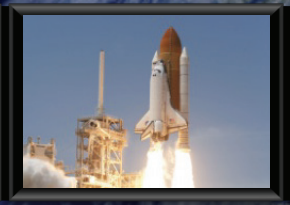
National Aeronautics and Space Administration

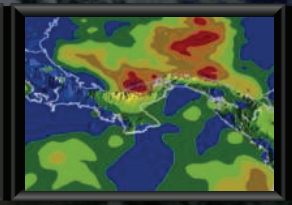
Marshall Space Flight Center

Launching the Future of Science and Exploration

Space Launch System

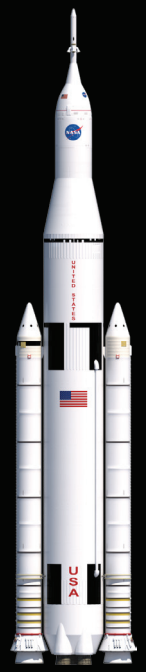







Robert D. (Daryl) Woods, Deputy Manager
Program Planning and Control Office
Space Launch System Program

Marshall's Role in Space Exploration



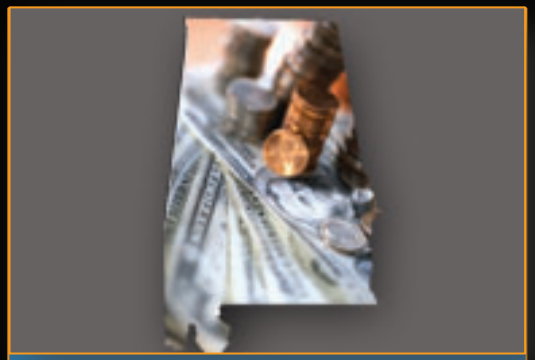
Lifting from Earth

Living and Working in Space

Understanding Our World and Beyond

Marshall makes significant contributions to America's space program.

From Exploration to Opportunity



$2.88 billion (FY2009)
impact to
Alabama economy

Nearly 6,000 employees
(civil service and contractor, approximate number)

3rd largest employer
in the Huntsville – Madison County area

4.5 million square feet
of space occupied
in Huntsville

2.2 million square feet
of manufacturing space at
Michoud Assembly Facility

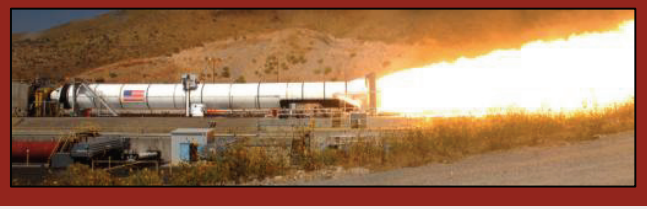
Marshall impacts the community.

Transitioning to Space Launch System

- Ares Project
- Shuttle Program
- Orion Project
- Mission Operations Project
- Extravehicular Systems Project
- Ground Operations Project

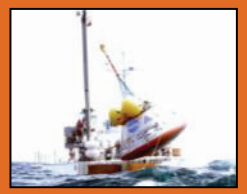
EXPLORATION SYSTEMS DEVELOPMENT

Space Launch System (SLS) Program


Orion Multi-Purpose Crew Vehicle (MPCV) Program




21st Century Ground Systems Program




Beginning With Available Resources and Technologies

Advancing the U.S. Legacy of Human Exploration

NASA Vision

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

NASA Strategic Goals

✔ *Extend and sustain human activities across the solar system.*

✓ Expand scientific understanding of the Earth and the universe in which we live.

✓ Create the innovative new space technologies for our exploration, science, and economic future.

Advance aeronautics research for societal benefit.

✓ Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.

✓ Share NASA with the public, educators, and students to provide opportunities to participate in our mission, foster innovation, and contribute to a strong national economy.

SLS — Safe, Affordable, and Sustainable

NASA Authorization Act of 2010

- **The Congress approved and the President signed the National Aeronautics and Space Administration Authorization Act of 2010**
  - Bipartisan support for human exploration beyond low-Earth orbit (LEO)

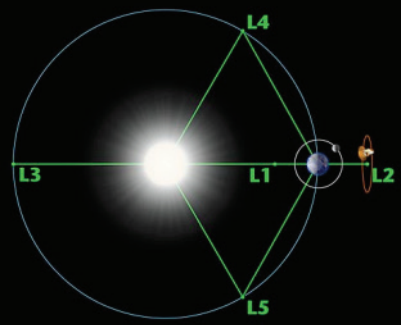
- **The Law authorizes**
  - Extension of the International Space Station (ISS) until at least 2020
  - Strong support for a commercial space transportation industry
  - **Development of the Orion Multi-Purpose Crew Vehicle (MPCV) and heavy lift launch capabilities**
  - A "flexible path" approach to space exploration, opening up vast opportunities including near-Earth asteroids and Mars
  - New space technology investments **to increase the capabilities beyond Earth orbit (BEO)**

This rocket is key to implementing the plan laid out by President Obama and Congress in the bipartisan 2010 NASA Authorization Act.
— NASA Administrator Charles Bolden
September 14, 2011

Delivering on the Laws of the Land ... and Obeying the Laws of Physics

SLS Is a National Asset for Multiple Stakeholders and Partners

SLS Offers Flexible Capability for Exploration Missions



High-Earth Orbit (HEO)/Geosynchronous-Earth Orbit (GEO)/Lagrange Points:
– Microgravity destinations beyond LEO
– Opportunities for construction, fueling, and repair of complex in-space systems
– Excellent locations for advanced space telescopes and Earth observatories

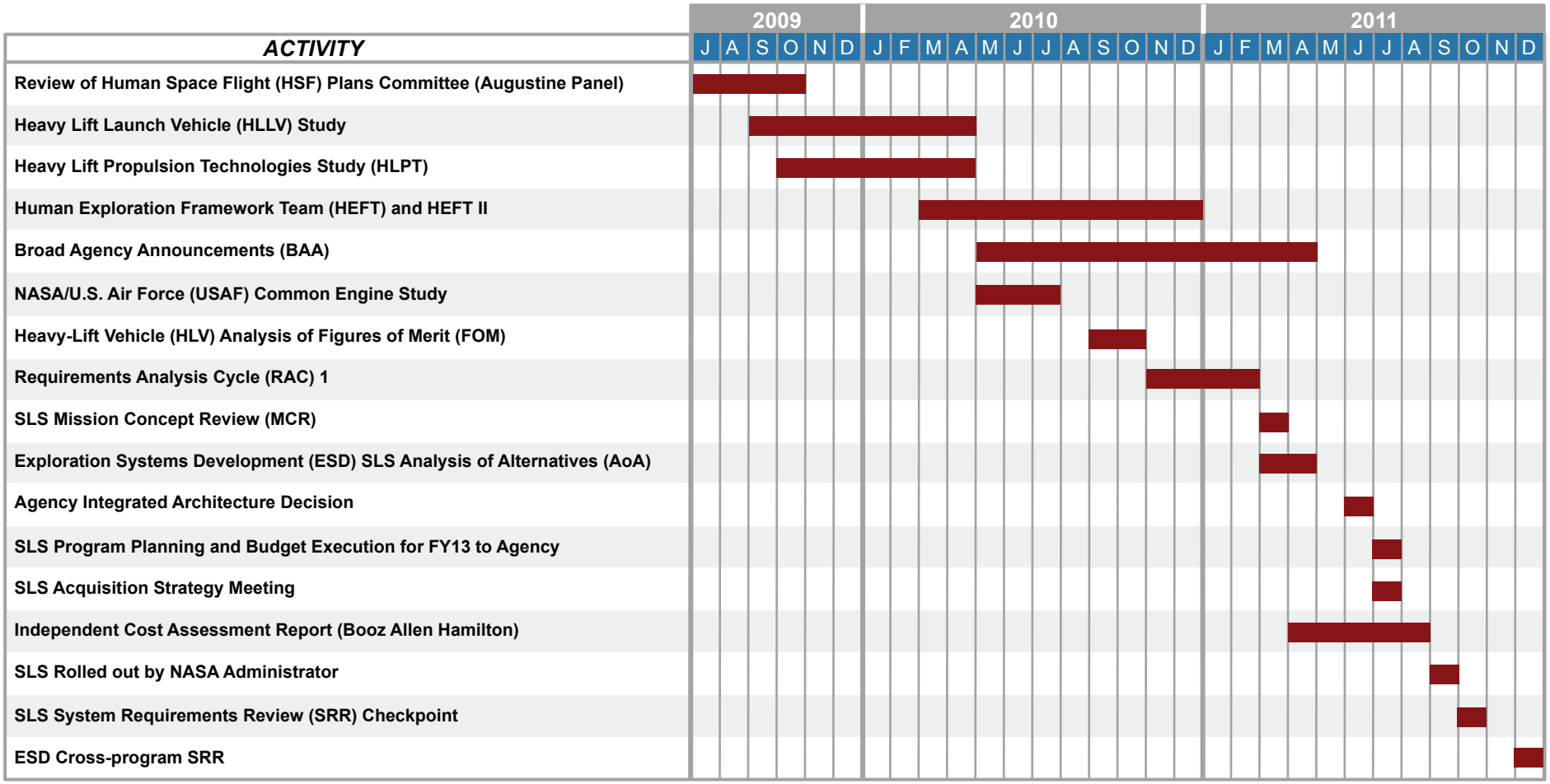
Mars and Its Moons Phobos and Deimos:
– A premier destination for discovery:
Is there life beyond Earth?
How did Mars evolve?
– True possibility for extended, even permanent, stays
– Significant opportunities for international collaboration
– Technological driver for space systems

Earth's Moon:
– Witness to the birth of the Earth and inner planets
– Has critical resources to sustain humans
– Significant opportunities for commercial and international collaboration

Near-Earth Asteroids:
– Compelling science questions:
How did the Solar System form? Where did Earth's water and organics come from?
– Planetary defense: Understanding and mitigating the threat of impact
– Potential for valuable space resources
– Excellent stepping stone for Mars

Increasing Our Reach and Expanding Our Boundaries

SLS Roadmap: Extensive Engineering and Business Analyses and Planning



"Take your time and get it right."

—Tom Gavin, Jet Propulsion Laboratory

SLS Mission Concept Review, March 2011

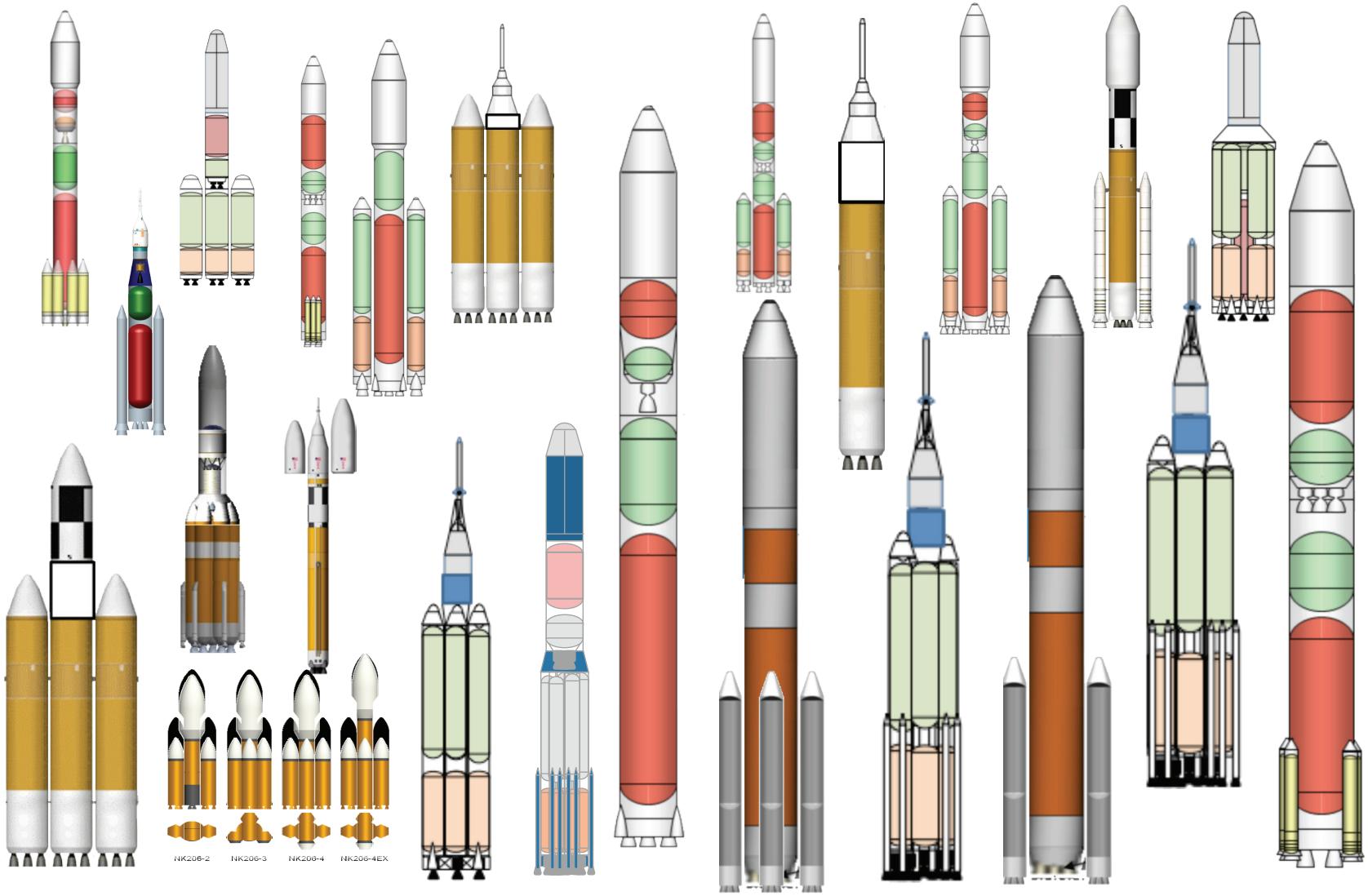
SLS Driving Objectives

- **Safe: Human-Rated**
  - Loss of Crew/Loss of Mission: TBR
- **Affordable**
  - Constrained budget environment, with no planned escalation
  - Maximum use of common elements and existing assets, infrastructure, and workforce

- **Initial Capability: 70 tonnes (t) 2017–2021**
  - Serves as primary transportation for Orion MPCV and exploration missions
  - Provides back-up capability for crew/cargo to ISS
- **Evolved Capability: 130 t post–2021**
  - Offers large volume for science missions and payloads
  - Modular and flexible, sized to mission requirements

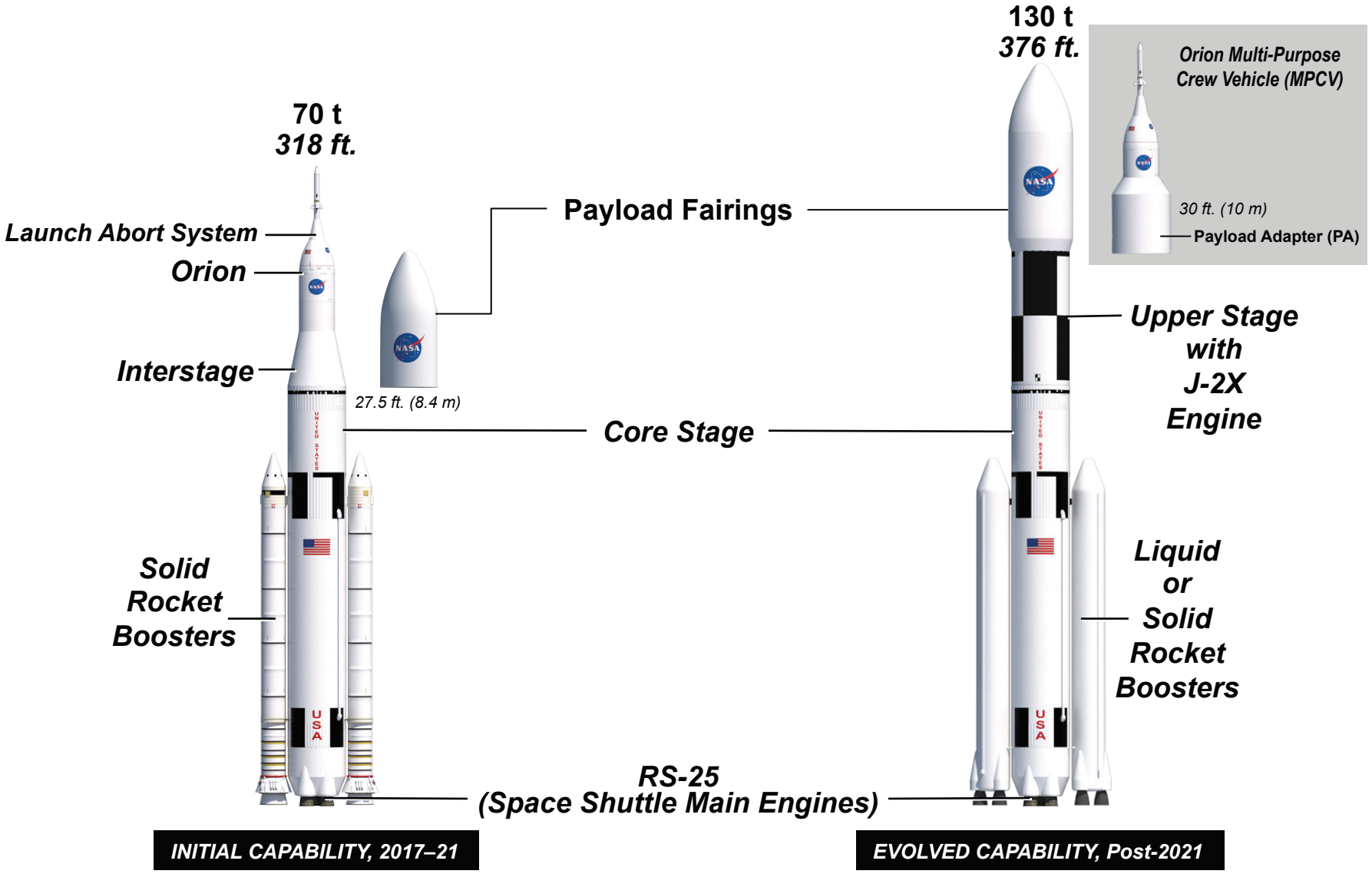
SLS First Flight 2017

Many Solutions Considered: One Affordable Answer



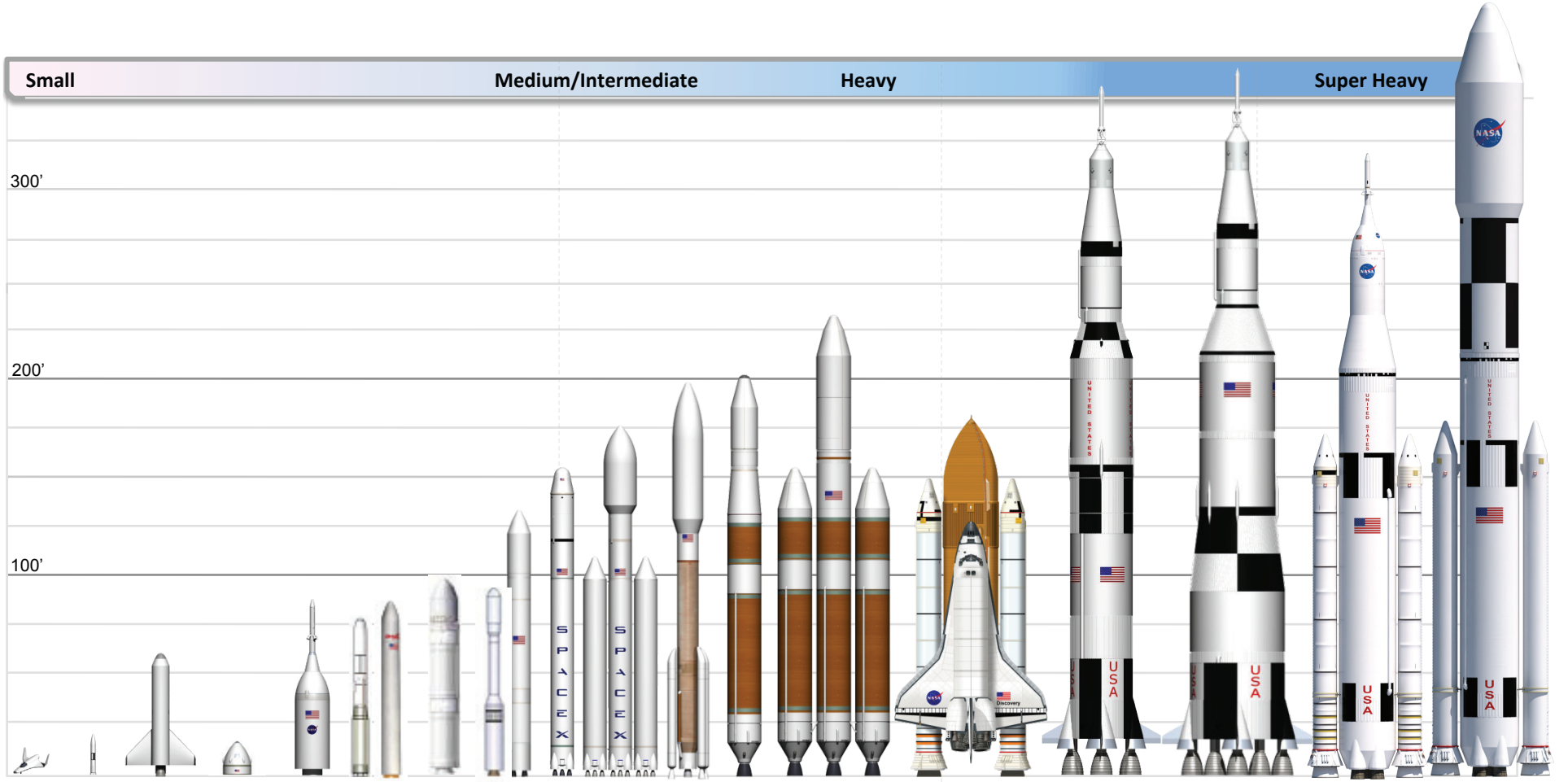
"This enterprise is not for the faint of heart."
—Wayne Hale

SLS Architecture Uses Existing and Advanced Technologies to Fly in 2017



Built in the U.S.A.

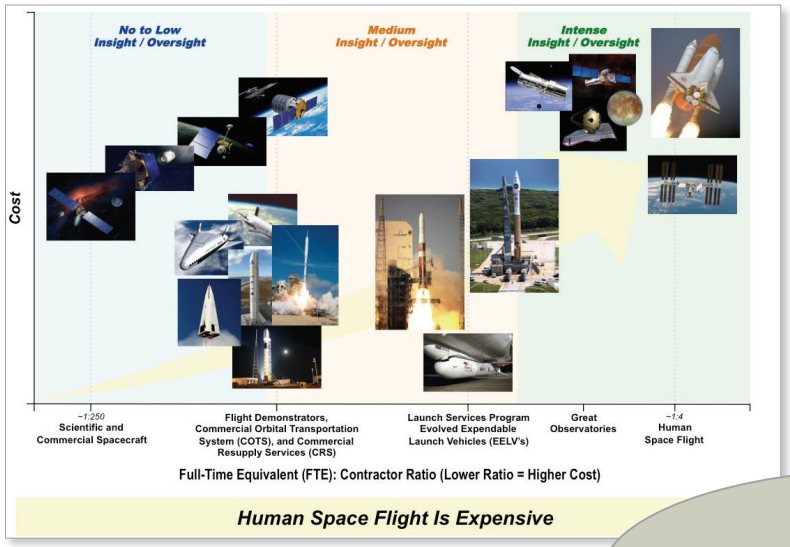
SLS Will Be the Most Capable U.S. Launch Vehicle

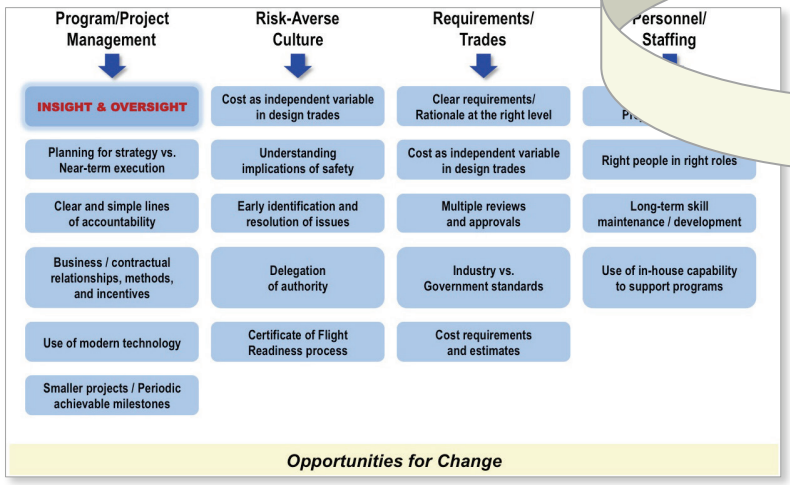


XCOR Lynx	Masten XA-1.0	AFRL RBX Pathfinder	NESC MLAS	Orbital AA-2	Orbital Minotaur IV & V	ATK Athena II C	Orbital Taurus I & II	SpaceX Falcon 9 & 9H	ULA Atlas V 551	ULA Delta IV M	ULA Delta IV H	NASA Space Shuttle	NASA Saturn V	NASA Nova Concept Only	NASA SLS 70 t 130 t

Sample of Proposed and Fielded U.S. Systems

SLS Affordability Tenets





- **Evolvable Development Approach**
  - Manage Within Constrained / Flat Budgets
  - Leverage Existing National Capabilities
  - Infuse New Design Solutions for Affordability
- **Robust Designs and Margins**
  - Performance Traded for Cost and Schedule
- **Risk-Informed Government Insight/Oversight Model**
  - Insight Based On:
    - Historic Failures
    - Industry Partner Past Performance/Gaps
    - Complexity and Design Challenges
  - Judicious Oversight:
    - Discrete Oversight vs Near Continuous
    - Decisions Made Timely and Effectively
- **Right Sized Documentation and Standards**
  - Reduction in the Number of Program Documents
  - Industry Practices and Tailored NASA Standards
- **Lean, Integrated Teams with Accelerated Decision Making**
  - Simple, Clear Technical Interfaces with Contractor
  - Integrated SE&I Organization
  - Empowered Decision Makers at All Levels

Improved Human Space Flight Affordability Required for Sustainability

Potential to Build on Heritage Hardware and Facilities

J-2X Test Firing/Space Shuttle Main Engine Testing
Stennis Space Center

Payloads
Goddard Space Flight Center

Orion MPCV Integration
Johnson Space Center

Composite Structures
Glenn Research Center

Ground and Launch Operations
Kennedy Space Center

Physics Based Analysis
Ames Research Center

Manufacturing and Transportation
Michoud Assembly Facility

Wind Tunnel Testing
Langley Research Center

Standing Review Team
Jet Propulsion Laboratory

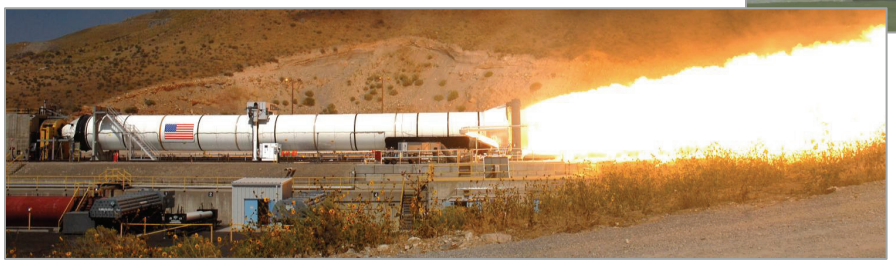
J-2X Upper Stage Engine Injector Firing
Marshall Space Flight Center

Smartly Selecting the Most Efficient Infrastructure

SLS Recent Activities and Accomplishments

Hardware Accomplishments

- J-2X upper stage engine testing
- Solid Rocket Booster development motor 3 firing



Formulation Activities

- Formulation Authorization Document (FAD)
- Key Decision Point A (KDP A) memo
- FY13 Program Planning & Budget Estimate submission
- Initial General Accountability Office engagement
- System Requirements Review checkpoint

SLS Program Roll-Out

- Marshall Team Pre-briefing
- Acquisition Strategy and Industry Day
- Website launched

Summary

- SLS is a national capability that empowers entirely new exploration missions.
- Program key tenets are *safety, affordability, and sustainability.*
- SLS builds on a solid foundation of experience and current capabilities to enable a fast start and a flexible heavy-lift capacity for missions of national importance.
- The SLS acquisition will help U.S. aerospace industry stay strong as it develops initial capabilities, as well as provide competitive opportunities for advanced technologies for evolved capabilities.
- The SLS Team has made significant progress and looks forward to working with you to continue America's leadership in space.

For More Information

www.nasa.gov/sls