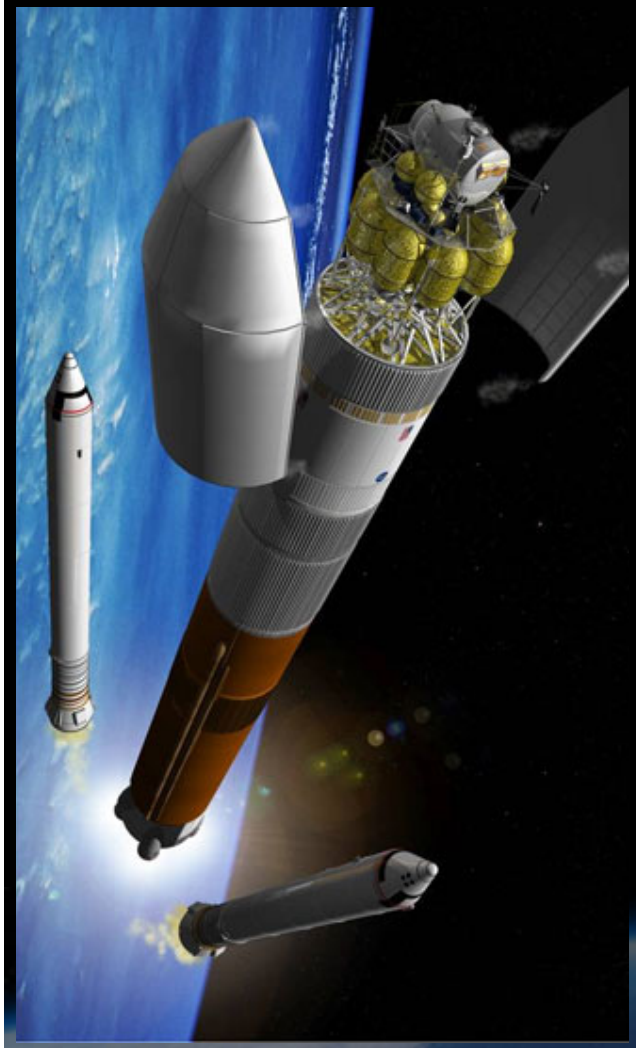
Height: 111m
Gross Liftoff Mass: 2950Mt

45Mt to TLI
119Mt to LEO

Ares I - Crew Launch Vehicle

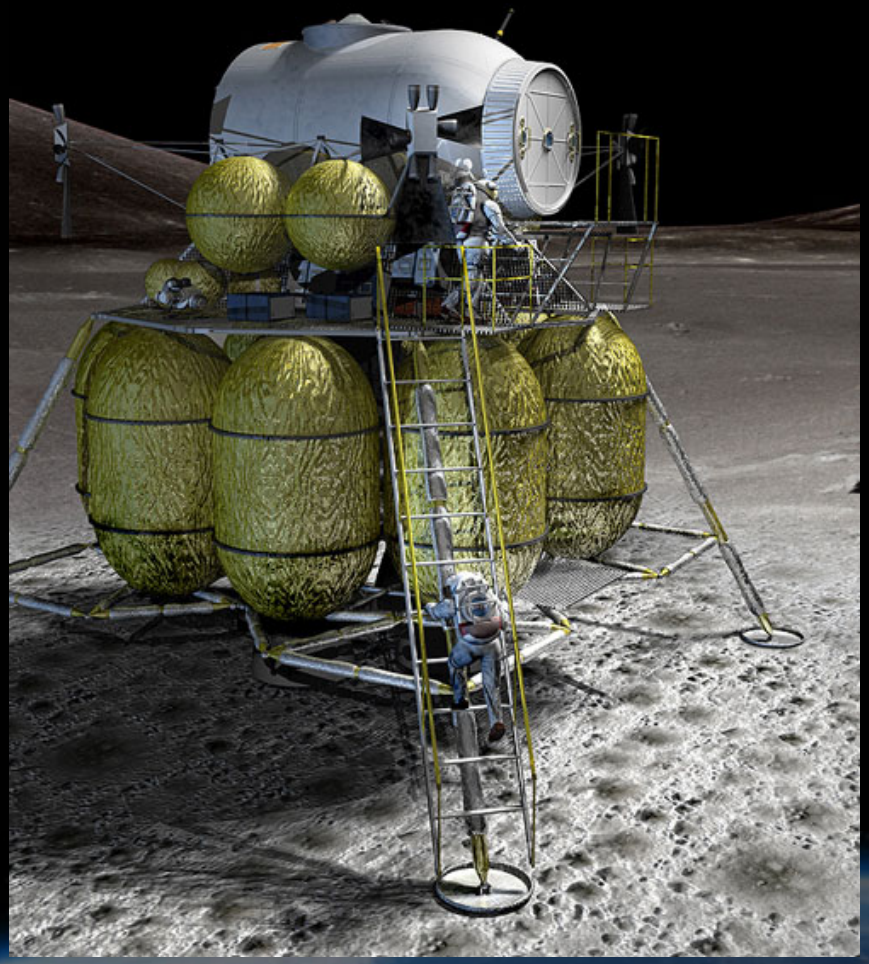
- **Serves as the long term crew launch capability for the U.S.**
- **5 Segment Shuttle Solid Rocket Booster**
- **New liquid oxygen / liquid hydrogen upperstage**
  - J2X engine
- **Large payload capability**

Ares V – Heavy Cargo Launch Vehicle



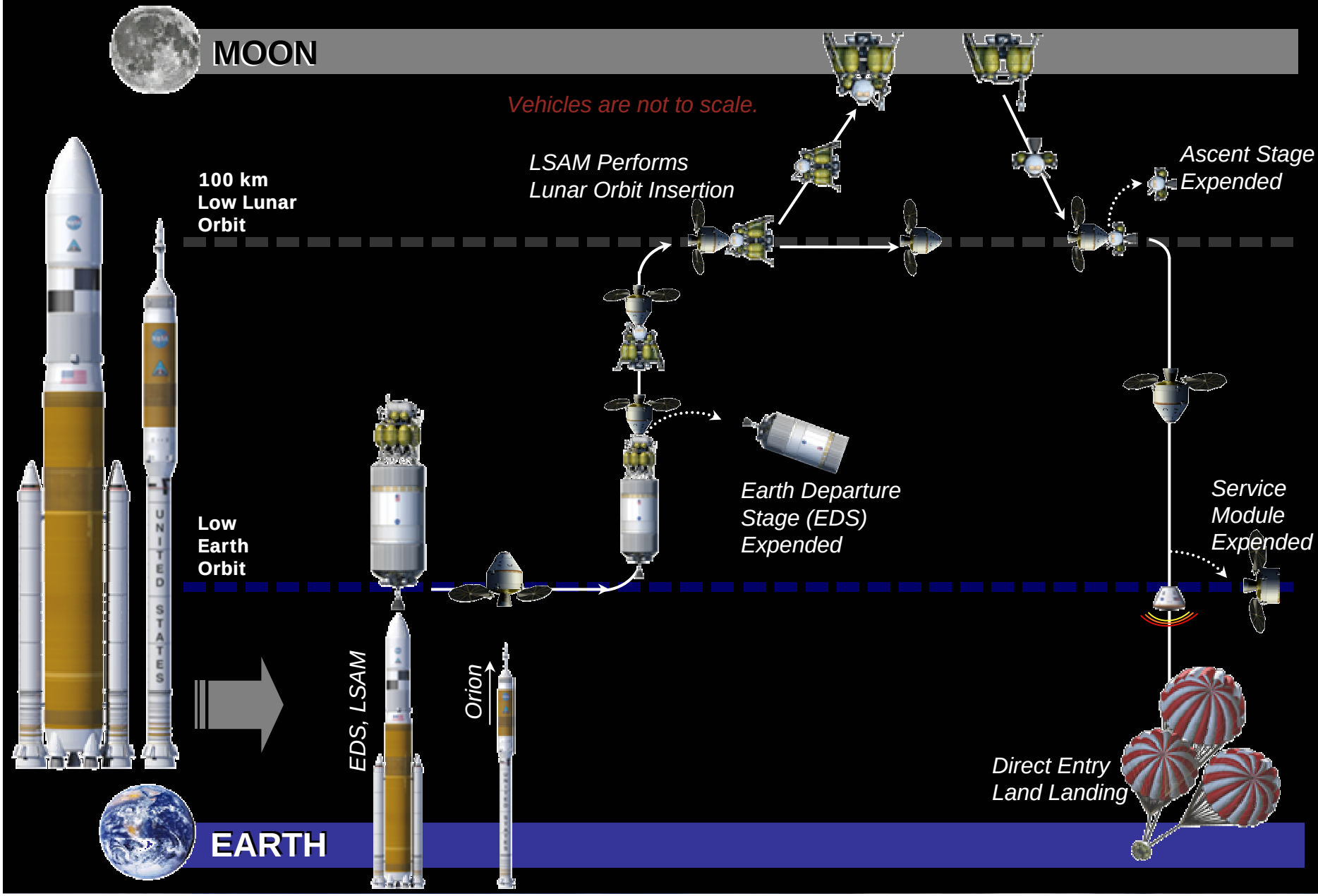
- **5 Segment Shuttle Solid Rocket Boosters**
- **Liquid Oxygen / liquid hydrogen core stage**
  - Heritage from the Shuttle External Tank
  - RS68 Main Engines
- **Payload Capability**
  - 106 metric tons to low Earth orbit
  - 131 Metric tons to low Earth orbit using Earth departure stage
  - 53 metric tons trans-lunar injection capability using Earth departure stage
- **Can be certified for crew if needed**

Lunar Lander

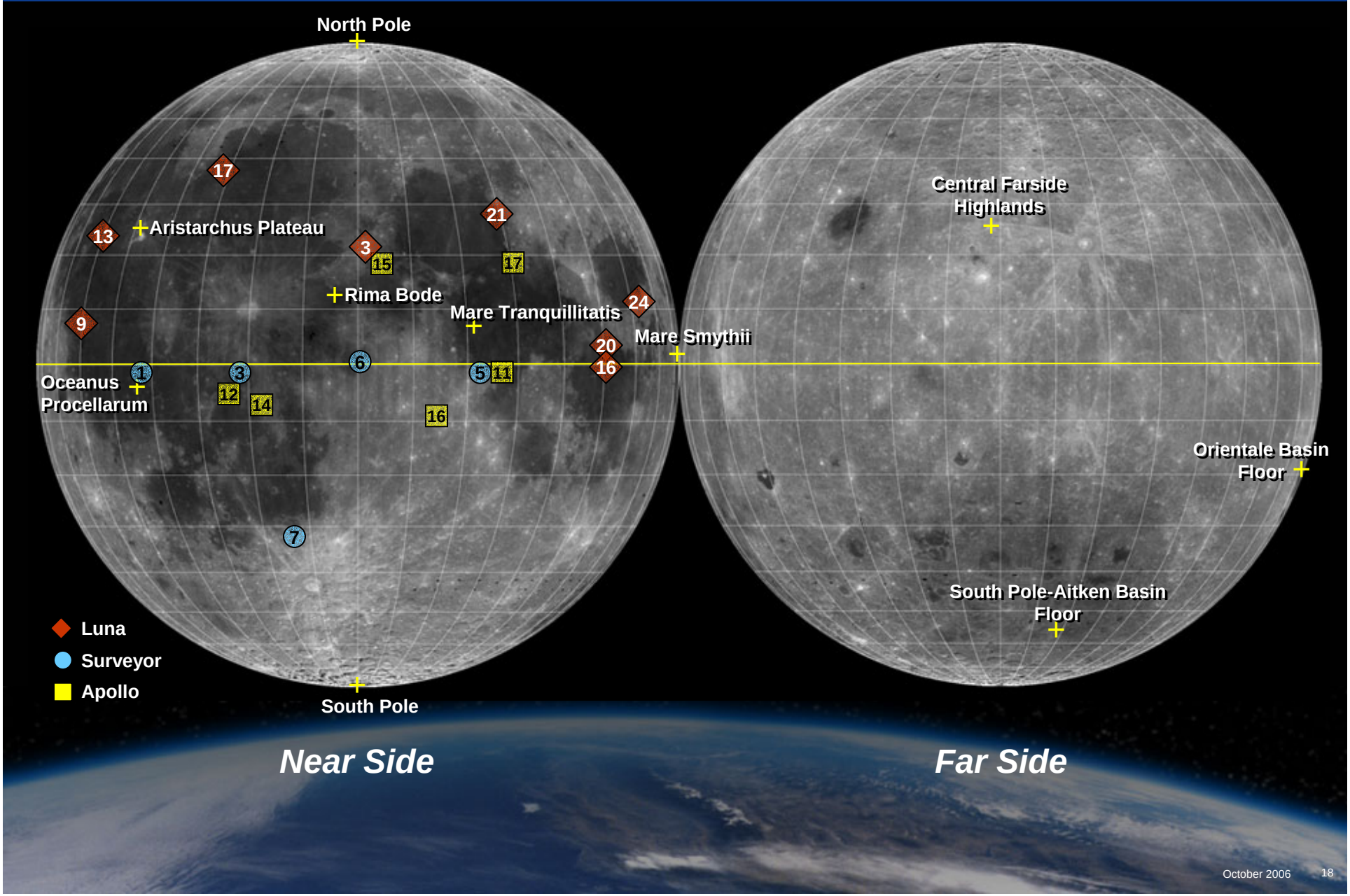


- **Transports 4 crew to and from the surface**
  - Seven days on the surface
  - Lunar outpost crew rotation
- **Global access capability**
- **Anytime return to Earth**
- **Capability to land 20 metric tons of dedicated cargo**
- **Airlock for surface activities**
- **Descent stage:**
  - Liquid oxygen / liquid hydrogen propulsion
- **Ascent stage:**
  - Storable Propellants

Typical Lunar Reference Mission

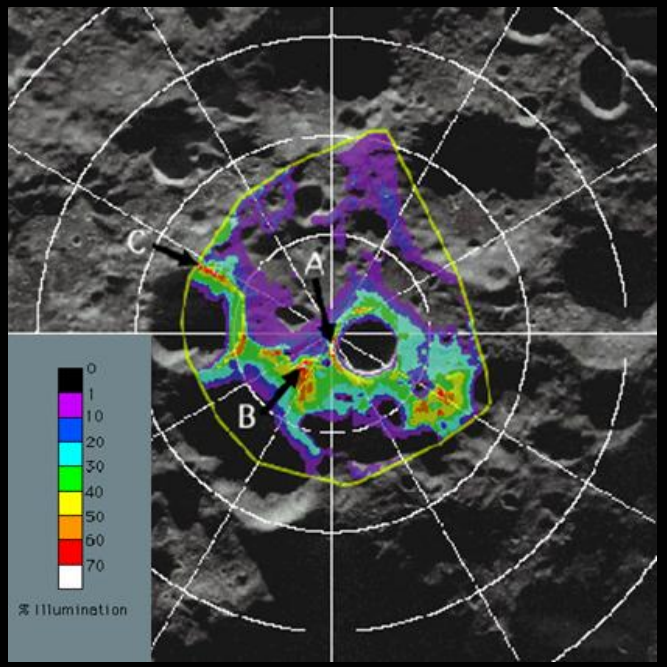


High Priority Lunar Exploration Sites



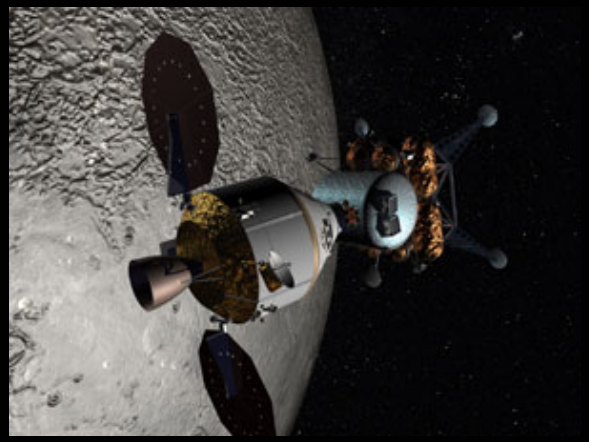
Possible South Pole Outpost

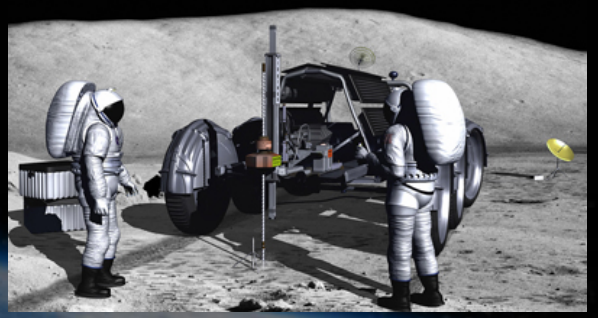
- **The lunar South Pole is a likely candidate for outpost site**
- **Elevated quantities of hydrogen, possibly water ice (e.g., Shackelton Crater)**
- **Several areas with greater than 80% sunlight and less extreme temperatures**
- **Incremental deployment of systems – one mission at a time**
  - Power system
  - Communications/navigation
  - Habitat
  - Rovers
  - Etc.



The Moon - the First Step to Mars and Beyond….

- Regaining and extending operational experience in a hostile planetary environment
- Developing capabilities needed for opening the space frontier
- Preparing for human exploration of Mars
- Science operations and discovery





The Next Step in Fulfilling Our Destiny As Explorers

Constellation Leverages Unique Skills and Capabilities Throughout NASA and the Aerospace Industry

Ames
- Lead Orion Thermal Protection System ADP
- Ares analysis support
- Mission & Ground Ops support
- Program Data Systems Support
- Program SE&I & T&V Support

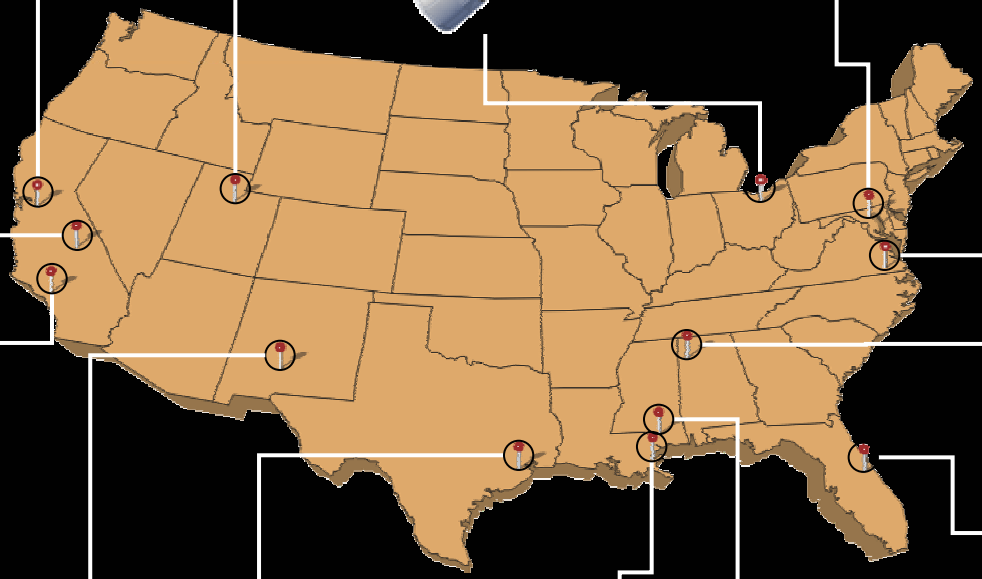
ATK Thiokol
- SRB Fuel Mfg & Test

Glenn
- Lead Orion Service Module and Spacecraft Adapter integration
- Ares Upper Stage support and development for ADFT-0 upper stage module
- Program SE&I & T&V Support

Goddard
- Communications Support
- SE&I support

Langley
- Lead Orion Launch Abort System Integration & Landing System ADP
- Lead Ares ADFT-0 vehicle integration
- Ares analysis support
- Program SE&I & T&V Support

Dryden
- Lead Orion Abort Flight Test Integ/Ops
- Abort Test Booster Procurement
- Flight Test Article Devt/Integ



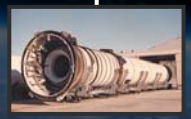
Marshall
- Ares Project Management
- Orion LAS and SM SE&I Support
- Program SE&I & T&V support

JPL
- Program SE&I & T&V support
- Mission Ops support
- Orion Thermal Protection System Support

Kennedy
- Ground Ops Project Management
- Leads ground processing, launch & landing/recovery planning & execution

White Sands
- Orion Abort Test Booster Test Site

Johnson
- Constellation Program Management
- Orion Project Management & Integration
- Lead Crew Module Integration
- Mission Ops Project Management



Michoud
- SRB Assembly

Stennis
- Rocket Propulsion Testing for Ares
- Program SE&I & T&V Support

Thank you!