MSFC-024- ABSTRACT

Human Space Exploration: The Moon, Mars, and Beyond

Jeffrey D. Sexton
Vehicle Integration Deputy Manager
Exploration Launch Projects Office
NASA Marshall Space Flight Center
Huntsville, AL 35812

Abstract

America is returning to the Moon in preparation for the first human footprint on Mars, guided by the U.S. Vision for Space Exploration. This presentation will discuss NASA's mission, the reasons for returning to the Moon and going to Mars, and how NASA will accomplish that mission in ways that promote leadership in space and economic expansion on the new frontier. The primary goals of the Vision for Space Exploration are to finish the International Space Station, retire the Space Shuttle, and build the new spacecraft needed to return people to the Moon and go to Mars. The Vision commits NASA and the nation to an agenda of exploration that also includes robotic exploration and technology development, while building on lessons learned over 50 years of hard-won experience.

Why the Moon? Many questions about the Moon's potential resources and how its history is linked to that of Earth were spurred by the brief Apollo explorations of the 1960s and 1970s. This new venture will carry more explorers to more diverse landing sites with more capable tools and equipment for extended expeditions. The Moon also will serve as a training ground before embarking on the longer, more difficult trip to Mars. NASA plans to build a lunar outpost at one of the lunar poles, learn to live off the land, and reduce dependence on Earth for longer missions. America needs to extend its ability to survive in hostile environments close to our home planet before astronauts will reach Mars, a planet very much like Earth. NASA has worked with scientists to define lunar exploration goals and is addressing the opportunities for a range of scientific study on Mars.

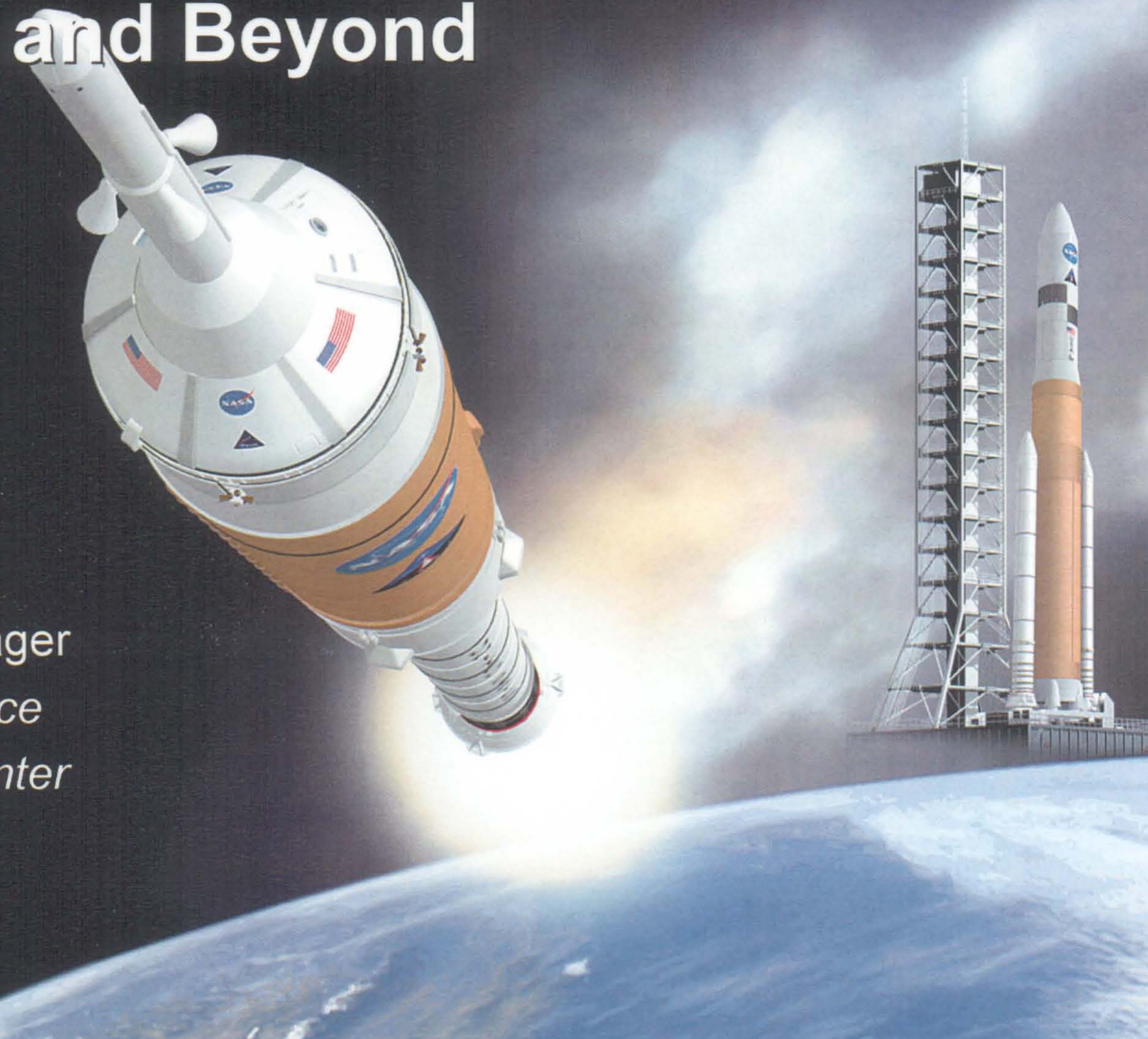
In order to reach the Moon and Mars within a lifetime and within budget, NASA is building on common hardware, shared knowledge, and unique experience derived from the Apollo Saturn, Space Shuttle and contemporary commercial launch vehicle programs. The journeys to the Moon and Mars will require a variety of vehicles, including the Ares I Crew Launch Vehicle, which transports the Orion Crew Exploration Vehicle, and the Ares V Cargo Launch Vehicle, which transports the Lunar Surface Access Module. The architecture for the lunar missions will use one launch to ferry the crew into orbit, where it will rendezvous with the Lunar Module in the Earth Departure Stage, which will then propel the combination into lunar orbit. The imperative to explore space with the combination of astronauts and robots will be the impetus for inventions such as solar power and water and waste recycling.

This next chapter in NASA's history promises to write the next chapter in American history, as well. It will require this nation to provide the talent to develop tools, machines, materials, processes, technologies, and capabilities that can benefit nearly all aspects of life on Earth. Roles and responsibilities are shared between a nationwide Government and industry team. The Exploration Launch Projects Office at the Marshall Space Flight Center manages the design, development, testing, and evaluation of both vehicles and serves as lead systems integrator. A little over a year after it was chartered, the Exploration Launch Projects team is testing engine components, refining vehicle designs, performing wind tunnel tests, and building hardware for the first flight test of Ares I-1, scheduled for spring 2009.

The U.S. Vision for Space Exploration lays out a roadmap for a long-term venture of discovery. This endeavor will inspire and attract the best and brightest students to power this nation successfully to the Moon, Mars, and beyond. If one equates the value proposition for space with simple dollars and cents, the potential of the new space economy is tremendous, from orbital space delivery services for the International Space Station to mining and solar energy collection on the Moon and asteroids. The Vision for Space Exploration is fundamentally about bringing the resources of the solar system within the economic sphere of humankind. Given the immense size of our solar system, the amount of available material and energy within it present an enormous economic opportunity.

MSFC-024-PRESENTATION

National Aeronautics and Space Administration



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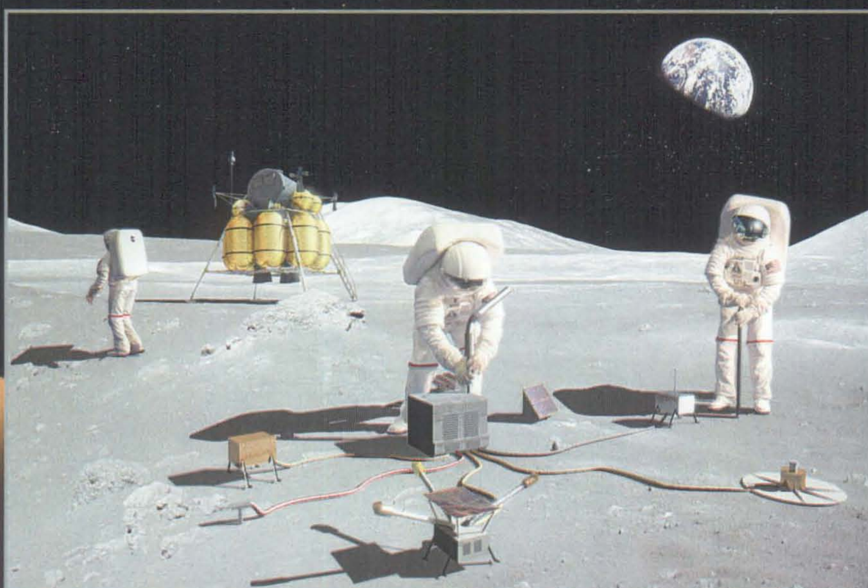
April 6, 2007

Today's Journey

- What NASA's mission is today, as defined by the Vision for Space Exploration
- Mission Objectives for Moon, Mars, and Beyond
- Timeline
- Vehicle Descriptions
- Who will be doing the work to get us there
- How you can help

The Vision for Space Exploration

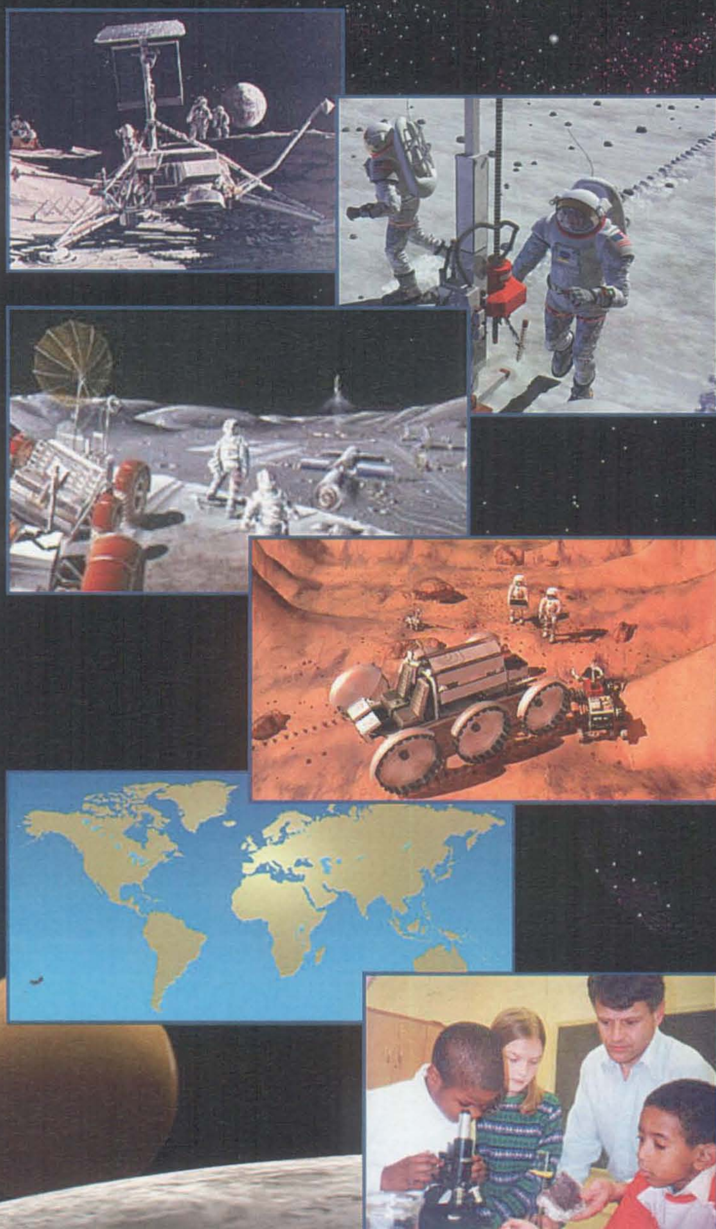
- Complete the International Space Station.
- Safely fly the Space Shuttle until 2010.
- Develop and fly the Crew Exploration Vehicle (CEV) no later than 2014.
- Return to the Moon no later than 2020.
- Extend human presence across the solar system and beyond.
- Implement a sustained and affordable human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



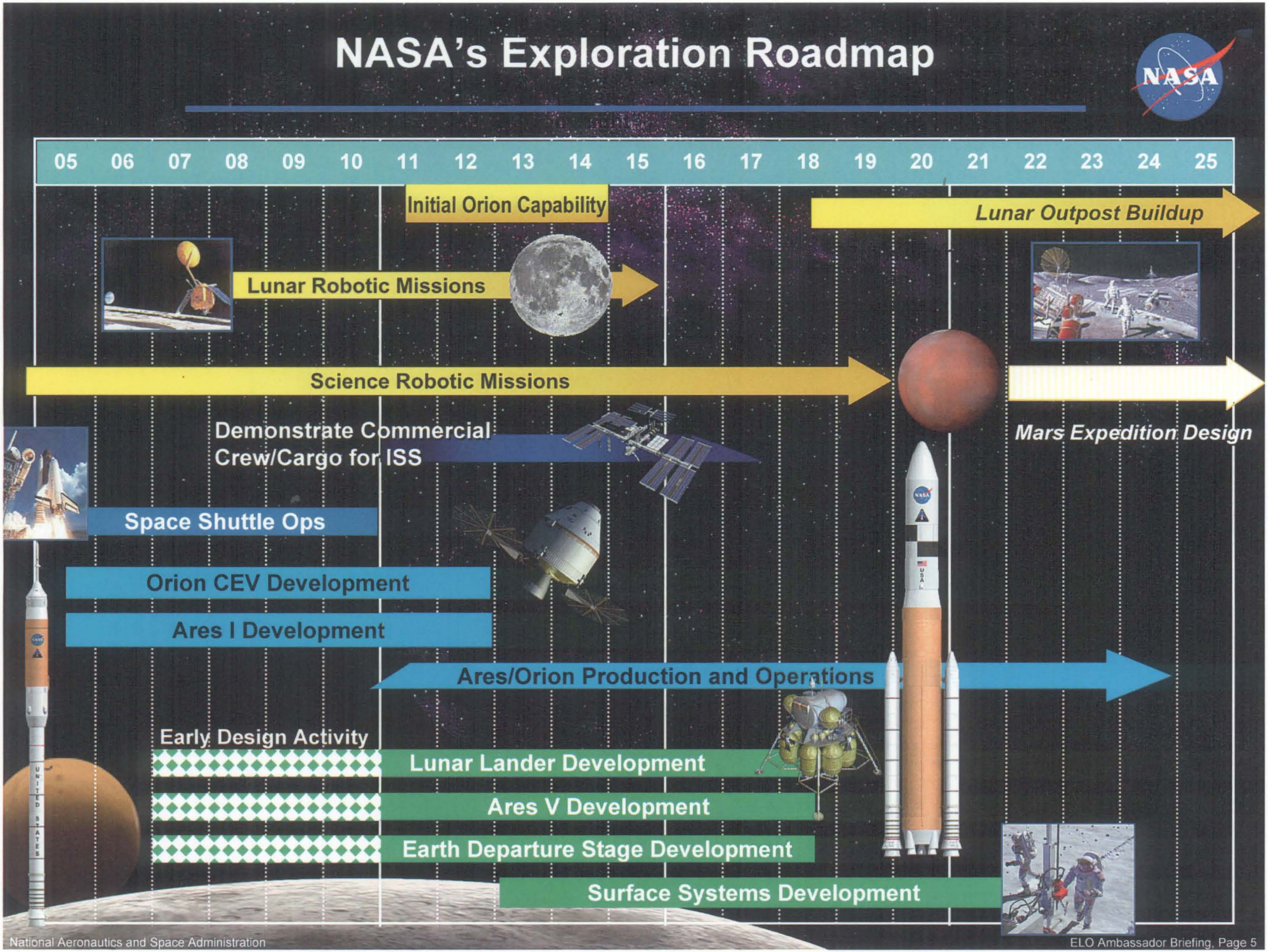
"The next steps in returning to the Moon and moving onward to Mars, the near-Earth asteroids, and beyond, are crucial in deciding the course of future space exploration. We must understand that these steps are incremental, cumulative, and incredibly powerful in their ultimate effect."

– NASA Administrator Michael Griffin
October 24, 2006

Great Nations Explore!

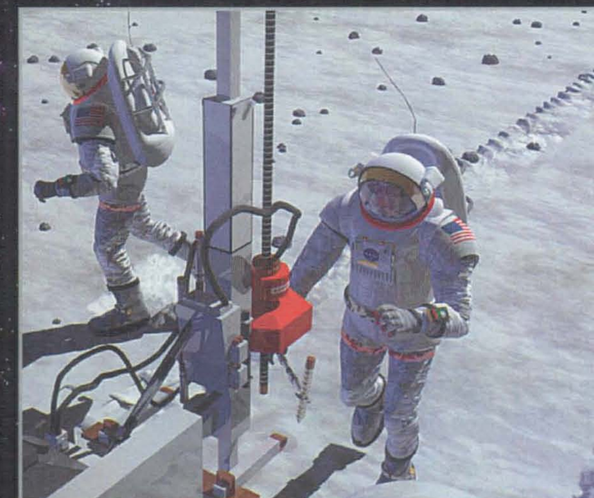


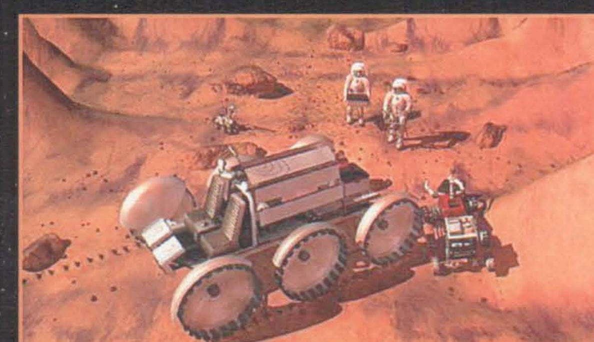
- Better understand the solar system, the universe, and our place in them.
- Expand our sphere of commerce, with direct benefits to life on Earth.
- Use the Moon to prepare for future human and robotic missions to Mars and other destinations.
- Extend sustained human presence to the moon to enable eventual settlement.
- Strengthen existing and create new global partnerships.
- Engage, inspire, and educate the next generation of explorers.


NASA's Exploration Roadmap
NASA
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
Science Robotic Missions
Mars Expedition Design
Demonstrate Commercial
Crew/Cargo for ISS
Space Shuttle Ops
Orion CEV Development
Ares I Development
Ares/Orion Production and Operations
Early Design Activity
Lunar Lander Development
Ares V Development
Earth Departure Stage Development
Surface Systems Development
National Aeronautics and Space Administration
ELO Ambassador Briefing, Page 5

The Moon
The First Step to Mars and Beyond

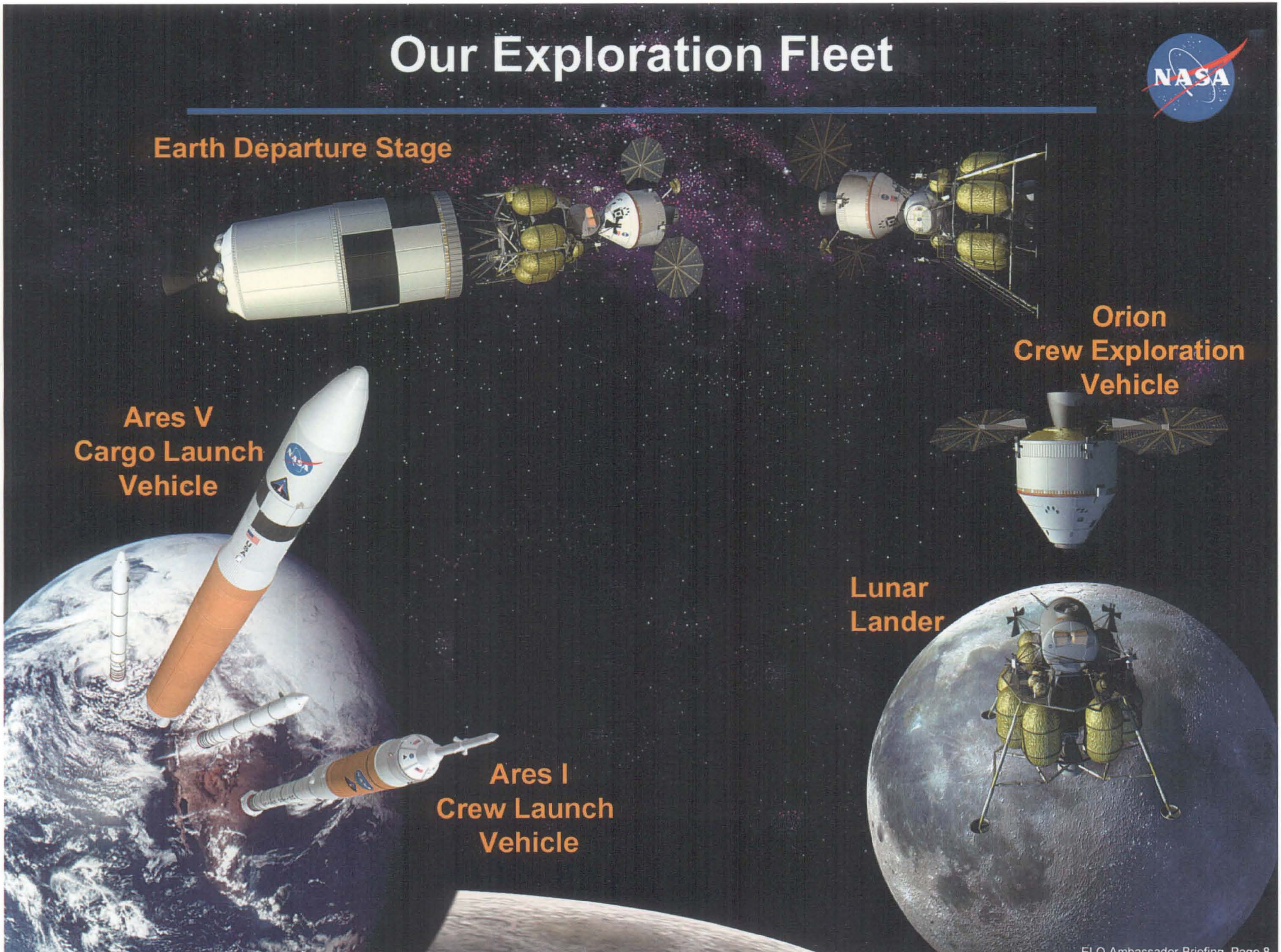
- **Gaining significant experience in operating away from Earth's environment**
  - Space will no longer be a destination visited briefly and tentatively
  - "Living off the land"
  - Human support systems
- **Developing technologies needed for opening the space frontier.**
  - Crew and cargo launch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



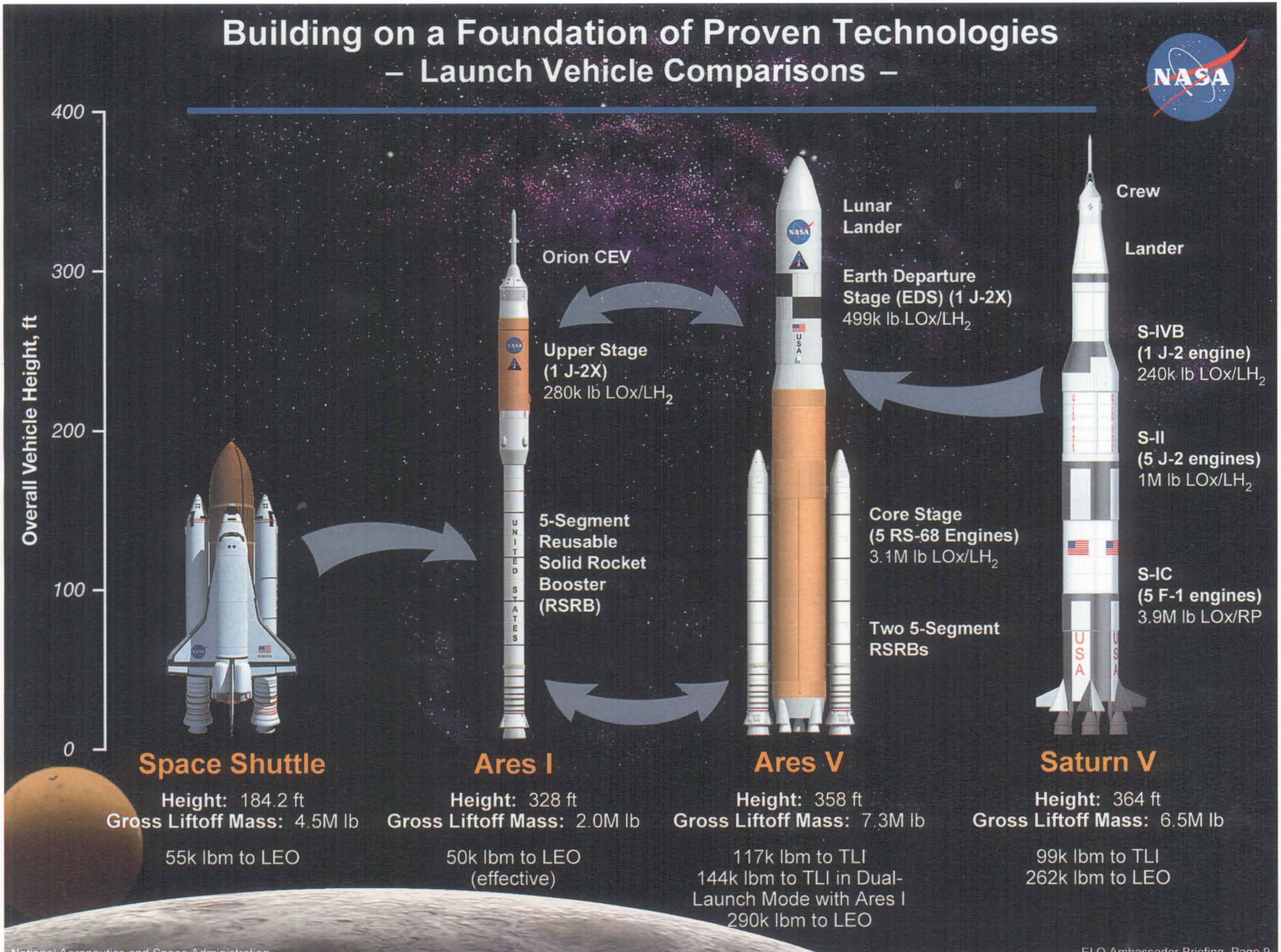


Next Step in Fulfilling Our Destiny As Explorers

There Are Many Places To Explore



Our Exploration Fleet
Earth Departure Stage
Orion
Crew Exploration
Vehicle
Ares V
Cargo Launch
Vehicle
Lunar
Lander
Ares I
Crew Launch
Vehicle


Building on a Foundation of Proven Technologies
– Launch Vehicle Comparisons –
NASA
Overall Vehicle Height, ft
400
300
200
100
0
Orion CEV
Upper Stage
(1 J-2X)
280k lb LOx/LH_2
5-Segment
Reusable
Solid Rocket
Booster
(RSRB)
Lunar
Lander
Earth Departure
Stage (EDS) (1 J-2X)
499k lb LOx/LH_2
Core Stage
(5 RS-68 Engines)
3.1M lb LOx/LH_2
Two 5-Segment
RSRBs
Crew
Lander
S-IVB
(1 J-2 engine)
240k lb LOx/LH_2
S-II
(5 J-2 engines)
1M lb LOx/LH_2
S-IC
(5 F-1 engines)
3.9M lb LOx/RP
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
50k lbm to LEO
(effective)
Ares V
Height: 358 ft
Gross Liftoff Mass: 7.3M lb
117k lbm to TLI
144k lbm to TLI in Dual-
Launch Mode with Ares I
290k lbm to LEO
Saturn V
Height: 364 ft
Gross Liftoff Mass: 6.5M lb
99k lbm to TLI
262k lbm to LEO
National Aeronautics and Space Administration
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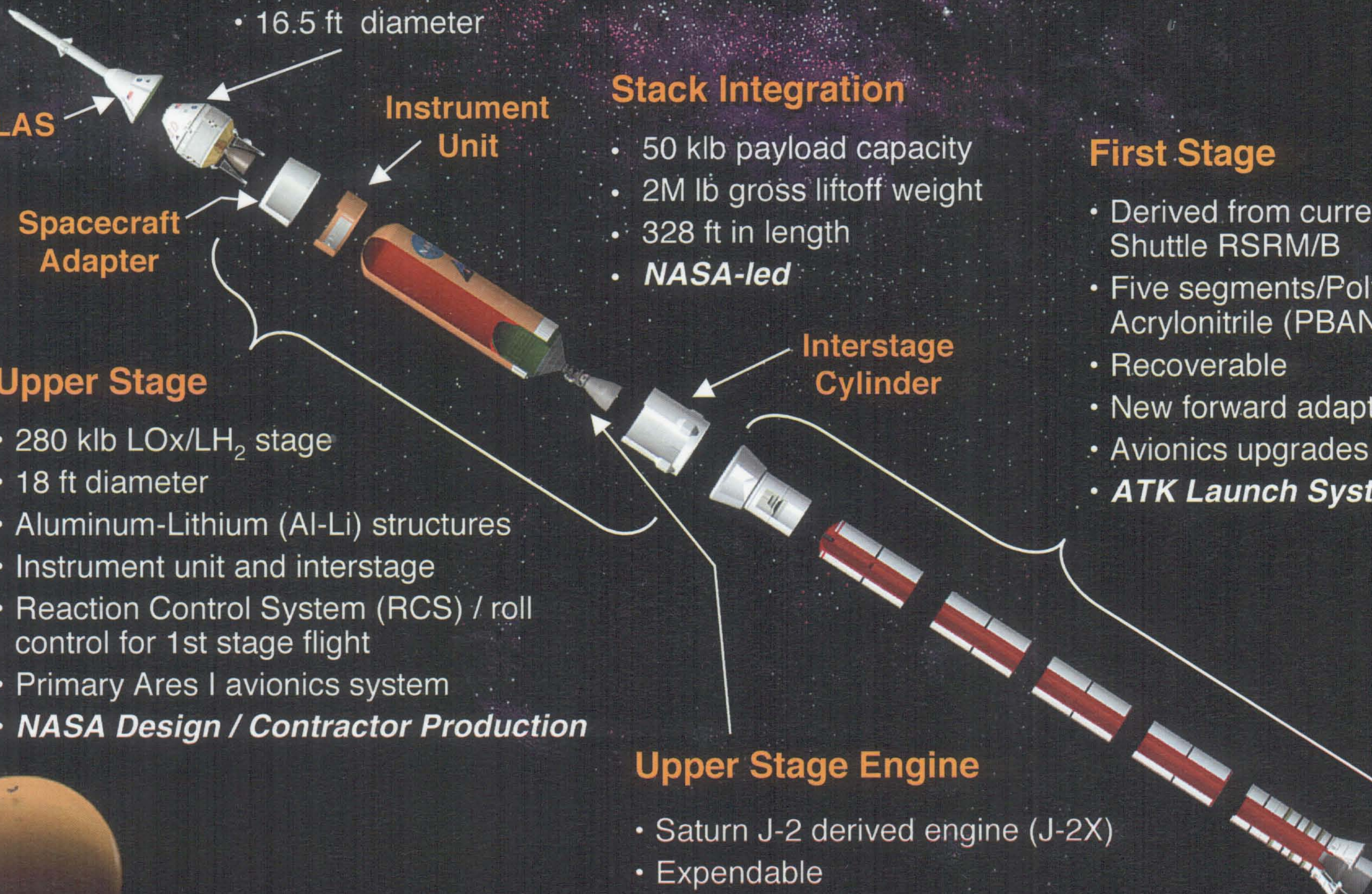
Ares I Elements



Orion

- 16.5 ft diameter

Stack Integration

- 50 klb payload capacity
- 2M lb gross liftoff weight
- 328 ft in length
- ***NASA-led***

First Stage

- Derived from current Shuttle RSRM/B
- Five segments/Polybutadiene Acrylonitrile (PBAN) propellant
- Recoverable
- New forward adapter
- Avionics upgrades
- ***ATK Launch Systems***

Upper Stage

- 280 klb LOx/LH_2 stage
- 18 ft diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- Reaction Control System (RCS) / roll control for 1st stage flight
- Primary Ares I avionics system
- ***NASA Design / Contractor Production***

Upper Stage Engine

- Saturn J-2 derived engine (J-2X)
- Expendable
- ***Pratt and Whitney Rocketdyne***

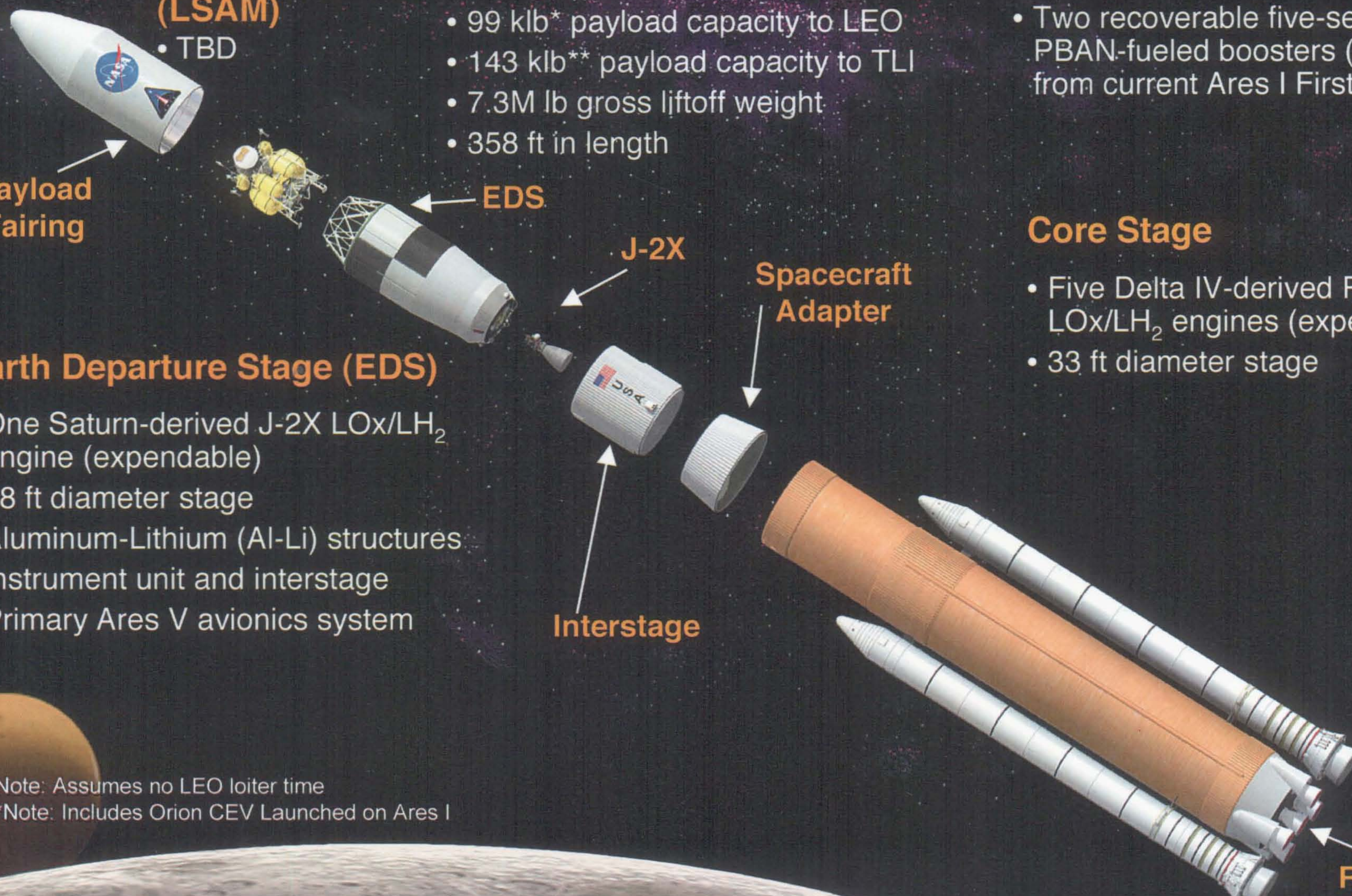
Ares V Elements

Lunar Surface Access Module (LSAM)
- TBD

Stack Integration
- 99 klb* payload capacity to LEO
- 143 klb** payload capacity to TLI
- 7.3M lb gross liftoff weight
- 358 ft in length

First Stage
- Two recoverable five-segment PBAN-fueled boosters (derived from current Ares I First Stage)

Core Stage
- Five Delta IV-derived RS-68 LOx/LH_2 engines (expendable)
- 33 ft diameter stage



Earth Departure Stage (EDS)
- One Saturn-derived J-2X LOx/LH_2 engine (expendable)
- 18 ft diameter stage
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- Primary Ares V avionics system

*Note: Assumes no LEO loiter time
**Note: Includes Orion CEV Launched on Ares I

NASA's Exploration Transportation System

Progress Towards Launch
(As of Early 2007)

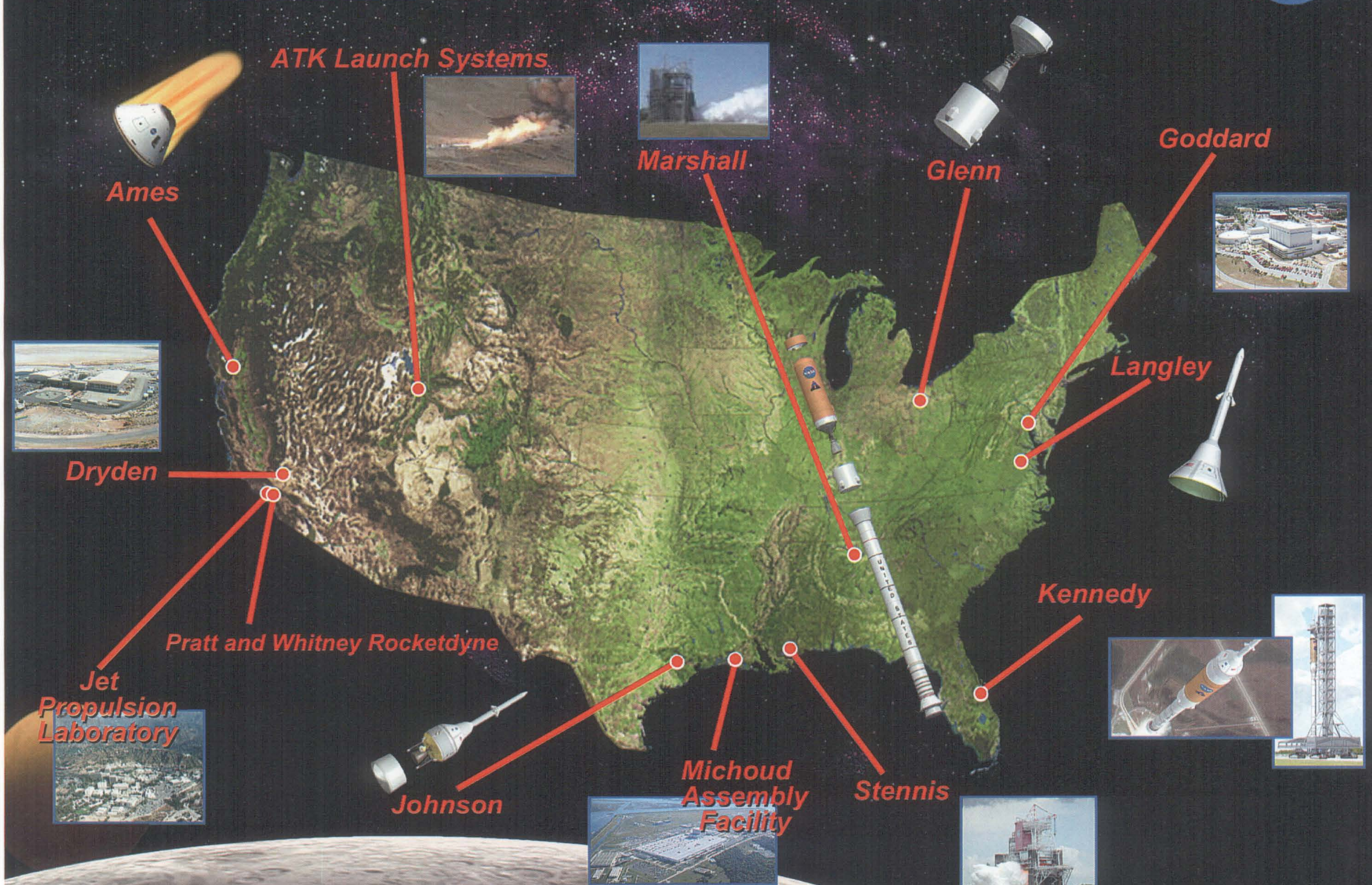
Programmatic Milestones

- Ares I System Requirements Reviews ongoing and some have been completed.
- Contracts awarded for creation of Orion (Lockheed Martin), First Stage (ATK), J-2X engine (Rocketdyne), and …

Technical Milestones

- Over 1,500 wind tunnel tests
- First Stage parachute testing
- First Stage nozzle development
- J-2X injector testing
- J-2S powerpack test preparation
- Upper Stage initial design analysis cycle
- Fabrication of Ares I-X Upper Stage mass simulator
- Ares I-X First Stage hardware fabrication

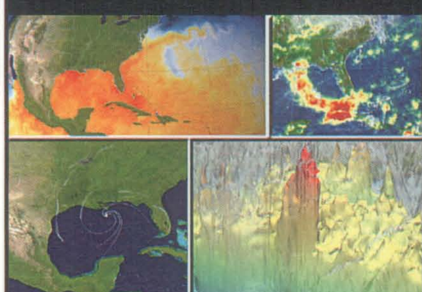
Our Nationwide Team

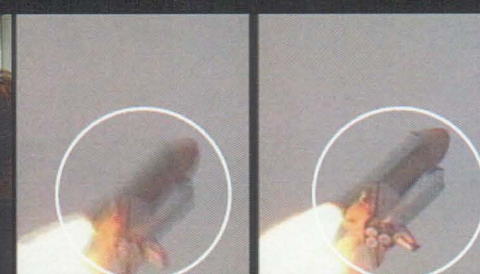


Everyday Benefits from Space Technologies

- **Health and Medicine**
  - Laser Angioplasty and CAT Scans
  - LED Healing
- **Public Safety**
  - Video Image Stabilization & Registration (VISAR®)
  - Life Shear Cutters
- **Consumer/Home/Recreation**
  - Satellite TV, Radio, Cell Phones, etc.
  - Cordless Products
  - Smoke Detectors
  - Car Insulation
- **Environment and Resources Management**
  - Weather Forecasting
  - Pollution Monitoring
- **Computers/Industrial/Manufacturing**
  - Digital Data Matrix
  - High-Strength Aluminum-Silicon Alloy
- **Positive Return on Investment**
  - In 2004, the aerospace industry delivered $100 billion into U.S. economy.
    - Over 500,000 jobs and $25 billion in direct salaries
    - Satellite launch services increased due to demand for services such as DirecTV and Remote sensing
    - Enabled industries such as real estate, automotive, entertainment, etc.
  - Every $1 spent on Apollo returned $8 to the economy
  - Math and science needed to continue America's competitiveness

For more information see NASA's Technology Transfer / Spinoff Web site





Original Video

With VISAR

Every Dollar Invested in Space is Spent on Earth

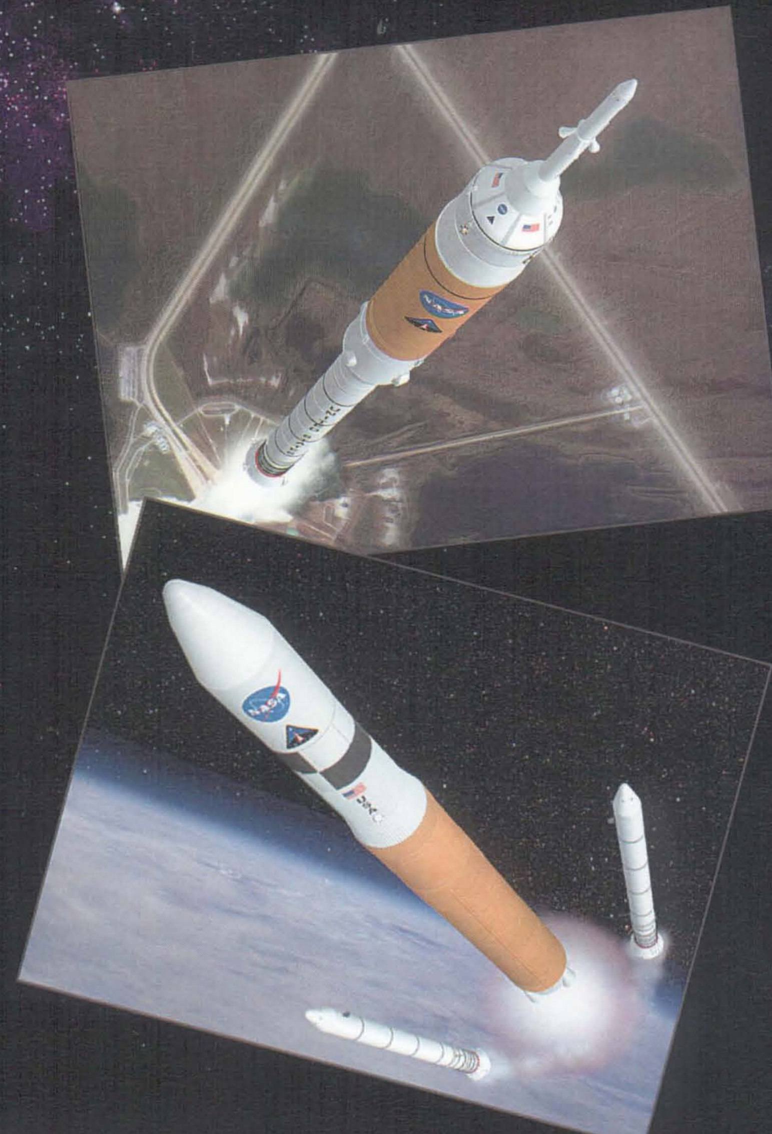
Education —
NASA Can, and Must, Make A Difference

NASA relies on well-educated U.S. citizens to carry out its far-reaching missions of scientific discovery that improve life on Earth

- **The Cold, Hard Facts**
  - Many U.S. scientists, engineers, and teachers are retiring
  - Fewer high school seniors are pursuing engineering degrees
  - China produces 6 times more engineers than the U.S.
- **The Stakes Are High**
  - U.S. students score lower than many other nations in math, science, and physics
  - We spend over $440 billion on public education, more per capita than any country except for Switzerland
- **Potential Solutions: Well-Qualified, Motivated Teachers and a National Commitment**
  - The highest predictor of student performance is teacher knowledge
  - The teacher's passion for the subject transmits to students
  - Education is the foundation of NASA's and the nation's success as a technological enterprise

Summary

- We must build beyond our current capability to ferry astronauts and cargo to low Earth orbit.
- We are starting to design and build new vehicles to using extensive lessons learned to minimize cost, technical, and schedule risks.
- To reach for Mars and beyond we must first reach for the Moon.
- Team is on board and making good progress.
- We need you, the owners, to help make this happen!

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