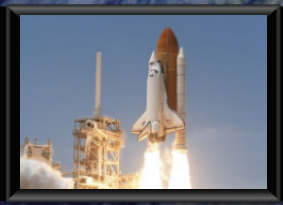
National Aeronautics and Space Administration

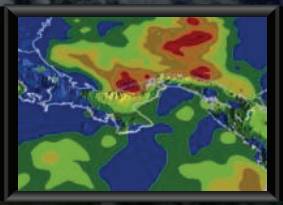
Space Launch System (SLS) Progress Report

NASA Project Management Challenge 2012

Space Launch System








Joan (Jody) A. Singer, Deputy Program Manager
Todd A. May, Program Manager
NASA Marshall Space Flight Center

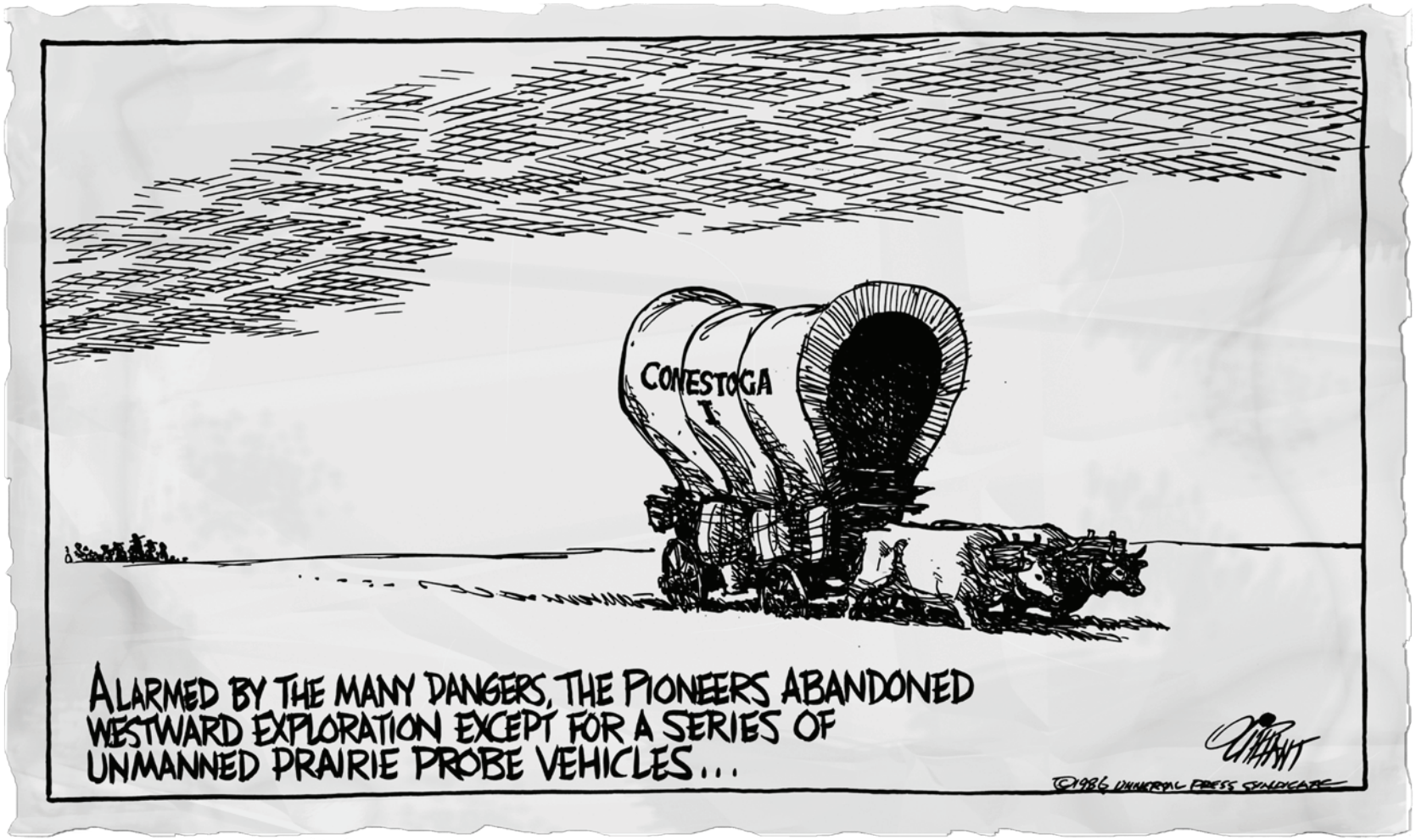
February 22—23, 2012

www.nasa.gov

Agenda

- **Our Mandate: Deliver the Nation's Next Human-Rated Space Transportation System**
- **How We Got Here: A Brief History of SLS**
- **Why We Will Succeed: Doing Things Differently and Expecting Different Results**
- **Questions & Answers**

The Next Horizon



Discovering, Learning, Understanding

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.

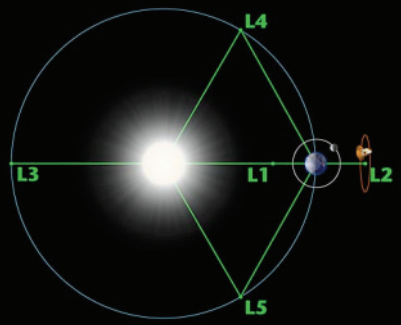
Advance aeronautics research for societal benefit.

✓ 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

Flexible Capability for Exploration Missions



High-Earth Orbit (HEO)/
Geosynchronous-Earth Orbit
(GEO)/Lagrange Points

Mars and Its Moons
Phobos and Deimos

Earth's Moon

Near-Earth Asteroids

Increasing Our Reach and Expanding Our Boundaries

Agenda

- Our Mandate: Deliver the Nation's Next Human-Rated Space Transportation System
- How We Got Here: A Brief History of SLS
- Why We Will Succeed: Doing Things Differently and Expecting Different Results
- Questions & Answers

NASA Authorization Act of 2010

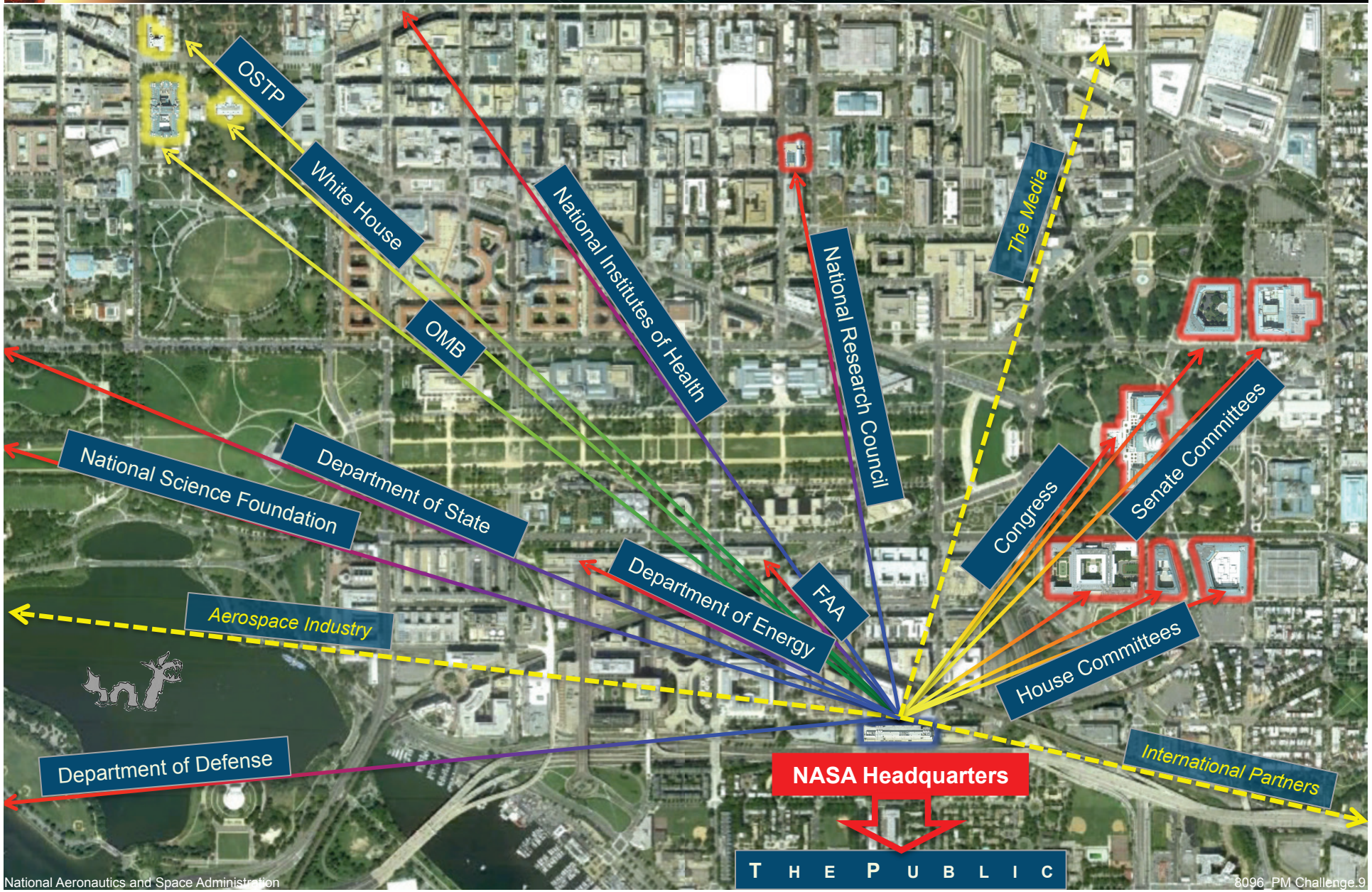
- **The Congress approved and the President signed the National Aeronautics and Space Administration Authorization Act of 2010.**
  - Bipartisan support for human exploration beyond low-Earth orbit (LEO).

- **The Law authorizes:**
  - Extension of the International Space Station (ISS) until at least 2020.
  - Strong support for a commercial space transportation industry.
  - Development of Orion 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 capabilities beyond Earth orbit (BEO).

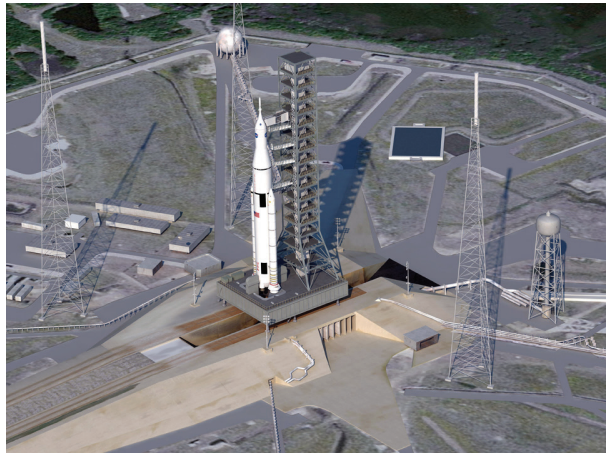
This rocket is key to implementing the plan laid out by President Obama and Congress in the bipartisan 2010 NASA Authorization Act.
— NASA Administrator Charles Bolden
September 14, 2011

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

SLS Serves Many Stakeholders



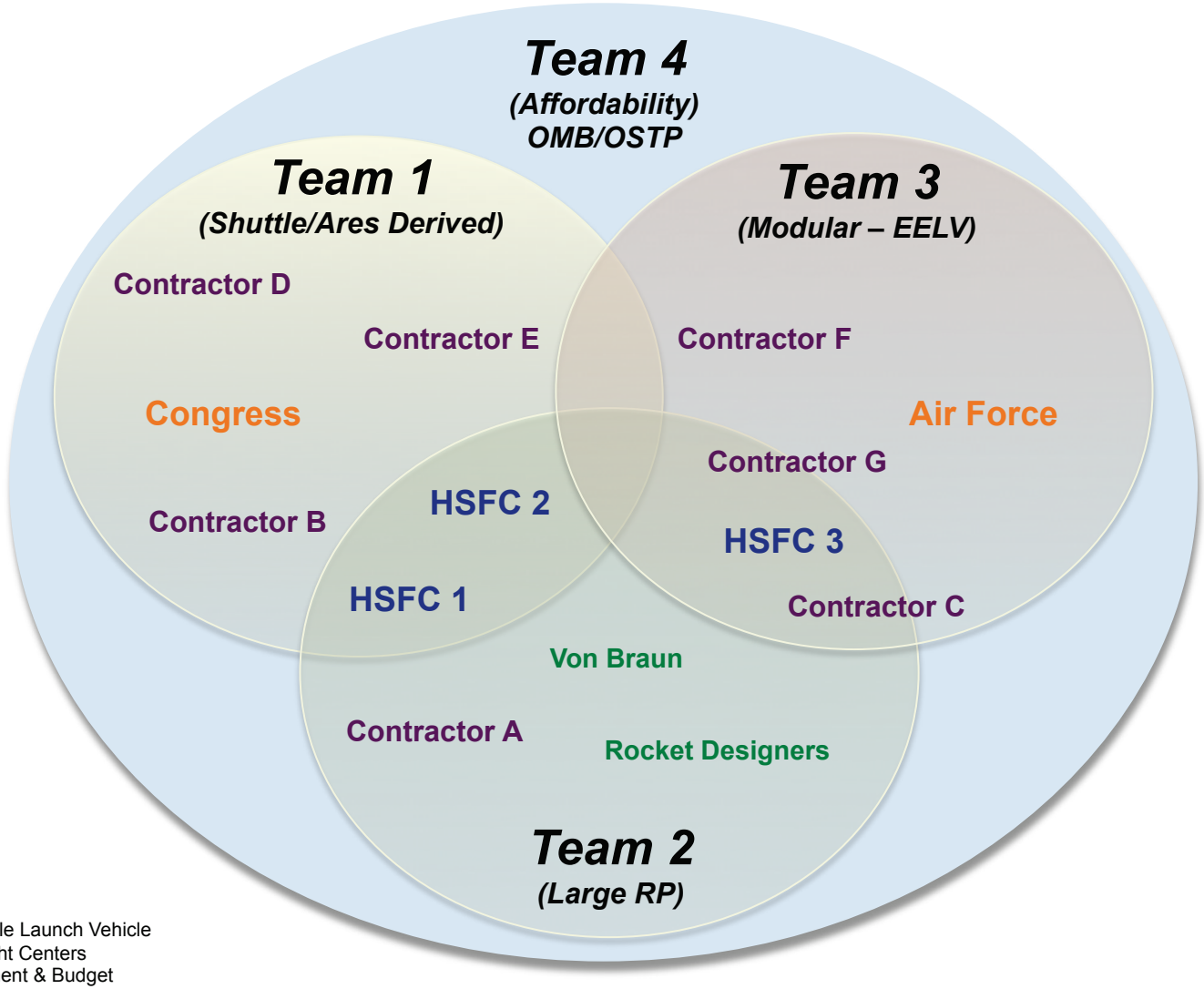
SLS Driving Objectives



- **Safe: Human-Rated**
- **Affordable**
  - Constrained budget environment
  - Maximum use of common elements and existing assets, infrastructure, and workforce
  - Competitive opportunities for affordability on-ramps
- **Initial capability: 70 metric tons (t), 2017–2021**
  - Serves as primary transportation for Orion 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, right-sized for mission requirements

SLS First Flight in 2017

Stakeholder Venn Diagram

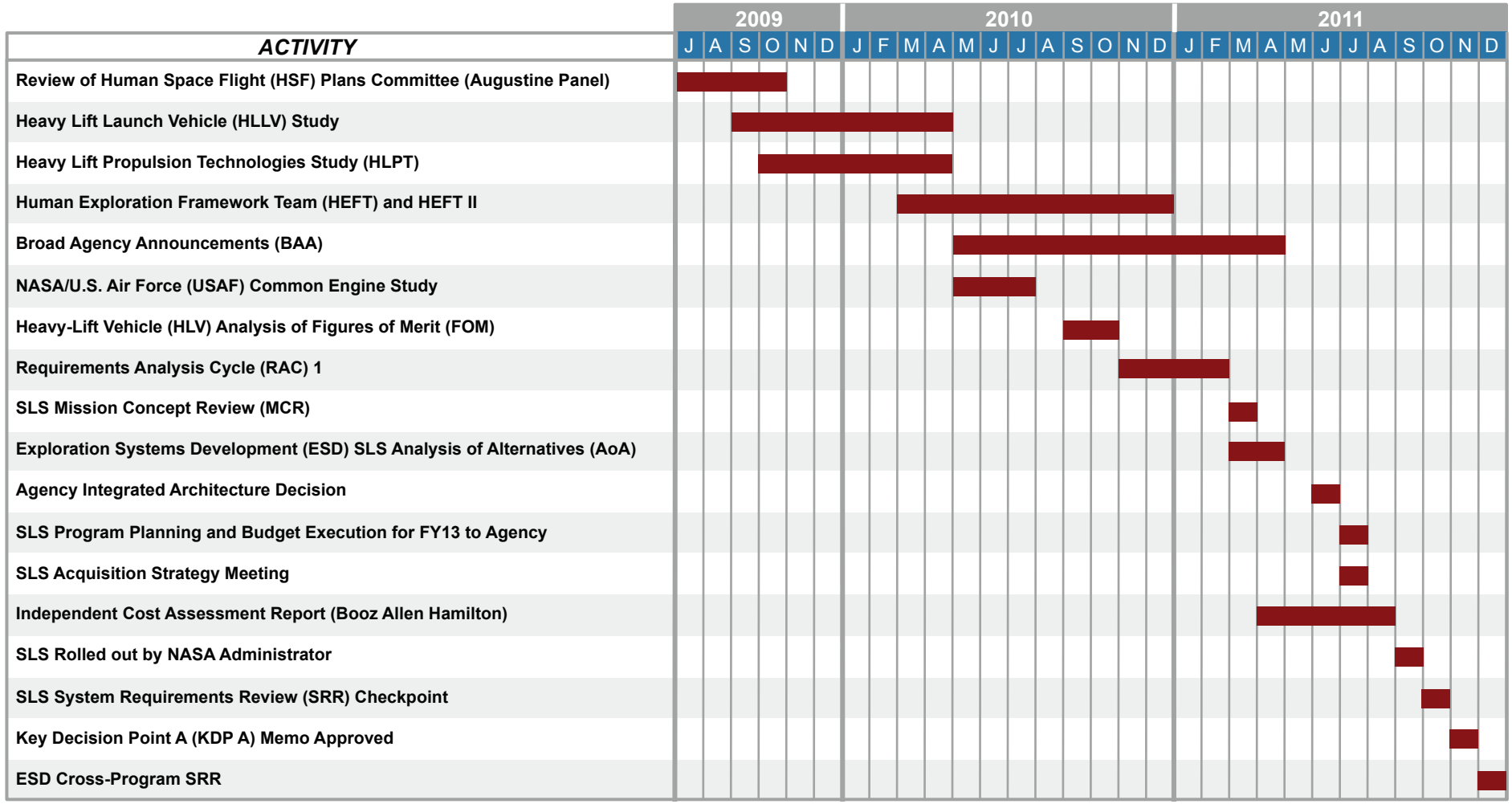


Legend

EELV Evolved Expendable Launch Vehicle
HSFC Human Space Flight Centers
OMB Office of Management & Budget
OSTP Office of Science & Technology Policy
RP Rocket Propellant

Requirements Analysis Cycle 1

SLS Roadmap: Extensive Engineering and Business Analyses and Planning

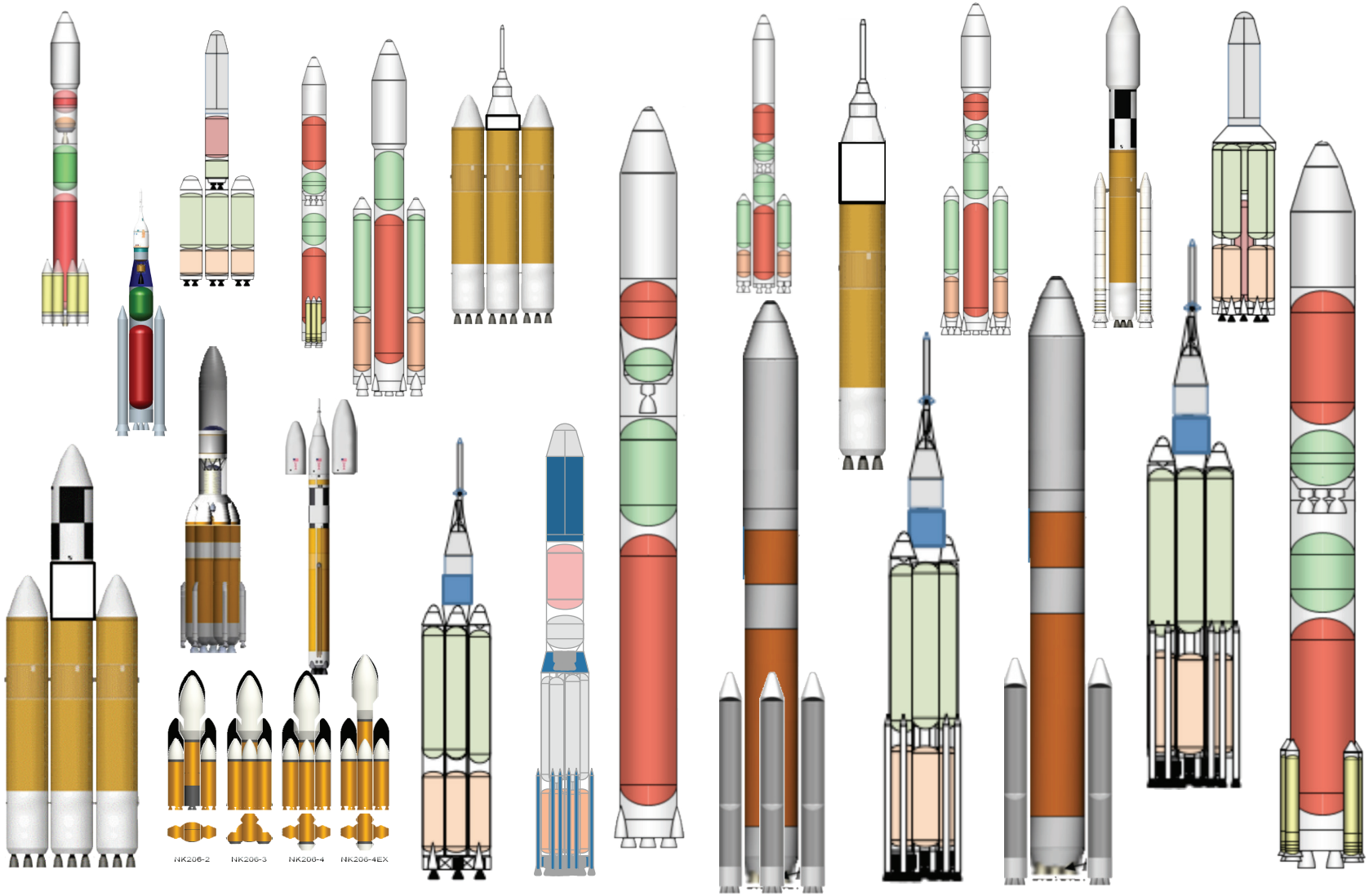


"Take your time and get it right."

—Tom Gavin, Jet Propulsion Laboratory

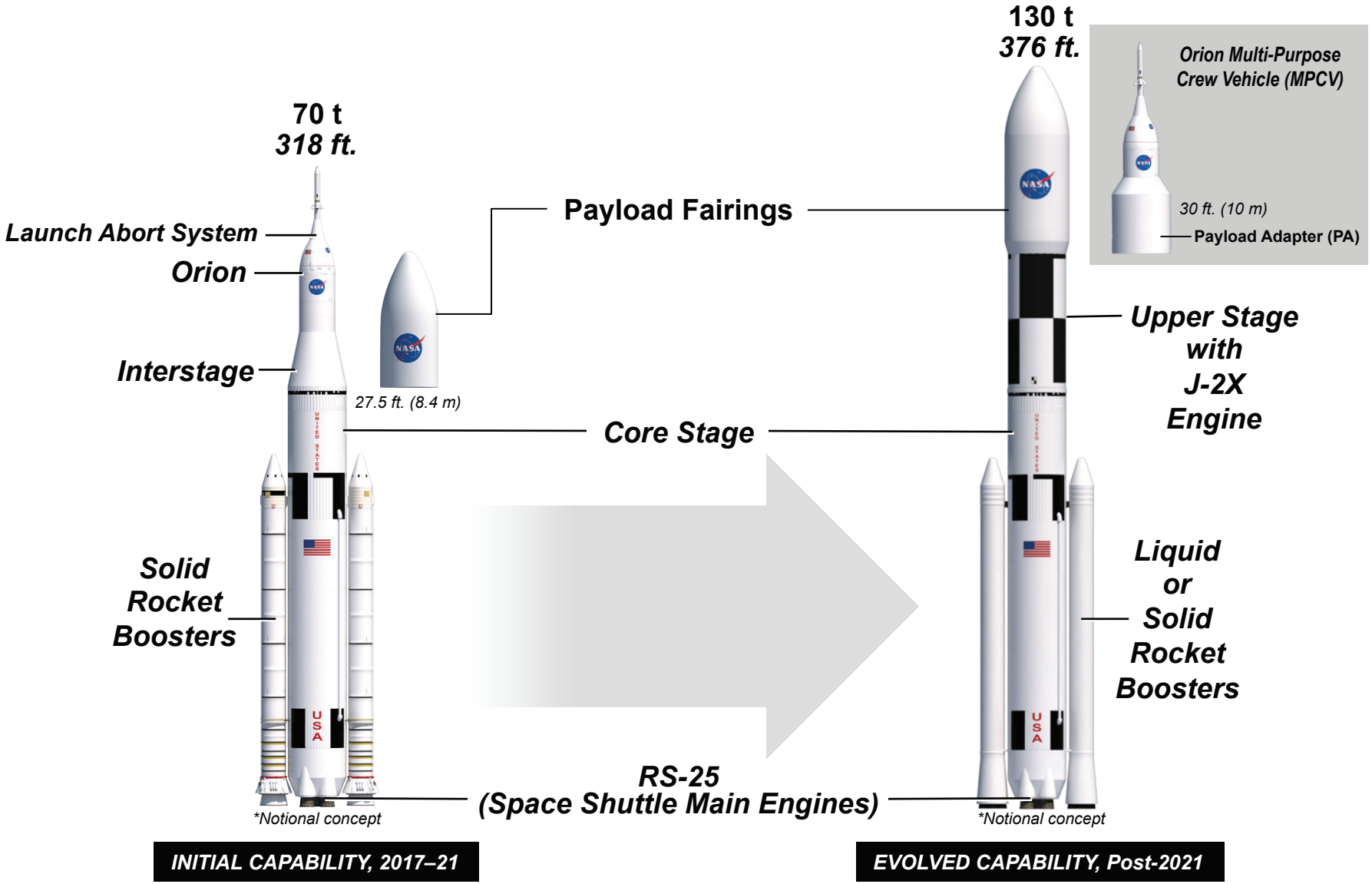
SLS Mission Concept Review, March 2011

Many Solutions, One Affordable Answer



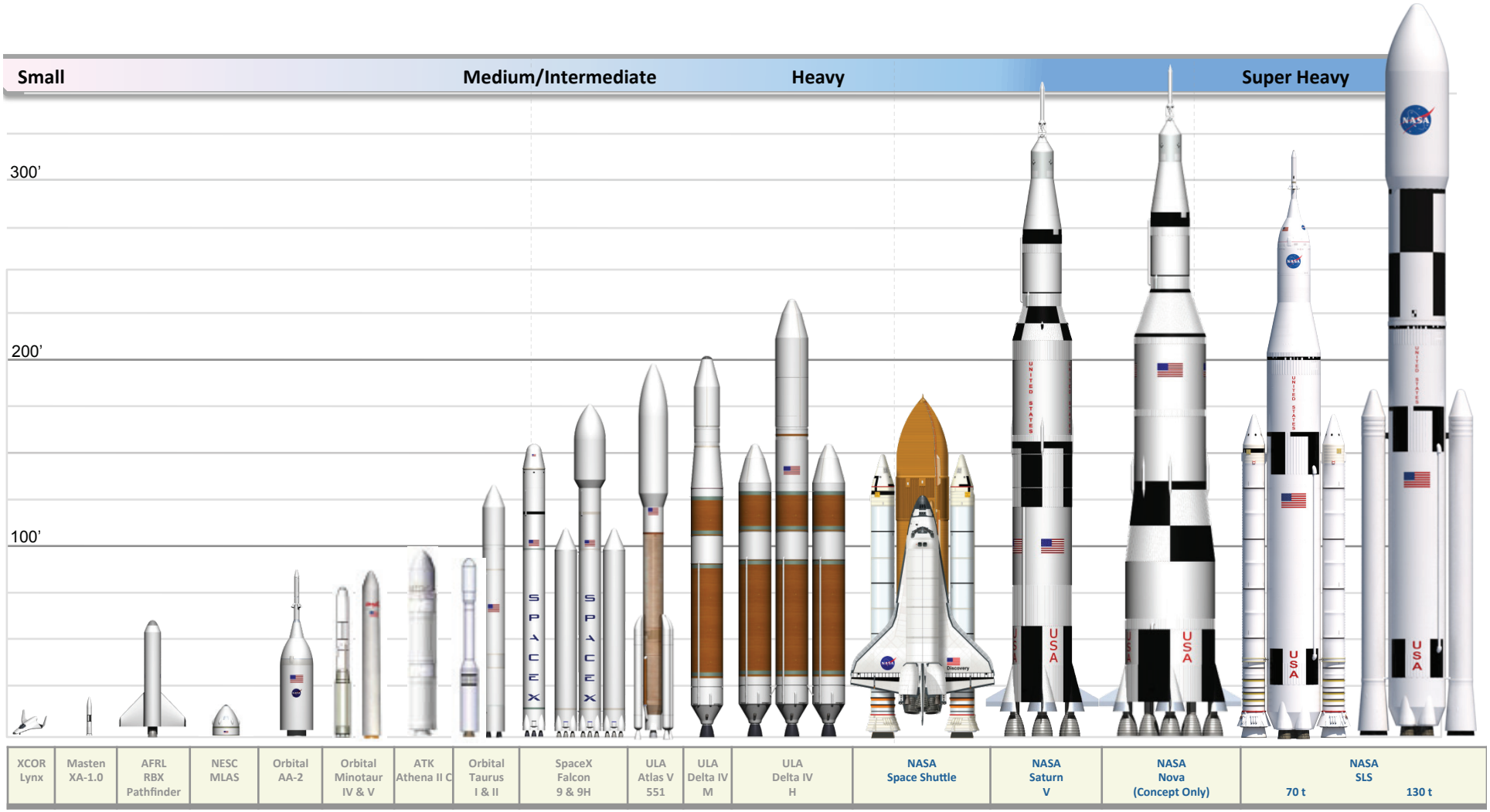
"This enterprise is not for the faint of heart."
*—**Wayne Hale,** former Space Shuttle Program Manager*

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



Some Proposed and Fielded U.S. Systems

Agenda

- Our Mandate: Deliver the Nation's Next Human-Rated Space Transportation System
- How We Got Here: A Brief History of SLS
- Why We Will Succeed: Doing Things Differently and Expecting Different Results
- Questions & Answers

Environmental Snapshot

- **Our world has changed:**
  - The Shuttle has been retired and Constellation has ended.
  - Funding levels are stagnant and hampered by slow U.S. economic recovery.
  - NASA is relying upon commercial crew / commercial orbital transportation services (COTS) / commercial resupply services (CRS) and foreign assets to deliver human space flight capabilities during the transition.
  - Programs must evolve as deliberately agile and lean organizations in order to survive.

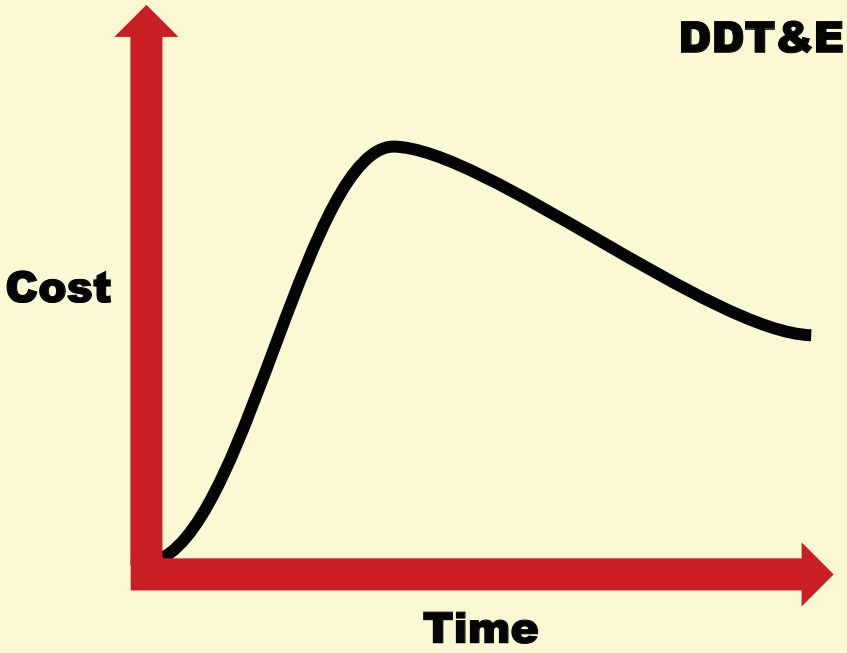
- **In a resource-constrained environment:**
  - New initiatives must fit within our resource envelope (e.g., budget, workforce, facilities).

- **An opportunity to do things differently:**
  - The Space Launch System Program is focusing on delivering maximum value for the American taxpayers' investment, within well-defined constraints and requirements.

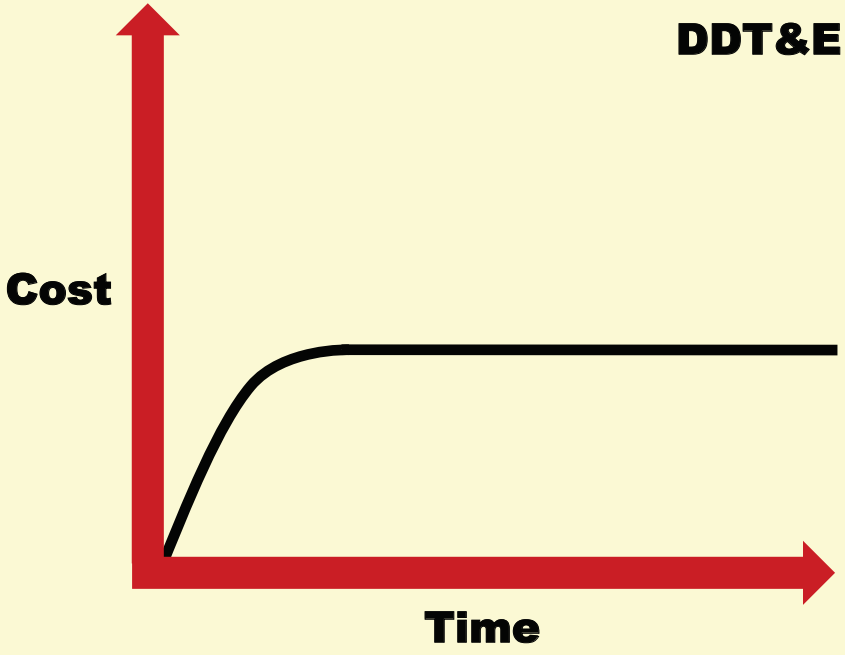
Time to Reconsider Our Approach

Design, Develop, Test, & Evaluation (DDT&E) Budget

Typical Budget Ramp-up for Hardware Development



SLS Budget Curve Reflects Using Existing Assets and Hardware in Development



Sustainability Through Life-Cycle Affordability

Assets in Inventory and Testing in Progress

First Flight 2017

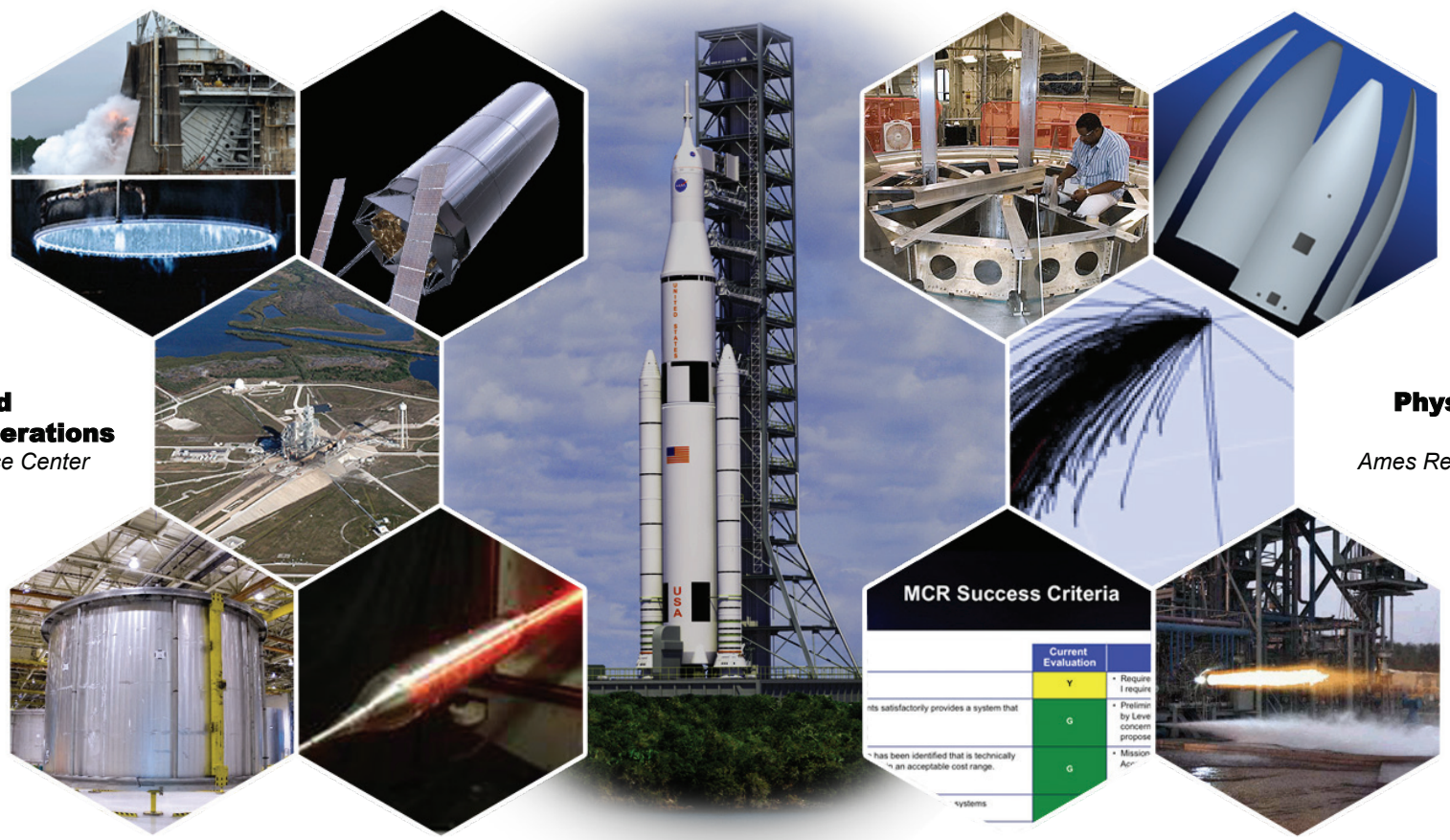
Building on Heritage Hardware and Facilities

J-2X Engine 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

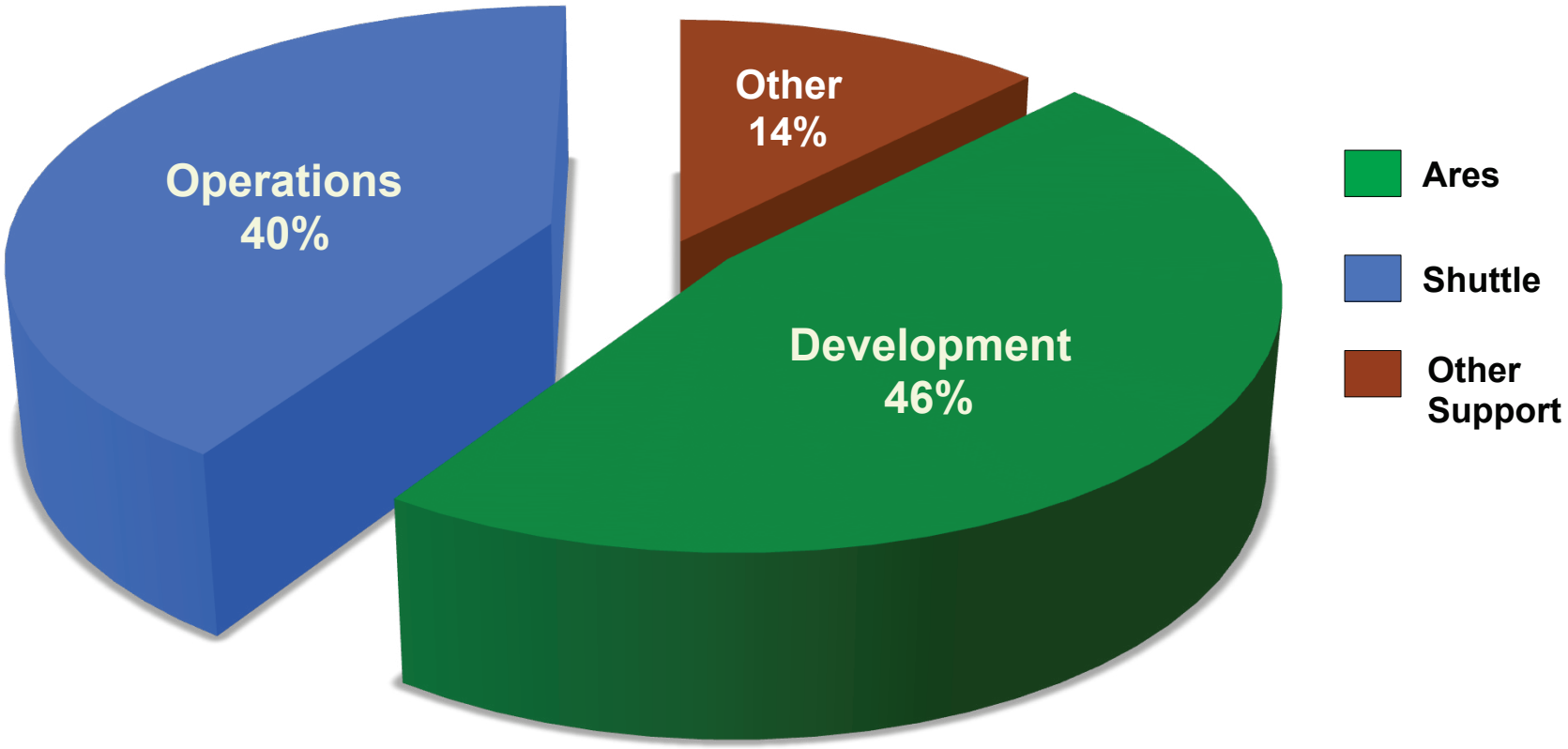
Standing Review Team
Jet Propulsion Laboratory

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

Smartly Selecting the Most Efficient Infrastructure

Merging Design and Operations Cultures

Marshall Workforce Supporting SLS



A Learning Organization Dedicated to Doing Things Differently

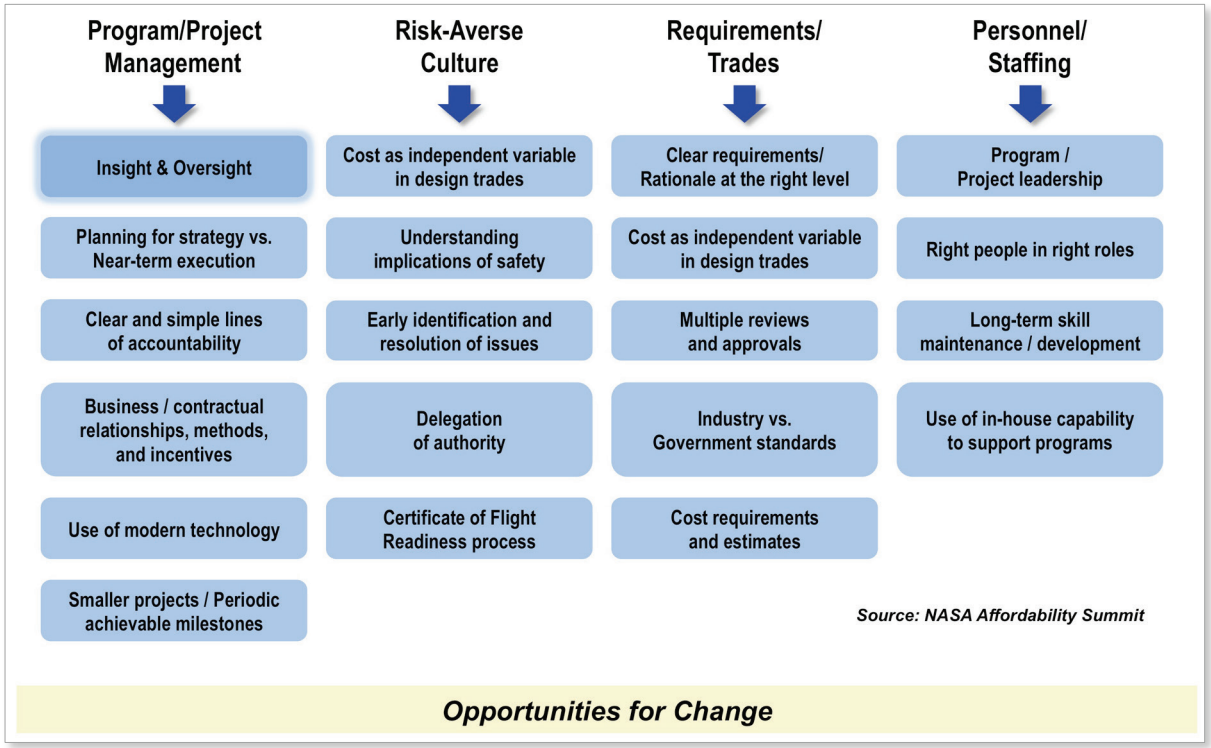
The Real Cost of Launch Vehicle Development

- **Affordability requirements demand that we develop the SLS in a faster and more efficient manner, including the decision-making process.**
- **We cannot afford to delay decisions … or to delay getting behind them!**

Time Is The One Resource That We Can Never Regain

SLS Affordability Begins with Accountability

- **Evolvable Development Approach**
  - Manage requirements within constrained, flat budgets.
  - Leverage existing National capabilities, including LOX/LH_2 propulsion infrastructure, manufacturing facilities, and and launch sites.
  - Infuse new design solutions for affordability.
- **Robust Designs and Margins**
  - Trade performance for cost and schedule.
  - Use heritage hardware and manufacturing solutions.
  - Maintain adequate management reserves controlled at lower levels.

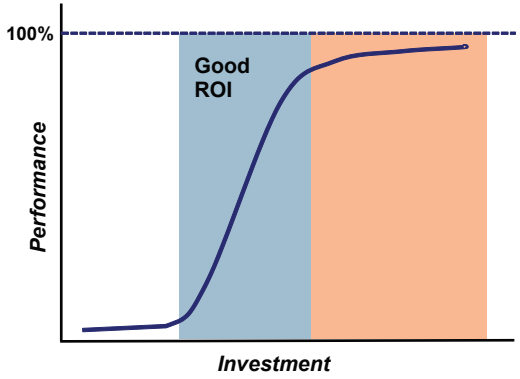


- **Risk-Informed Government Insight/Oversight Model**
  - Insight based on:
    - Historic failures.
    - Industry partner past performance and gaps.
    - Complexity and design challenges.
  - Judicious oversight:
    - Discrete vs. near-continuous oversight.
    - Timely and effective decisions.
- **Right-Sized Documentation and Standards**
  - Up to 80% reduction in the number of Data Requirement (DR) and Program documents from the Ares Projects.
  - Industry practices and tailored NASA standards.
- **Lean, Integrated Teams with Accelerated Decision Making**
  - Simple, clear technical interfaces with contractors.
  - Integrated Systems Engineering & Integration (SE&I) organization.
  - Empowered decision makers at all levels.
  - Fewer Control Boards and streamlined change process.

Affordability: The ability to develop and operate the SLS within the National means, to sustain funding for the Program.

Cost is a Function of Performance

- Extreme requirements drive up costs by 215%.
- Question: Is a 14% increase in maximum speed (performance) *worth* a 215% increase in cost?
- Question: Is a 34% increase in 0 – 60 mph acceleration (performance) *worth* a 215% increase in cost?



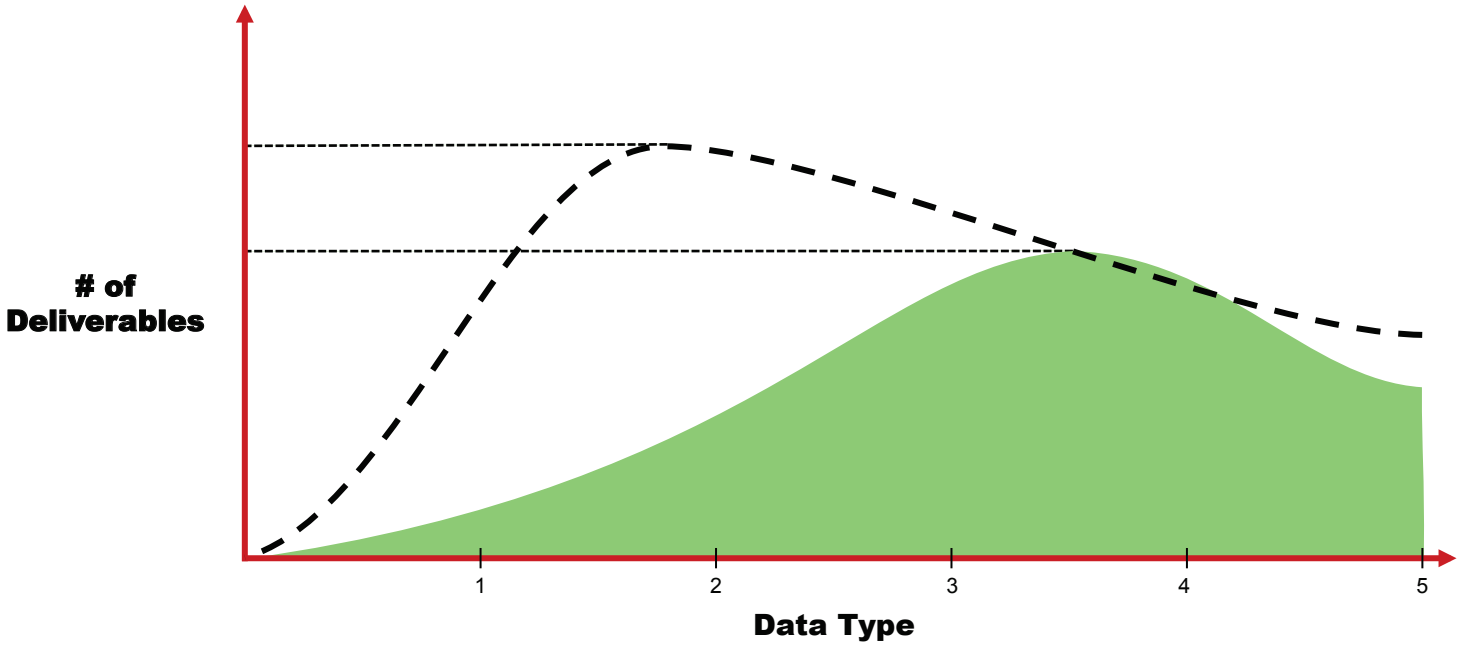
	Porsche 911 Carrera	*Porsche 911 Turbo*	*Porsche 911 GT2 RS*
			
Cylinders	6	6	6
Engine layout	Rear	Rear	Rear
Performance	180 mph	195 mph	205 mph
0-60 mph	4.7 sec	3.5 sec	3.4 sec
MSRP	$77,800	$160,700	$245,000
	Horsepower 345	*Horsepower 530*	*Horsepower 620*

— *Source: Porsche website*

We Will Factor the Real Cost into Our Decisions

SLS Deliverables

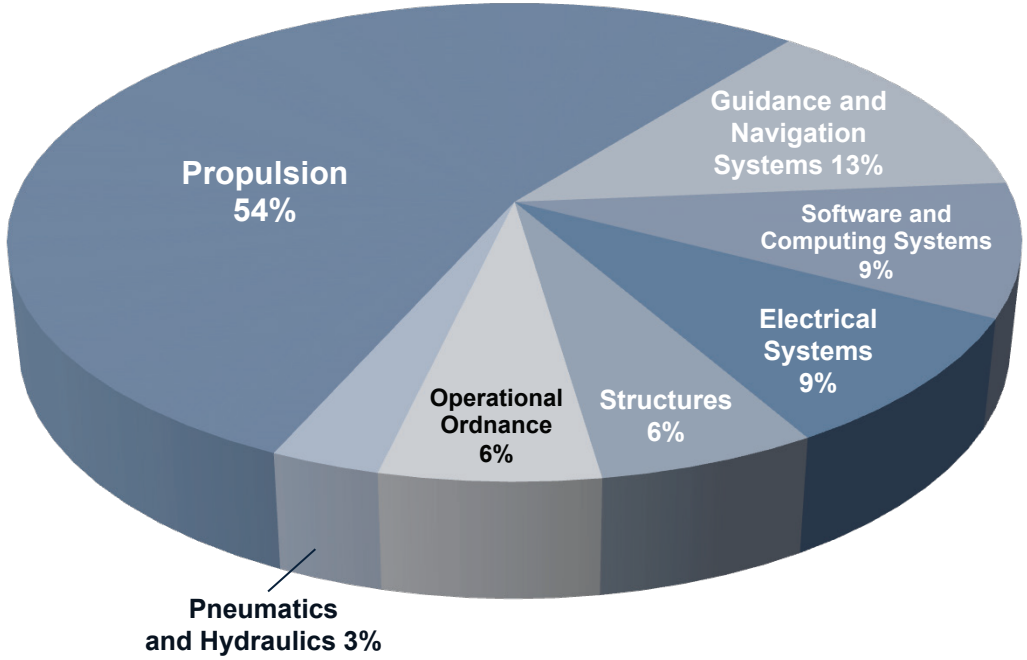
- Reduced number of deliverables.
- More Type 3, 4 and 5's (which do not require Government approval).
- Less Type 1 and 2's (which do require Government approval).
- Contractor's format acceptable.
- Electronic access to soft copies.



Focuses on Data Content and Access

Risk-Based Insight

- **Based on vehicle risk and historic failures, concentrate/augment insight in key areas:**
  - Risk-informed Concentration
    - Propulsion
    - Guidance, Navigation, and Control (GN&C)
    - Avionics
    - Software
    - Electrical
    - Crew Systems
    - Separation Systems
  - Nominal Concentration
    - Power and Thermal
    - Structures
    - Mission Operations
    - Ground Operations
    - Probabilistic
    - Environmental Control and Life Support

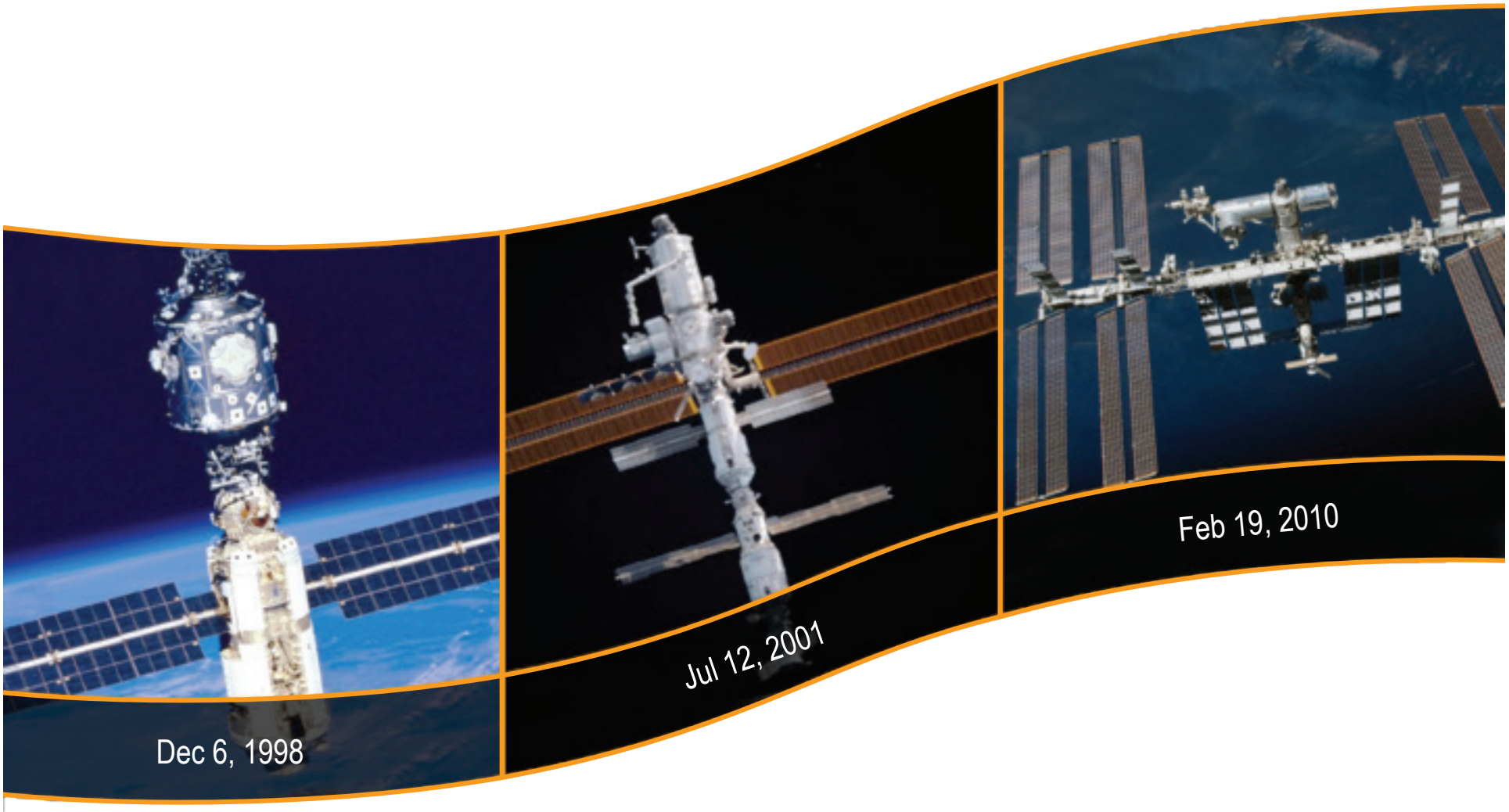


1980 – 2007
Worldwide Launch Failure Causes

Source: FAA Launch Vehicle Failure Mode Database, May 2007

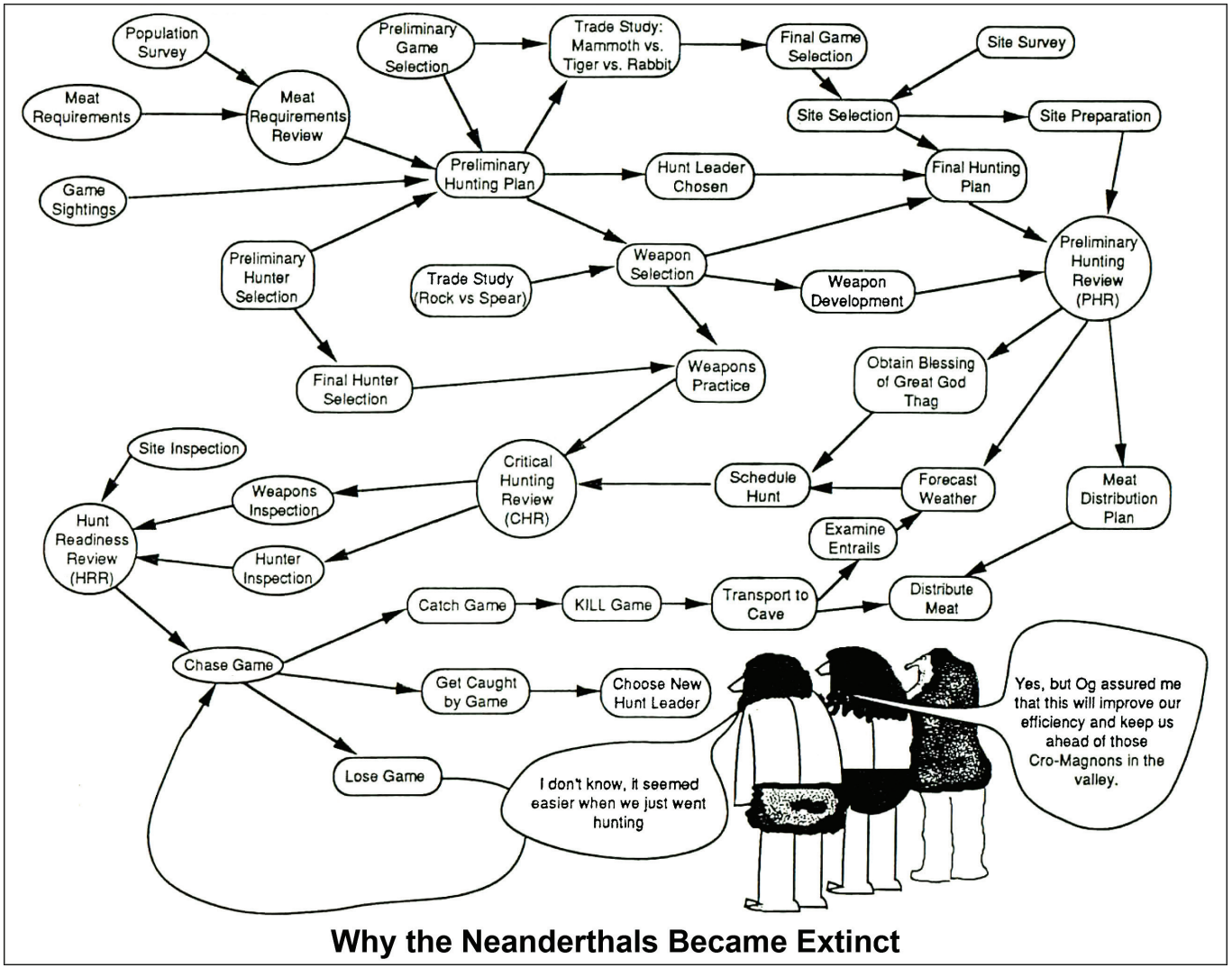
Discipline Experts and Systems Engineering Team Comprise the Government Sustaining Insight Team

Planning Programmatic Content to Deliver Incremental Capability



Like ISS, the SLS is a long-term commitment to America's future in space.

Driving in Complexity: The Path to Extinction

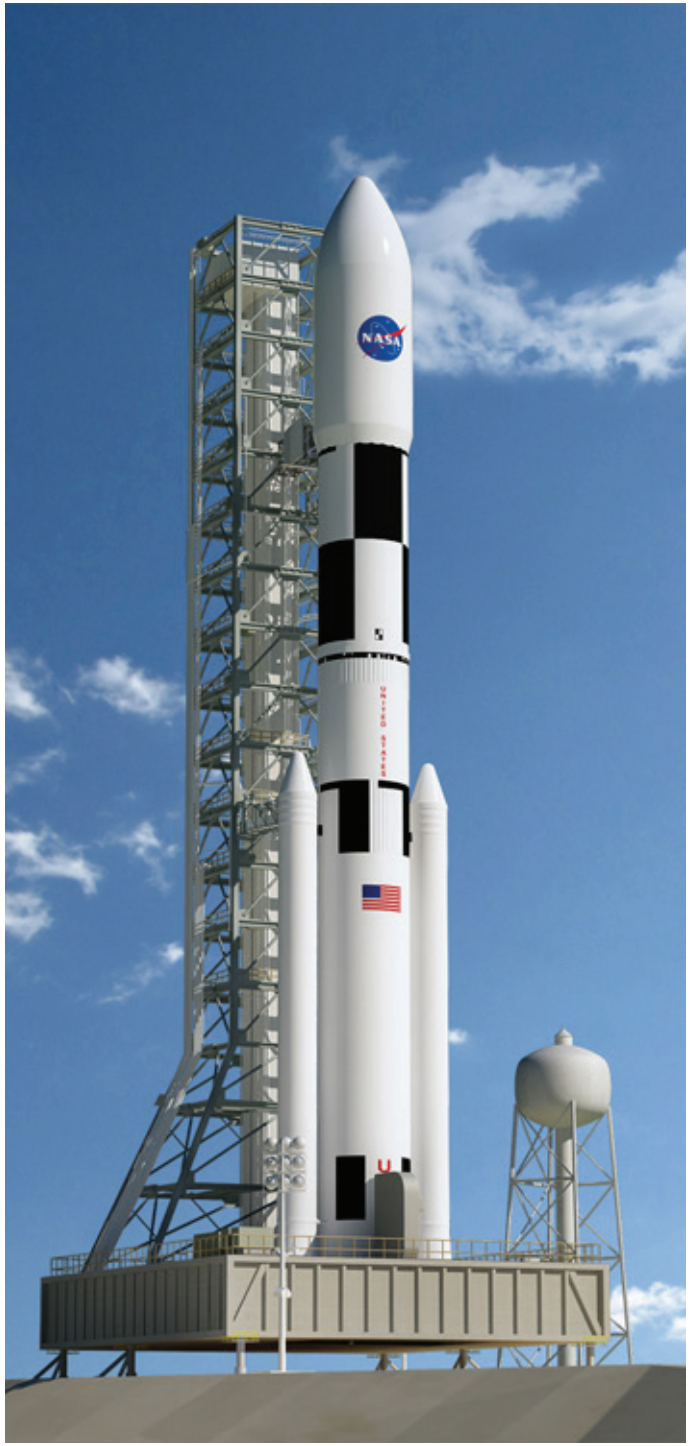


Why the Neanderthals Became Extinct

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 evolvable capabilities.
- The road ahead promises to be an exciting journey for current and future generations.

For More Information



www.nasa.gov/sls