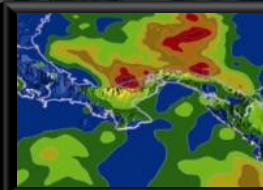




Space Launch System (SLS) Program Progress Report



Space Launch System



Name
NASA Marshall Space Flight Center
Date

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*

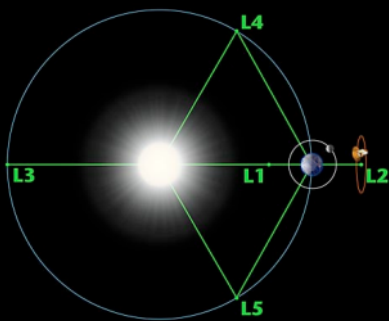


Delivering on the Laws of the Land ... and Obeying the Laws of Physics

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

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



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

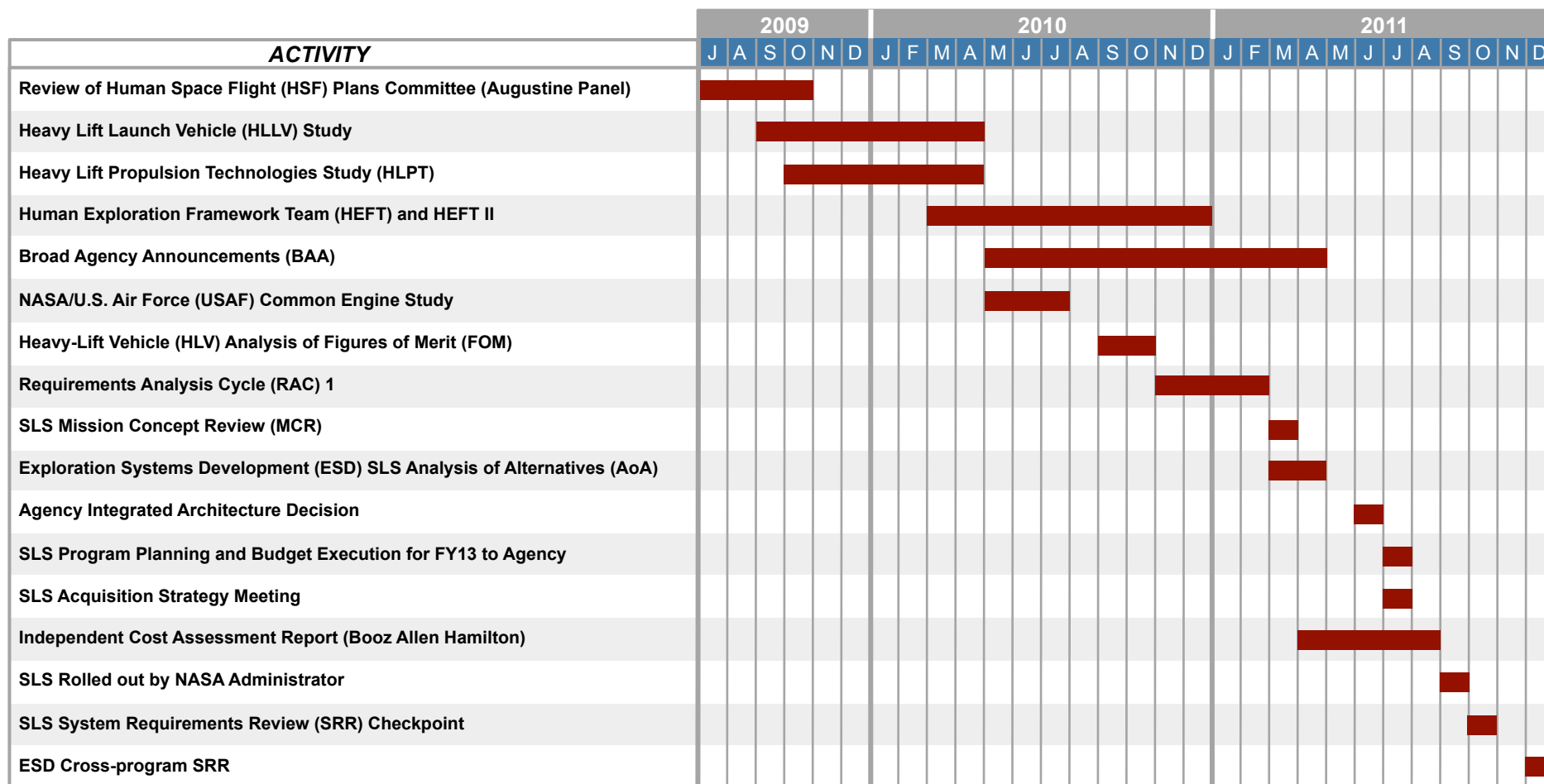


Near-Earth Asteroids:

- 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

- Loss of Crew: 1/700
- Loss of Mission: 1/100

◆ Affordable

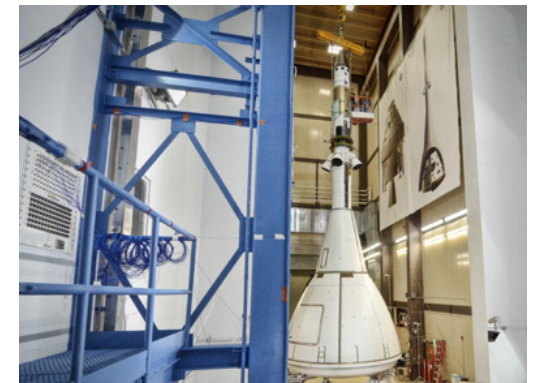
- Constrained budget environment, with no planned escalation
- Maximum use of common elements and existing assets, infrastructure, and workforce

◆ Initial Capability: 70 tonnes (t), 2017–2021

- Primary transportation for Orion MPCV and exploration missions
- Back-up capability for crew/cargo to ISS

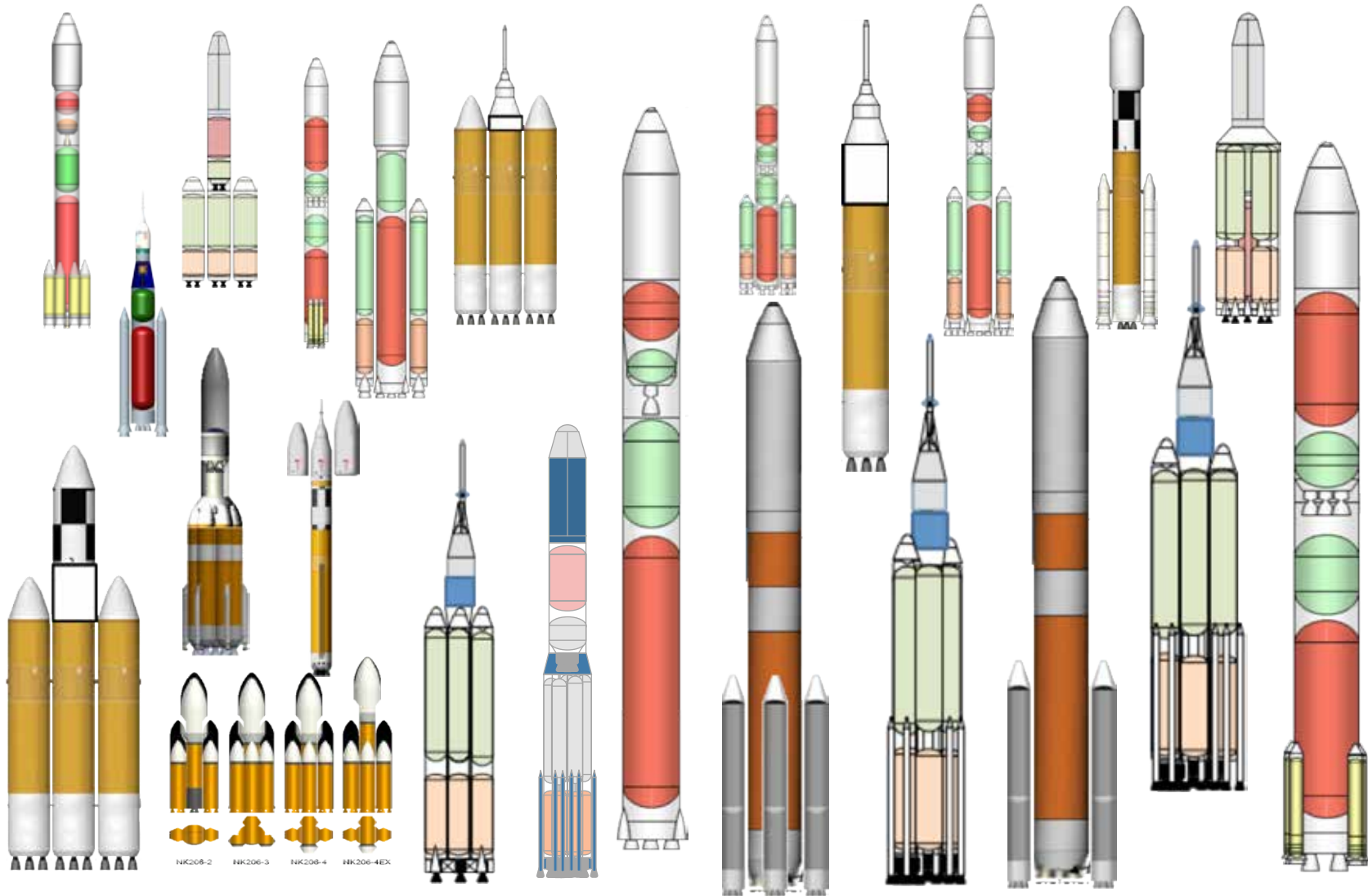
◆ Evolved Capability: 130 t, post–2022

- Large volume for science missions and payloads
- Modular and flexible, sized for mission requirements



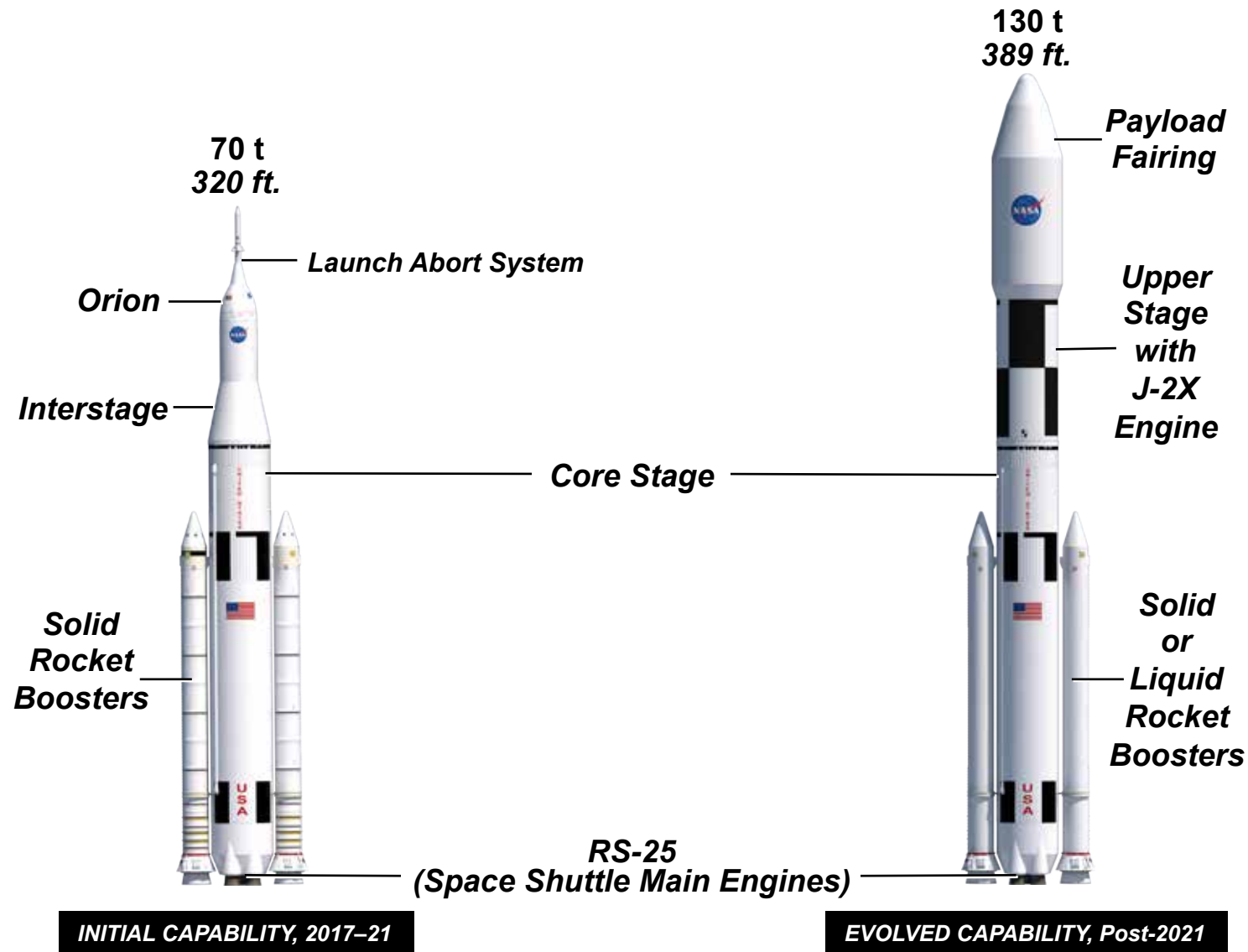
SLS First Flight in 2017

Many Solutions Considered: One Affordable Answer



***“This enterprise is not for the faint of heart.”
—Wayne Hale***

SLS Maximizes U.S. Aerospace Workforce and Capabilities



INITIAL CAPABILITY, 2017-21

EVOLVED CAPABILITY, Post-2021

Leverages Existing Contracts, While Competing the Future

SLS Vehicle Configuration Decision



◆ Maintains U.S. leadership in liquid oxygen/liquid hydrogen (LOX/LH₂) technology

- LOX/LH₂ Core Stage uses RS-25 engines
- LOX/LH₂ Upper Stage uses J-2X engines
- Establishes fixed central design path, with logical use of existing strength in design and modern manufacturing approaches
- Harnesses existing knowledge base, skills, infrastructure, workforce, and industrial base for existing state-of-the-art systems



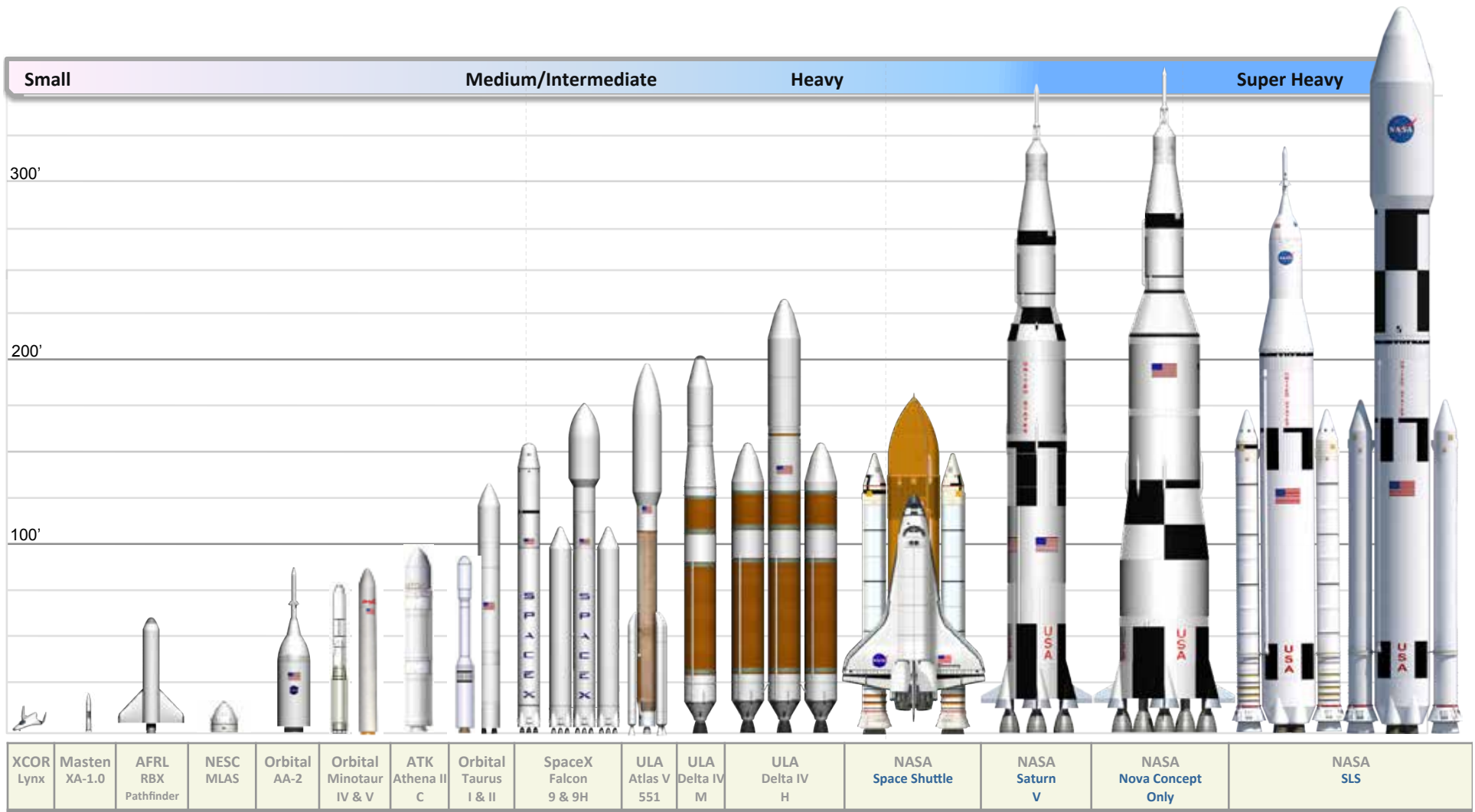
◆ Minimizes unique configurations during vehicle development

- Evolutionary path to 130 t allows incremental development; thus, progress will be made, even within constrained budgets
- Allows early flight certification for Orion
- May be configured for Orion or science payloads, providing flexible/modular design and system for varying launch needs
- Gains synergy, thus reducing design, development, test, and evaluation (DDT&E) costs and schedule by building the Core Stage and Upper Stage in parallel, thereby leveraging common tooling and engine-feed components



Technical Trade Studies and Business Planning Validated Independently

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

Sample of Proposed and Fielded U.S. Systems

Notional Mission Design for First Flight in 2017 Orion Certification (Lunar Flyby, No Crew)



◆ Objectives

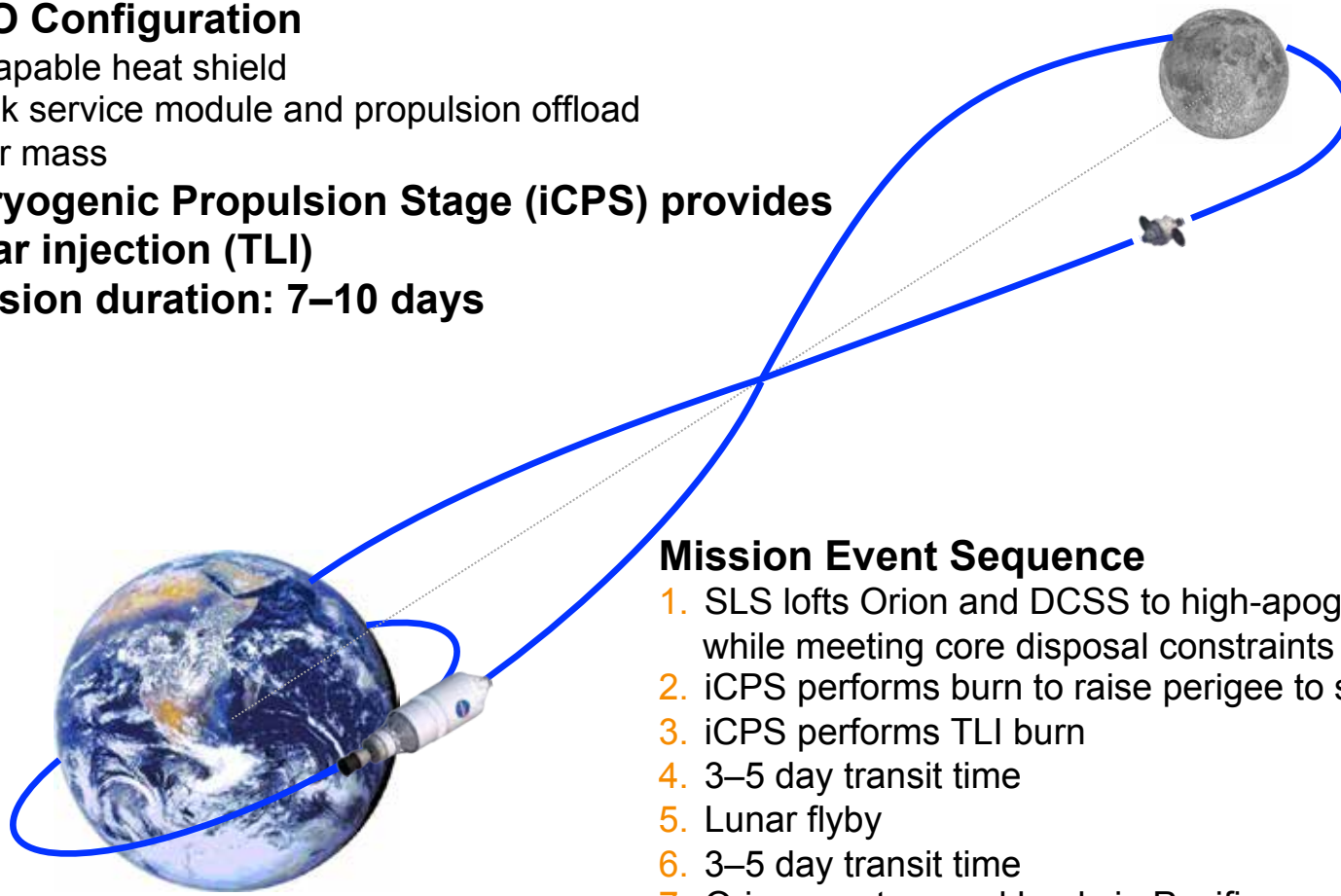
- Demonstrate spacecraft systems performance prior to crewed flight
 - High-speed entry (~11 km/s)
 - Thermal Protection System performance

◆ Orion BEO Configuration

- Lunar capable heat shield
- Two tank service module and propulsion offload for lower mass

◆ Interim Cryogenic Propulsion Stage (iCPS) provides trans-lunar injection (TLI)

◆ Orion Mission duration: 7–10 days



Mission Event Sequence

1. SLS lofts Orion and DCSS to high-apogee orbit while meeting core disposal constraints
2. iCPS performs burn to raise perigee to safe height
3. iCPS performs TLI burn
4. 3–5 day transit time
5. Lunar flyby
6. 3–5 day transit time
7. Orion reenters and lands in Pacific ocean

SLS Is a National Capability for International Cooperation



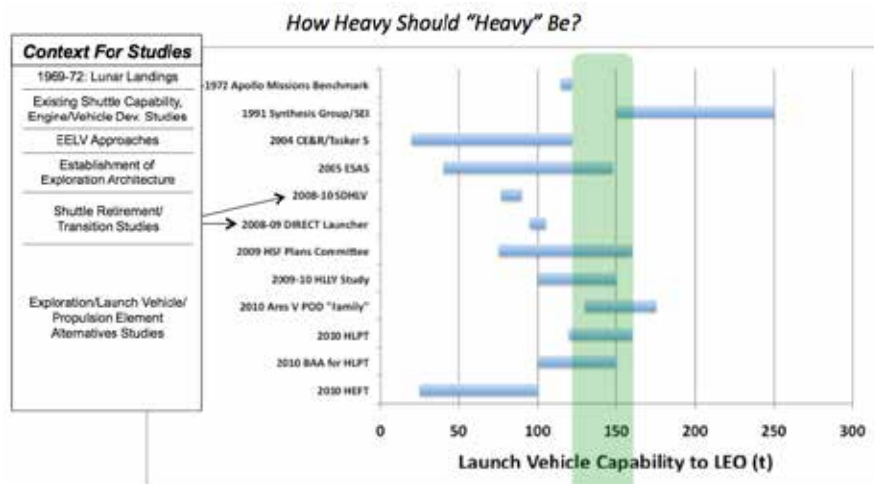
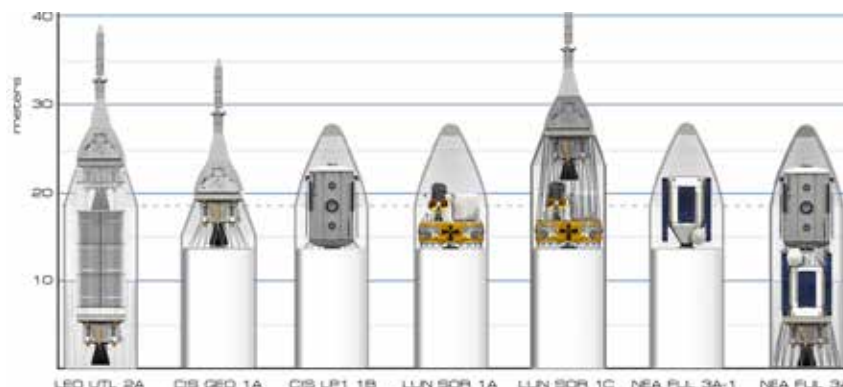
◆ Very Large Payload Diameters: 8.5–12 m

- BEO missions require 8-m to 10-m diameter
- Mars missions drive to diameters 10-m and larger, and increased heights above 22 m

◆ Large Mass Requirements

- Maintains reasonable number of launches per mission
- Simplifies on-orbit operations
- Maximizes mission reliability

◆ National capability for other endeavors



Capability Range From 125-160 T Agrees With Most Major Human Space Exploration Studies/Activities

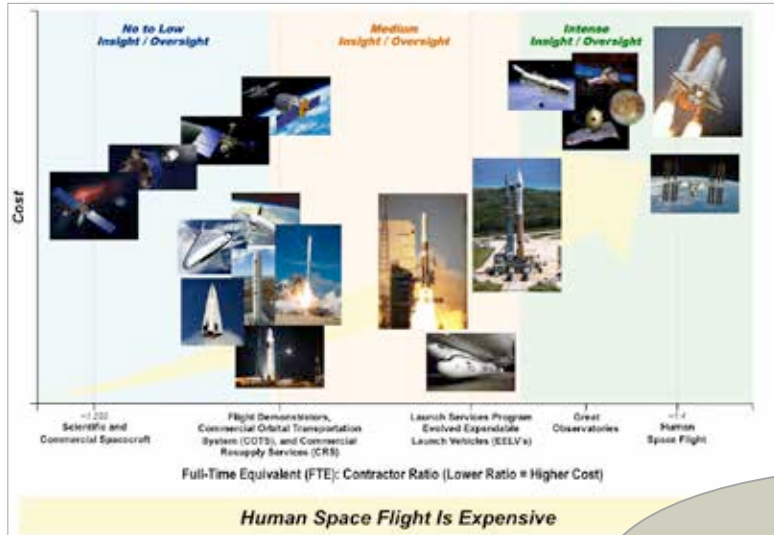
◆ Heavy Lift Unique Payload Capacity

- Mars Transfer Vehicle
- Deep Space Exploration Systems
- Planetary Landers
- Human Habitats
- Great Observatories
- Space Solar Power
- Outer Planet Missions
- National Security

"Agencies agree that human space exploration will be most successful as an international endeavor because there are many challenges to preparing for these missions and because of the significant social, intellectual, and economic benefits to people on Earth."

—Global Exploration Roadmap, September 2011

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 and gaps
 - Complexity and design challenges
- Judicious oversight:
 - Discrete oversight vs. near-continuous oversight
 - Timely and effective decisions

◆ 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 Systems Engineering & Integration organization
- Empowered decision makers at all levels

Improved Human Space Flight Affordability Required for Sustainability

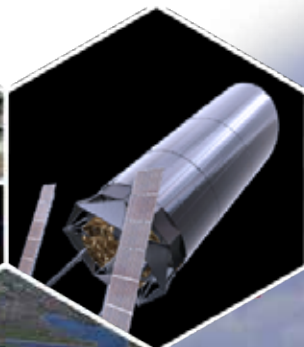
Potential to Build on Heritage Hardware and Facilities



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



Payloads
Goddard Space Flight Center



Orion 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

MCR Success Criteria	
	Current Evaluation
Does the system provide a system that	Y
Has been identified that is technically in an acceptable cost range.	N

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



Smartly Selecting the Most Efficient Infrastructure

SLS Recent Activities and Accomplishments



◆ NASA Pre-Formulation Phase Completed

- Program chartered
- Control Board chartered
- Team formed



◆ Hardware Accomplishments

- J-2X testing
- Development Motor 3 firing



◆ Formulation Activities

- Formulation Authorization Document
- Key Decision Point A memo
- FY13 budget submitted
- Initial General Accountability Office engagement
- System Requirements Review checkpoint in Oct.

◆ SLS Program Roll-Out

- Marshall team all-hands meeting
- Industry Day with 600 potential business partners
- Website launched



Summary



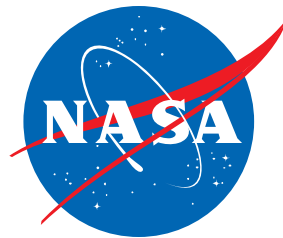
- ◆ **SLS is a national capability that empowers entirely new exploration missions.**
- ◆ **Program key tenets are *safety, affordability, and sustainability*.**
- ◆ **SLS builds on a solid foundation of experience and current capabilities to enable a fast start and a flexible heavy-lift capacity for 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.**



Exploring Space for America's Future

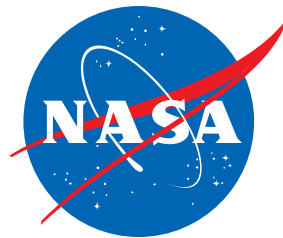


For More Information



www.nasa.gov/sls

BACKUP



www.nasa.gov/sls

SLS Maximizes U.S. Aerospace Workforce and Capabilities



◆ Boosters

- 5-segment Solid Rocket Booster in-scope modification to existing Ares contract with ATK for initial flights through 2021
- Advanced Boosters
 - Engineering demonstration and risk reduction via NASA Research Announcement (NRA): Full and Open Competition later this year
 - Design, Develop, Test, & Evaluation (DDT&E): Full and Open Competition

◆ Stages

- Core/Upper Stage: Justification for Other Than Full and Open Competition (JOFOC) to Boeing, modifying current Ares Upper Stage contract
- Avionics
 - Instrument Unit Avionics: In-scope modification to existing Ares contract with Boeing; to be consolidated with Stages contract to Boeing

◆ Engines

- Core Stage Engine: RS-25 JOFOC to existing Space Shuttle contract with Pratt & Whitney Rocketdyne (PWR)
- Upper Stage Engine: J-2X in-scope modification to existing Ares contract with PWR

◆ Spacecraft and Payload adapter and Fairing

- Full and Open Competition to begin in FY13

◆ Advanced Development

- Broad Agency Announcement (BAA)/NRA: Full and Open Competition
- Future Core Stage Engine: Separate contract activity to be held in the future



Delivers Near-Term Initial Capabilities and Spurs Competition for Evolved Capabilities

Key Milestones