Launching to the Moon, Mars, and Beyond

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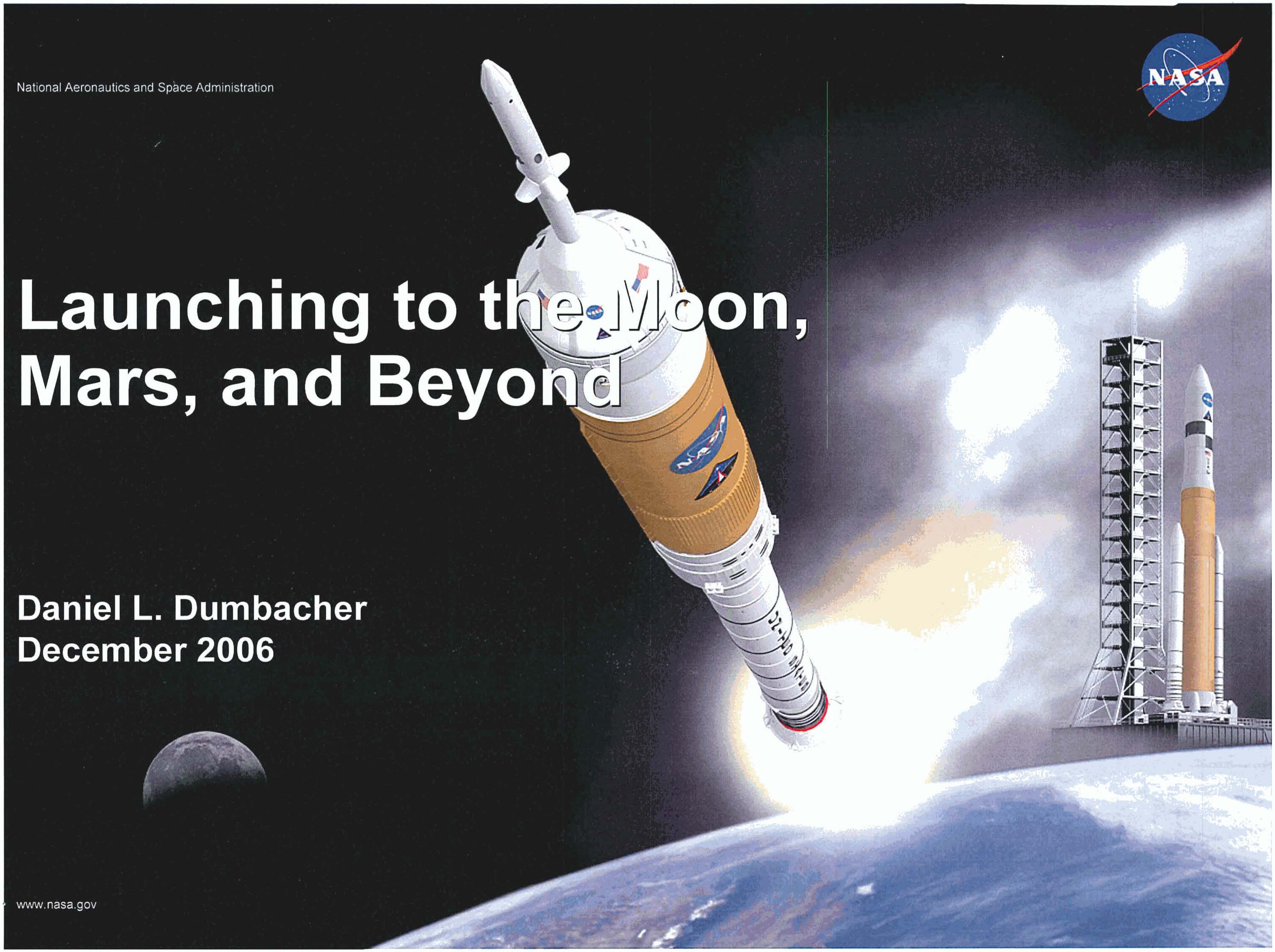
The U.S. Vision for Space Exploration, announced in 2004, calls on NASA to finish constructing the International Space Station, retire the Space Shuttle, and build the new spacecraft needed to return to the Moon and go on the Mars. By exploring space, America continues the tradition of great nations who mastered the Earth, air, and sea, and who then enjoyed the benefits of increased commerce and technological advances. The progress being made today is part of the next chapter in America's history of leadership in space.

In order to reach the Moon and Mars within the planned timeline and also within the allowable budget, NASA is building upon the best of proven space transportation systems. Journeys to the Moon and Mars will require a variety of vehicles, including the Ares I Crew Launch Vehicle, the Ares V Cargo Launch Vehicle, the Orion Crew Exploration Vehicle, and the Lunar Surface Access Module. What America learns in reaching for the Moon will teach astronauts how to prepare for the first human footprints on Mars. While robotic science may reveal information about the nature of hydrogen on the Moon, it will most likely take a human being with a rock hammer to find the real truth about the presence of water, a precious natural resource that opens many possibilities for explorers. In this way, the combination of astronauts using a variety of tools and machines provides a special synergy that will vastly improve our understanding of Earth's cosmic neighborhood.

The Ares I (bottom) and Ares V will provide U.S. access to space for exploration journeys.

Like the Apollo Program that first delivered Americans to the Moon, such a massive effort would be impossible without the cooperation and expertise of thousands of government and private-sector contractors throughout NASA and the domestic aerospace industry. U.S. talent is needed if America is to continue advancing science, engineering, and related industries, which leads to everyday benefits such as medical diagnostics, information technology, and satellite-based services such as television and navigation. NASA needs well-educated U.S. citizens to carry out its far-reaching missions of scientific discovery that improve life on Earth and make the country competitive in the global marketplace.


National Aeronautics and Space Administration
Launching to the Moon, Mars, and Beyond
Daniel L. Dumbacher
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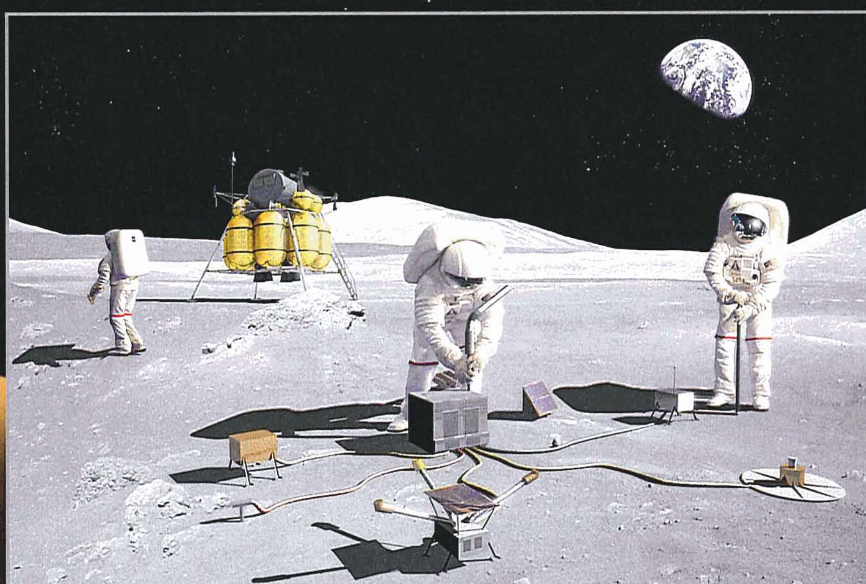
www.nasa.gov

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 there
- How you can help

The Vision for Space Exploration

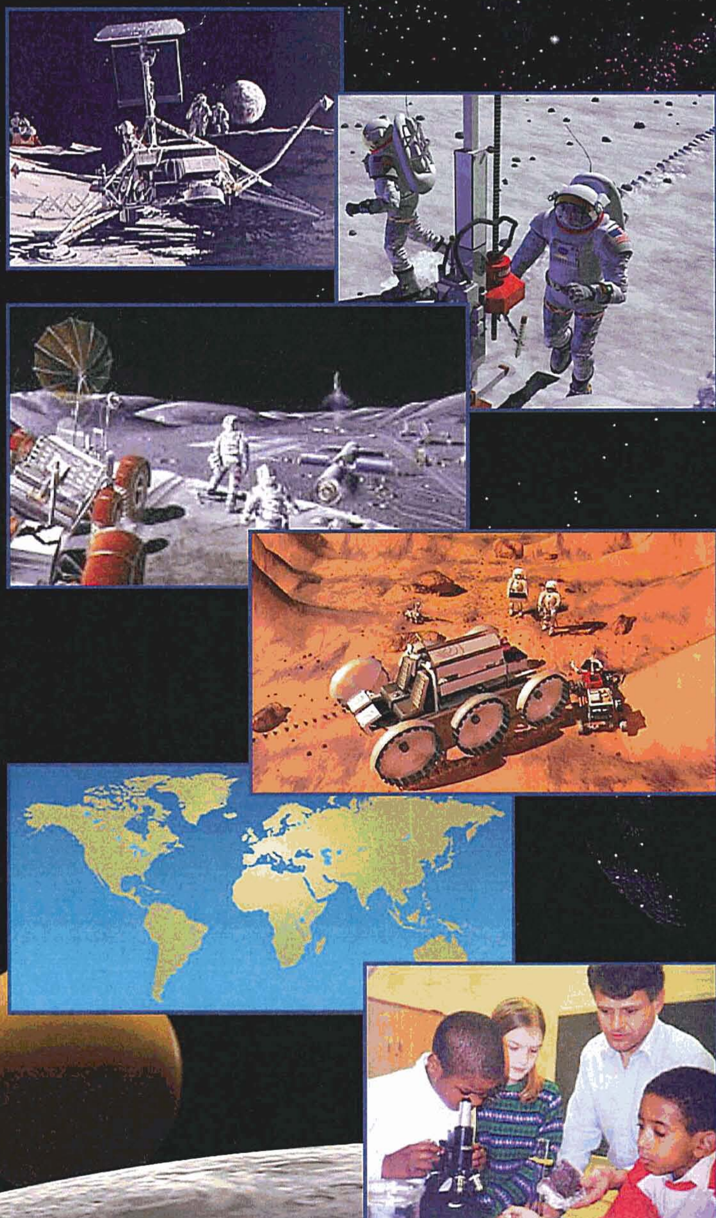
- Complete the International Space Station
- Safely fly the Space Shuttle until 2010
- Develop and fly the Crew Exploration Vehicle no later than 2014 (goal of 2012)
- Return to the Moon no later than 2020
- Extend human presence across the solar system and beyond
- Implement a sustained and affordable human and robotic program
- Develop supporting innovative technologies, knowledge, and infrastructures
- Promote international and commercial participation in exploration



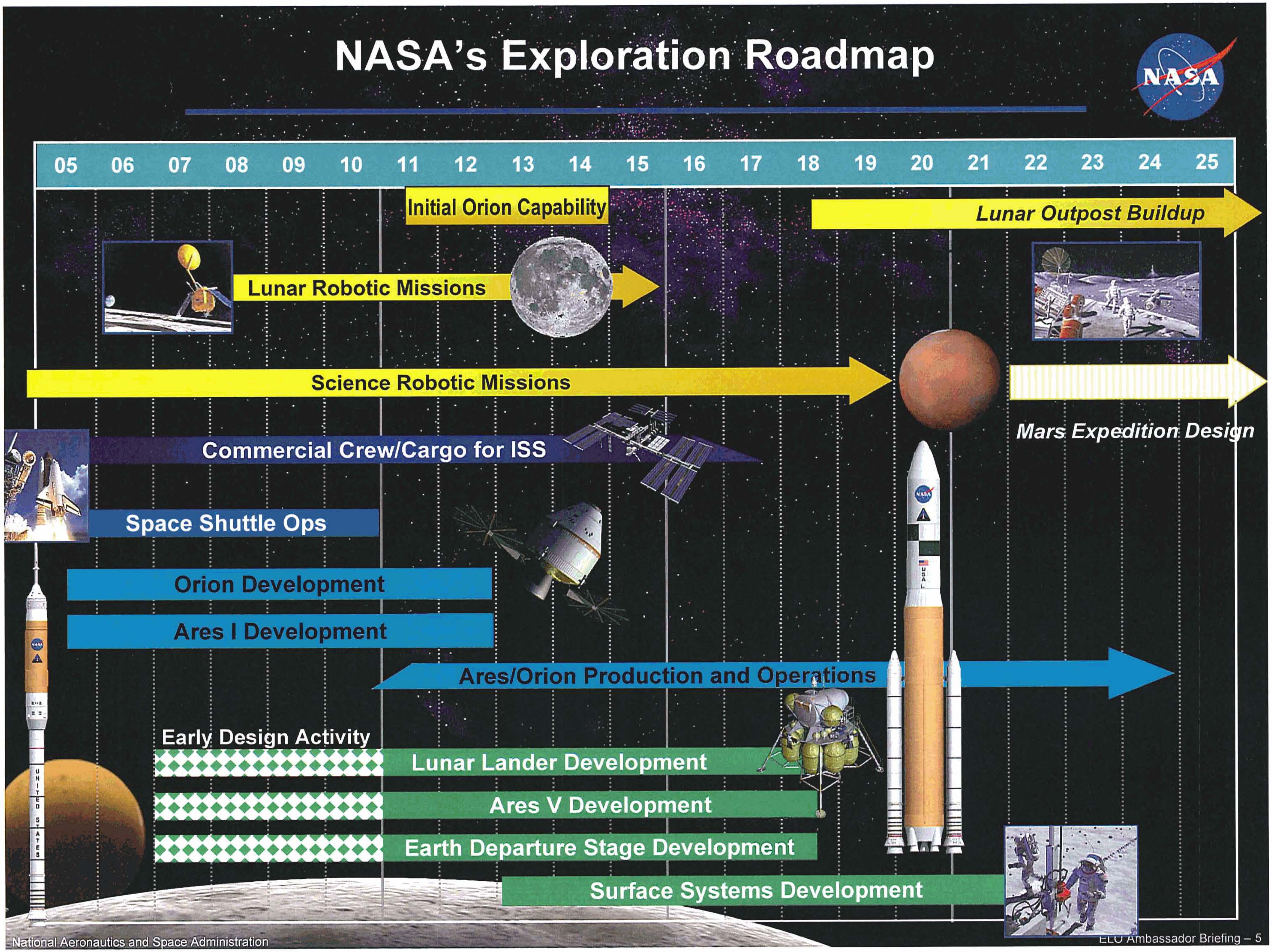
"The next steps in returning to the Moon and moving onward to Mars, the near-Earth asteroids, and beyond, are crucial in deciding the course of future space exploration. We must understand that these steps are incremental, cumulative, and – incredibly powerful in their ultimate effect."

– NASA Administrator Michael Griffin
October 24, 2006

Great Nations Explore!

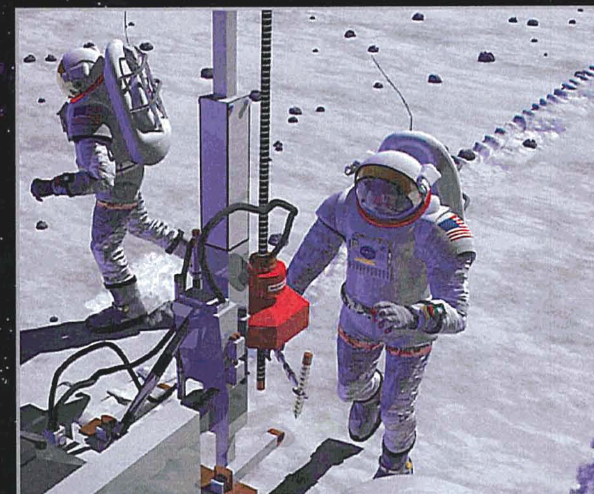


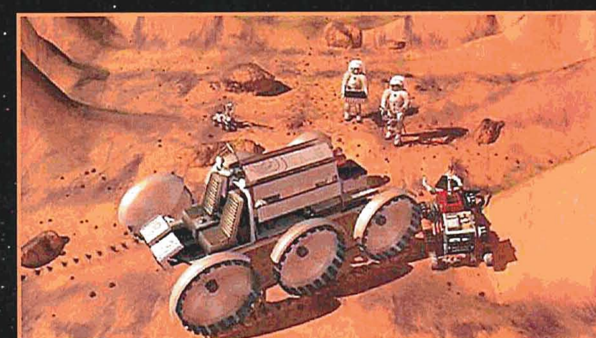
- Better understand the solar system, the universe, and our place in them
- Expand our sphere of commerce to include the moon - with direct benefits to life on Earth
- Use the Moon to prepare for future human and robotic missions to Mars and other destinations
- Extend sustained human presence to the 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
Commercial Crew/Cargo for ISS
Space Shuttle Ops
Orion 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 – 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

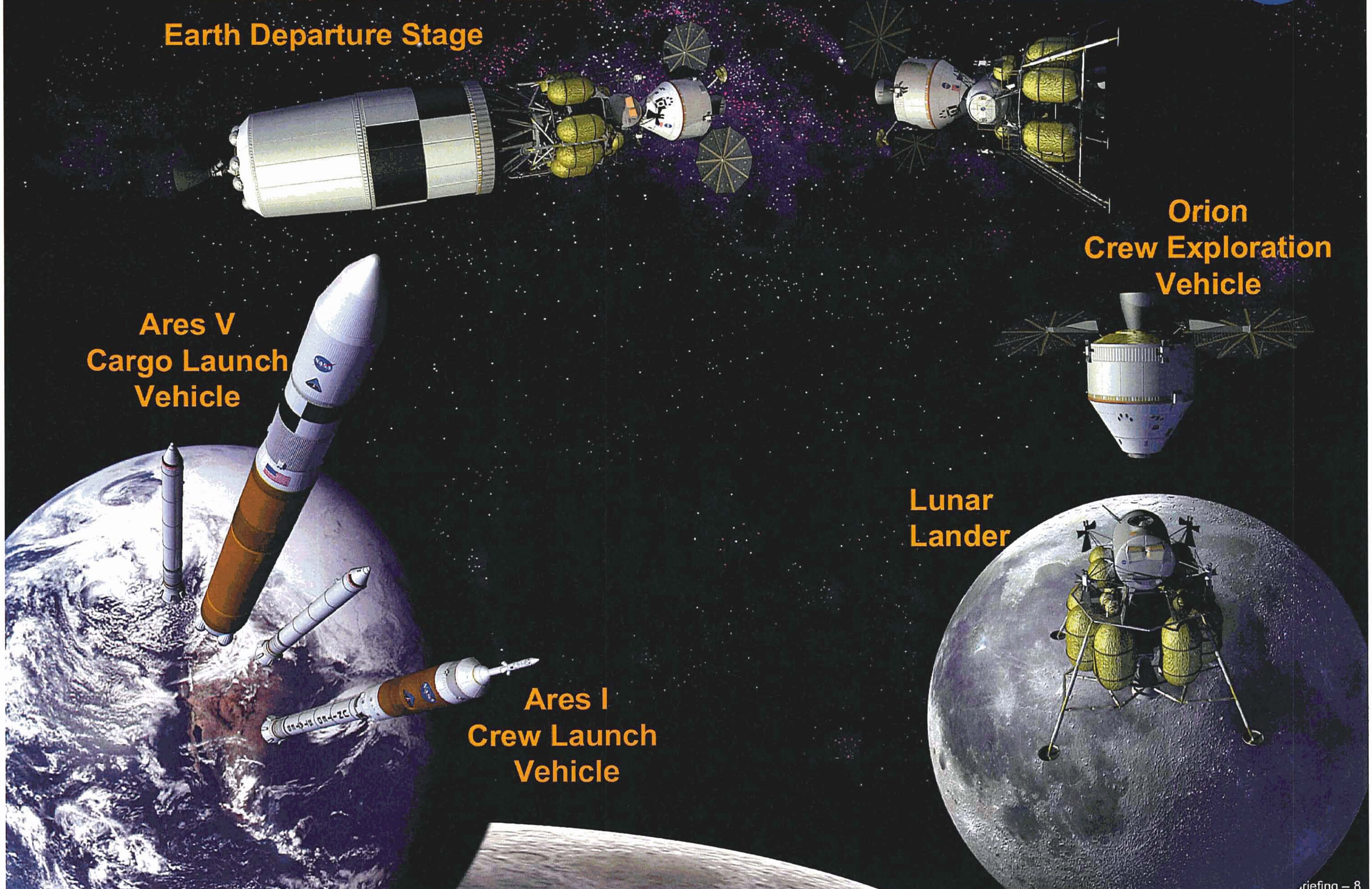




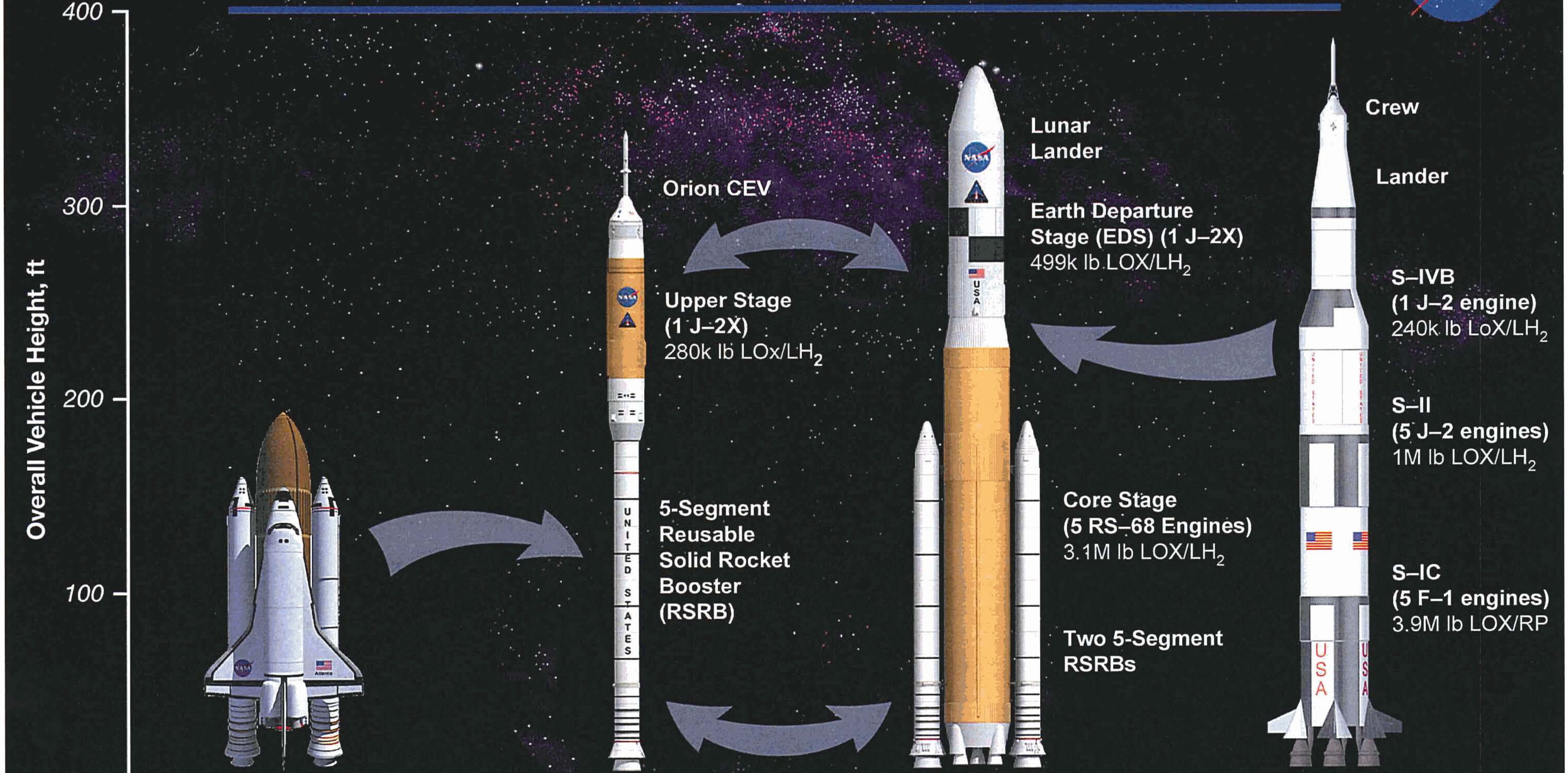
Next Step in Fulfilling Our Destiny As Explorers

There Are Many Places To Explore

Our Exploration Fleet



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



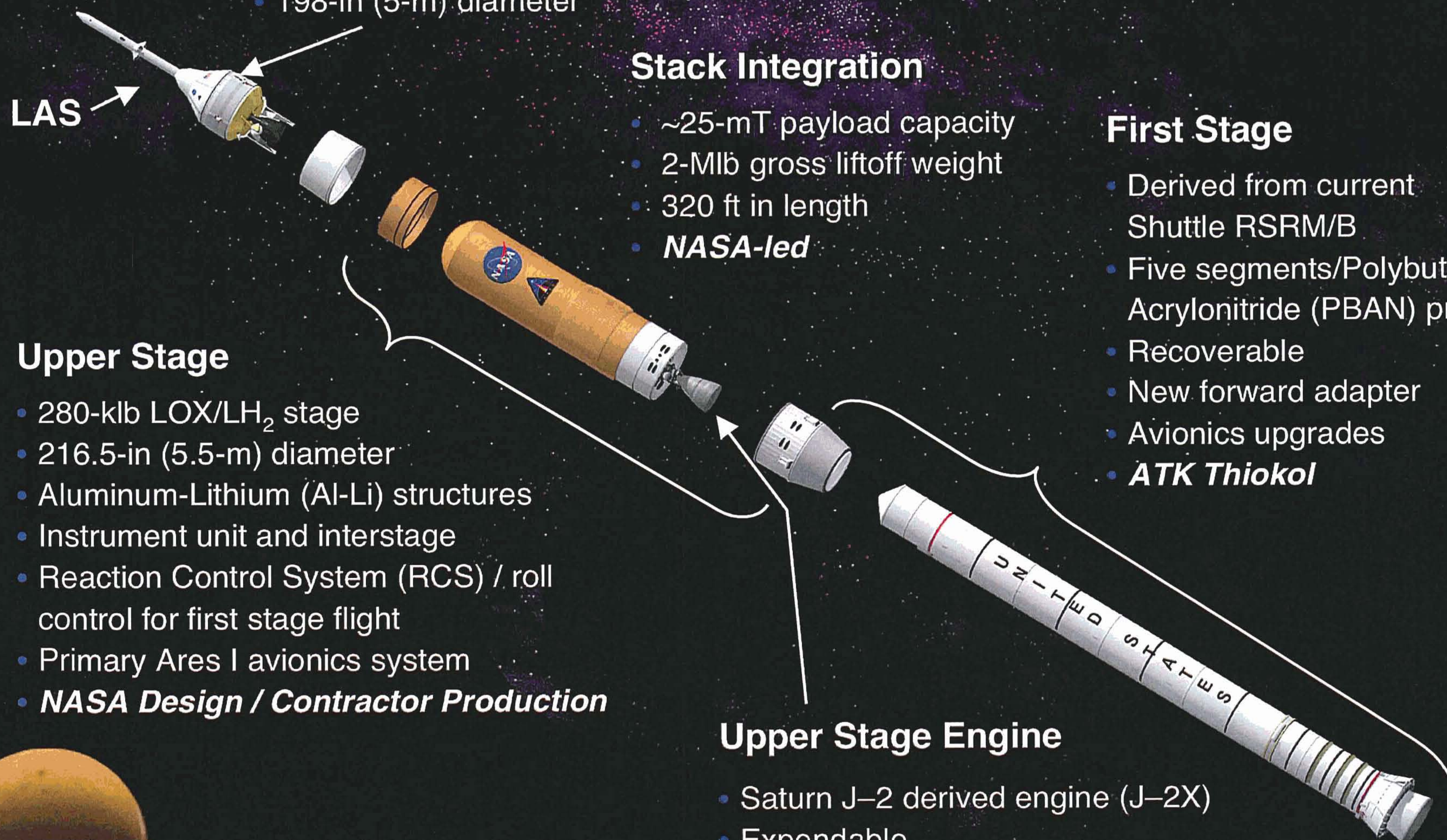
Space Shuttle
Height: 184.2 ft
Gross Liftoff Mass: 4.5M lb
55k lbm to LEO

Ares I
Height: 321 ft
Gross Liftoff Mass: 2.0M lb
48k lbm to LEO

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

Ares I Elements



Orion CEV

- 198-in (5-m) diameter

Stack Integration

- ~25-mT payload capacity
- 2-Mlb gross liftoff weight
- 320 ft in length
- ***NASA-led***

First Stage

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

Upper Stage

- 280-klb LOX/LH_2 stage
- 216.5-in (5.5-m) diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- Reaction Control System (RCS) / roll control for first stage flight
- Primary Ares I avionics system
- ***NASA Design / Contractor Production***

Upper Stage Engine

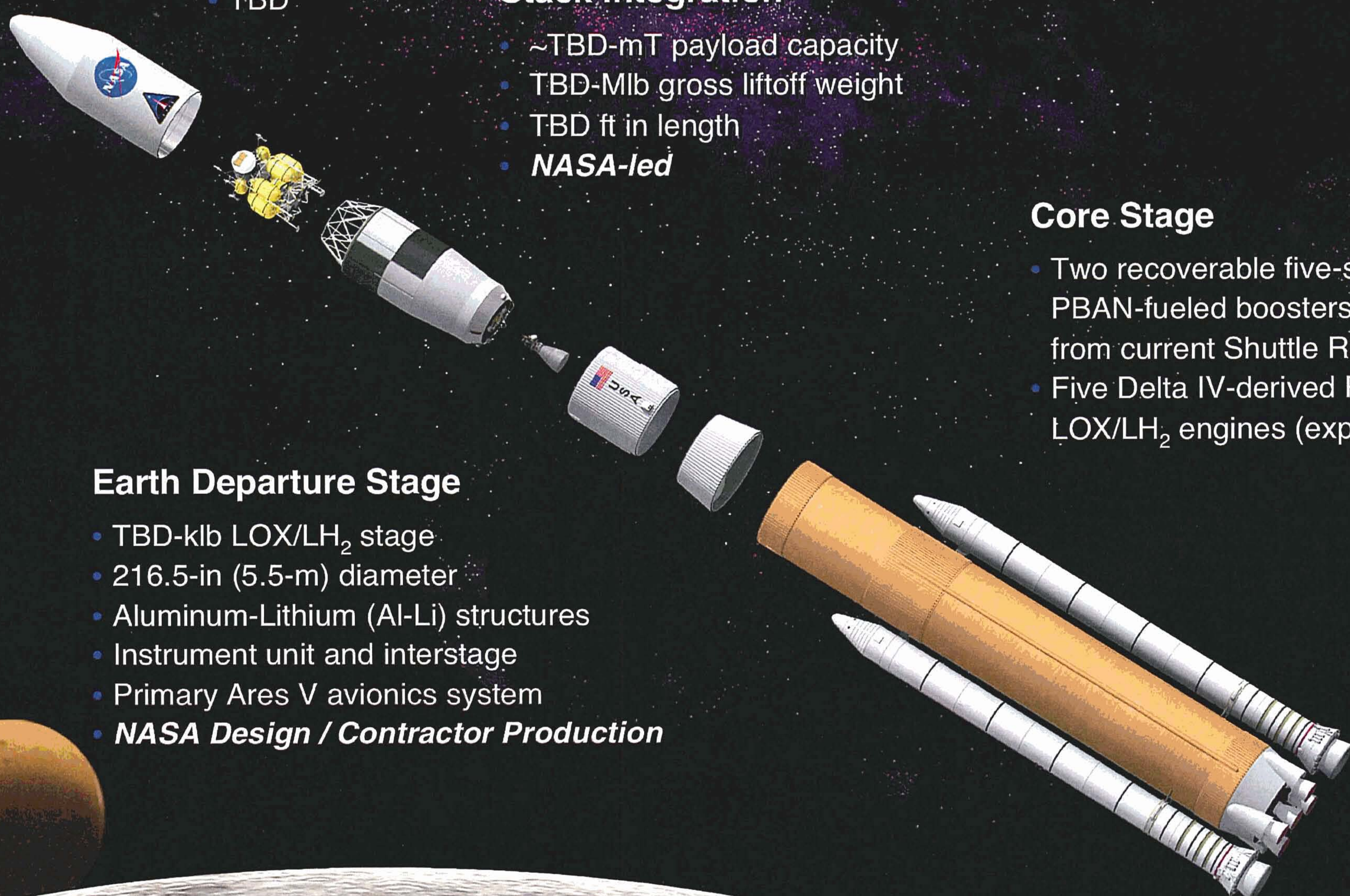
- Saturn J–2 derived engine (J–2X)
- Expendable
- ***Pratt and Whitney Rocketdyne***

Ares V Elements

LSAM
- TBD

Stack Integration
- ~TBD-mT payload capacity
- TBD-Mlb gross liftoff weight
- TBD ft in length
- ***NASA-led***

Core Stage
- Two recoverable five-segment PBAN-fueled boosters (derived from current Shuttle RSRM/B).
- Five Delta IV-derived RS–68 LOX/LH_2 engines (expendable).



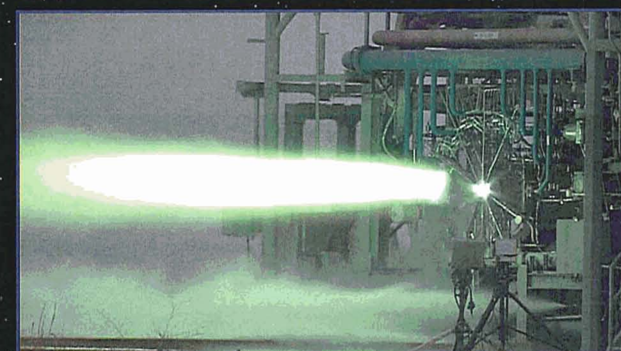
Earth Departure Stage
- TBD-klb LOX/LH_2 stage
- 216.5-in (5.5-m) diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- Primary Ares V avionics system
- ***NASA Design / Contractor Production***

NASA's Exploration Transportation System

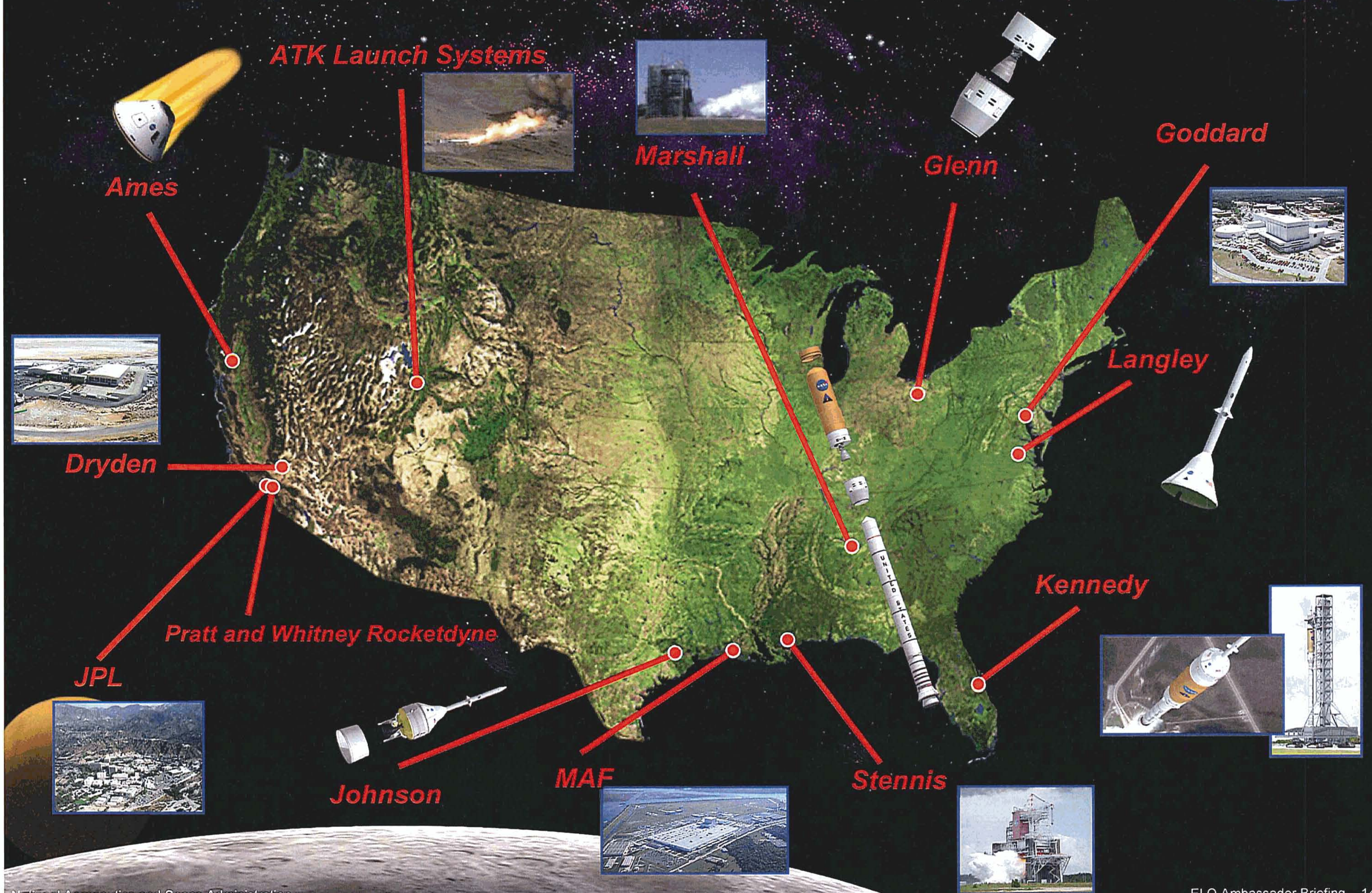
Progress Towards Launch

- **Programmatic Milestones**
  - CLV System Requirements Review ongoing.
  - 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–1 Upper Stage mass simulator
  - Ares I–1 First Stage hardware fabrication

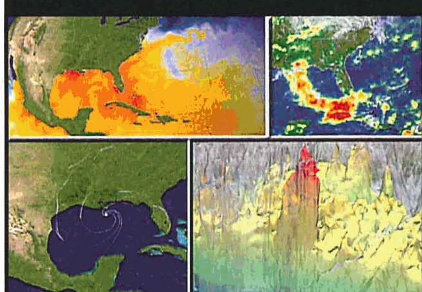


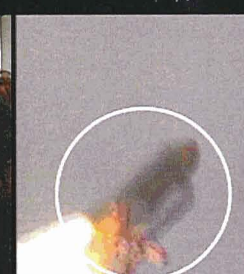
Our Nationwide Team



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 services such as direct TV and remote sensing drove an upswing
    - 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





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

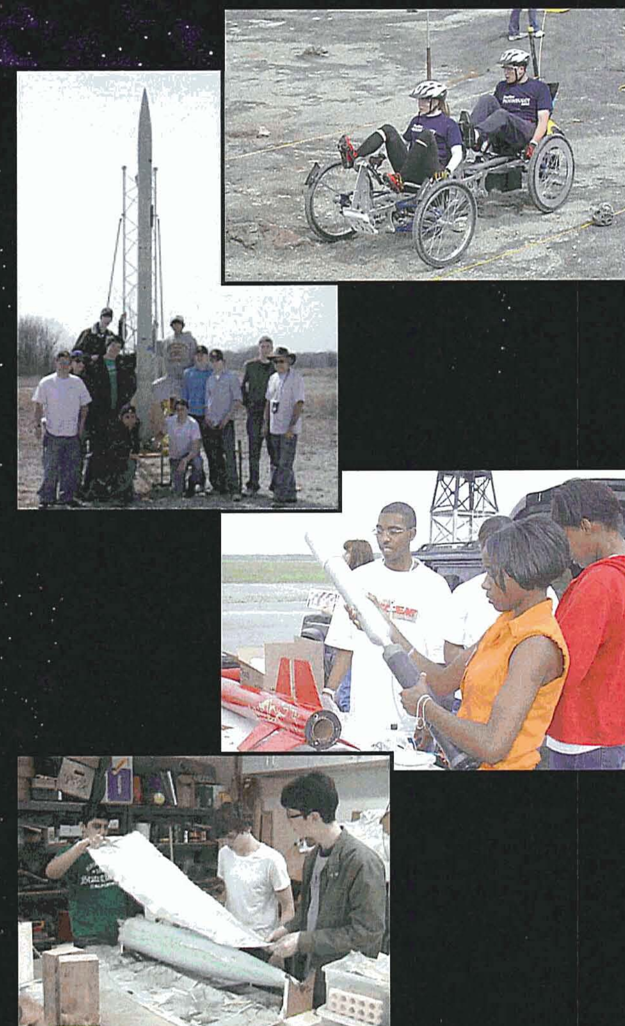
- Many U.S. scientists and engineers, and teachers of those subjects, will retire in the next 10 years
- Less than 6% of high school seniors are pursuing engineering degrees, down from 36% a decade ago
- China produces 6 times more engineers than the U.S., and the European Union produces 3 times as many as the U.S.

The Stakes Are High

- In a survey on math and science literacy, U.S. 8th graders scored 15th in math and 9th in science out of 45 countries
- U.S. high school seniors scored 19th out of 21 countries in math and last among 16 countries in physics
- We spend over $440 billion on public education, more per capita than any country except for Switzerland

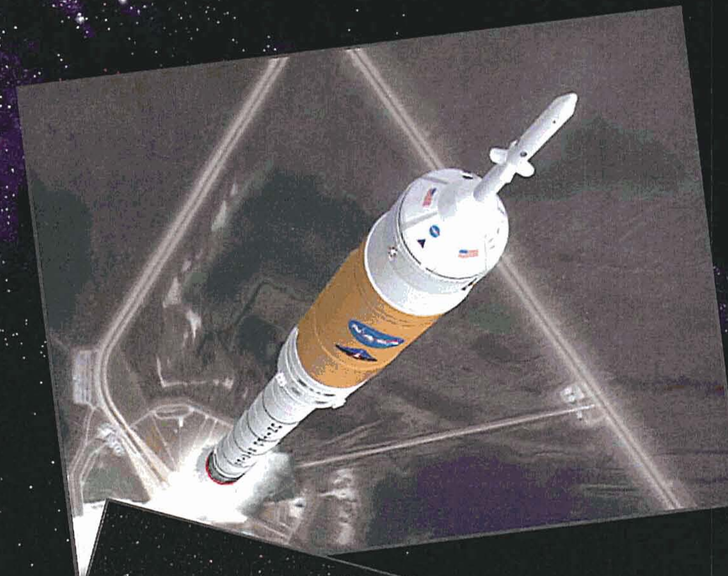
Potential Solutions: Well-Qualified, Motivated Teachers and a National Commitment

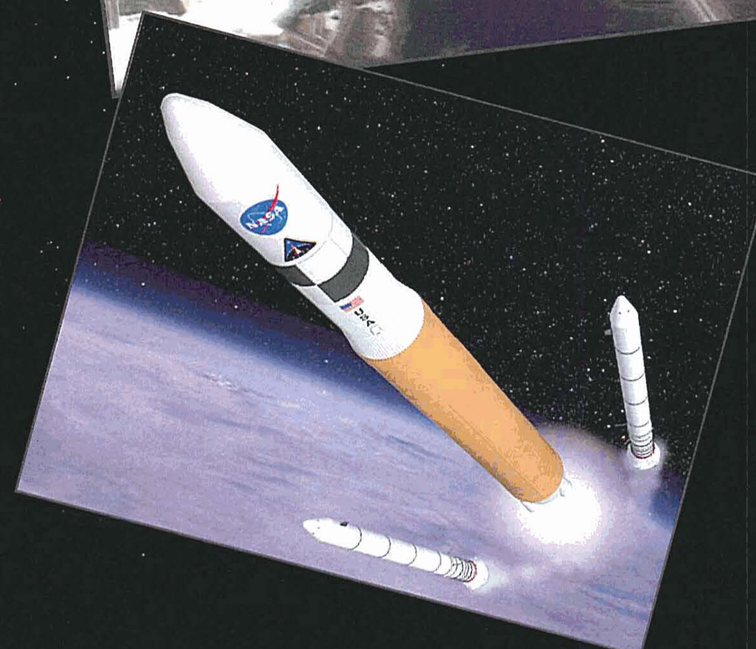
- The highest predictor of student performance is teacher knowledge
- The teacher's passion for the subject transmits to students
- The NASA Explorer Schools Program was chosen one of the Top 50 Government innovations in 2005 by the Ash Institute for Democratic Governance and Innovations



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!





It's Up To You To Make It Happen!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