National Aeronautics and Space Administration

America’s New Rocket: Space Launch System

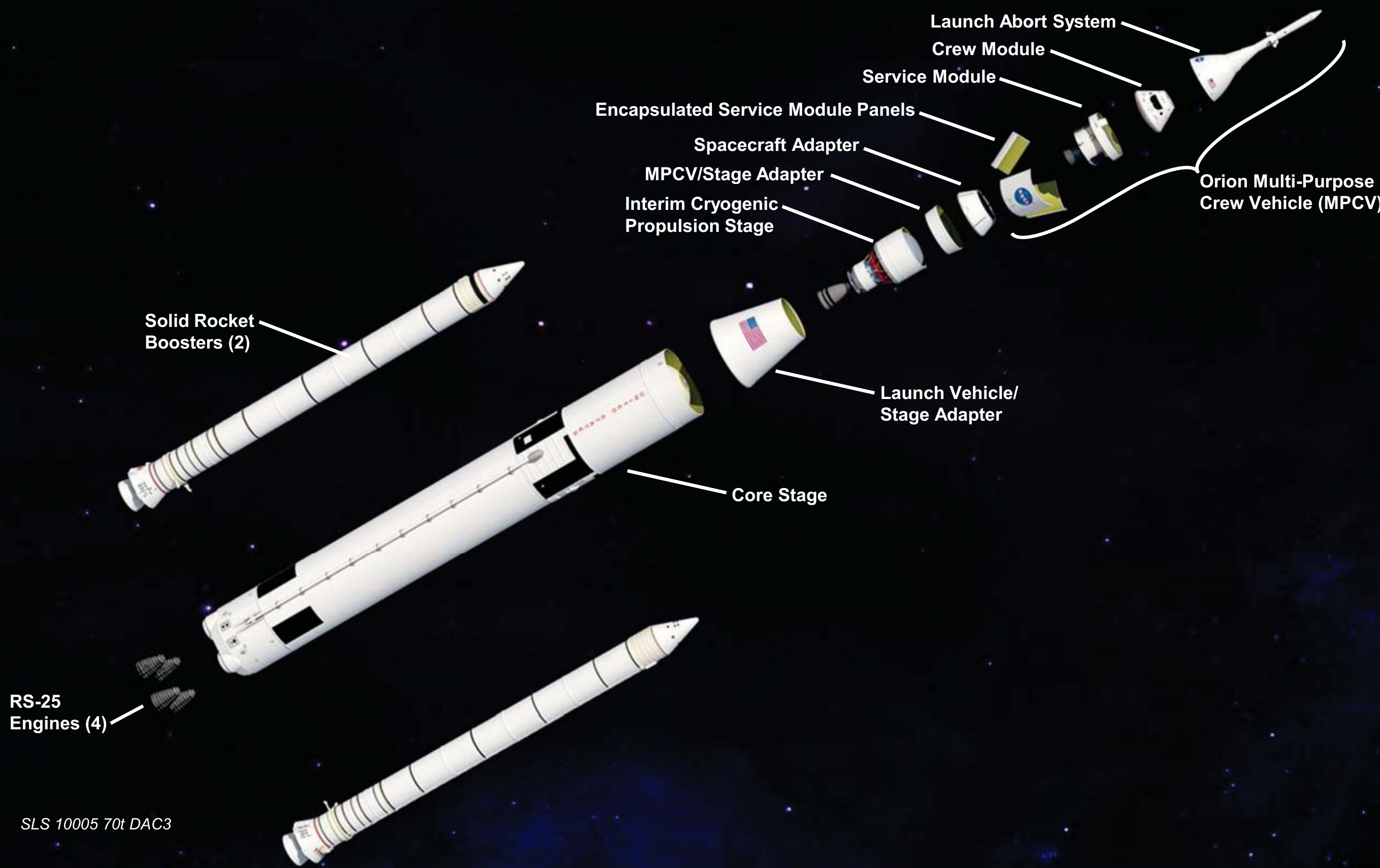
Keith Hefner,

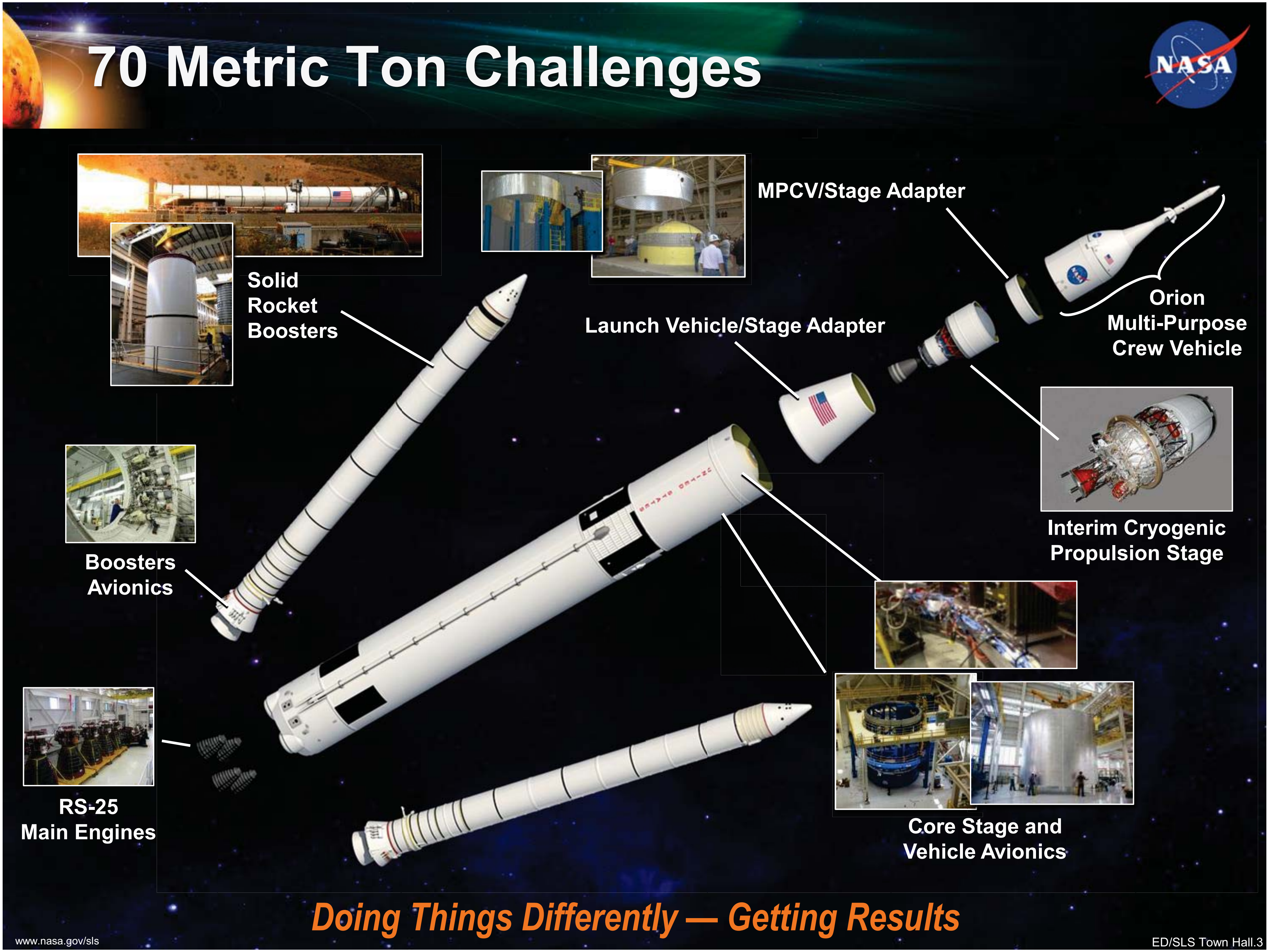
SLS Associate Program Manager

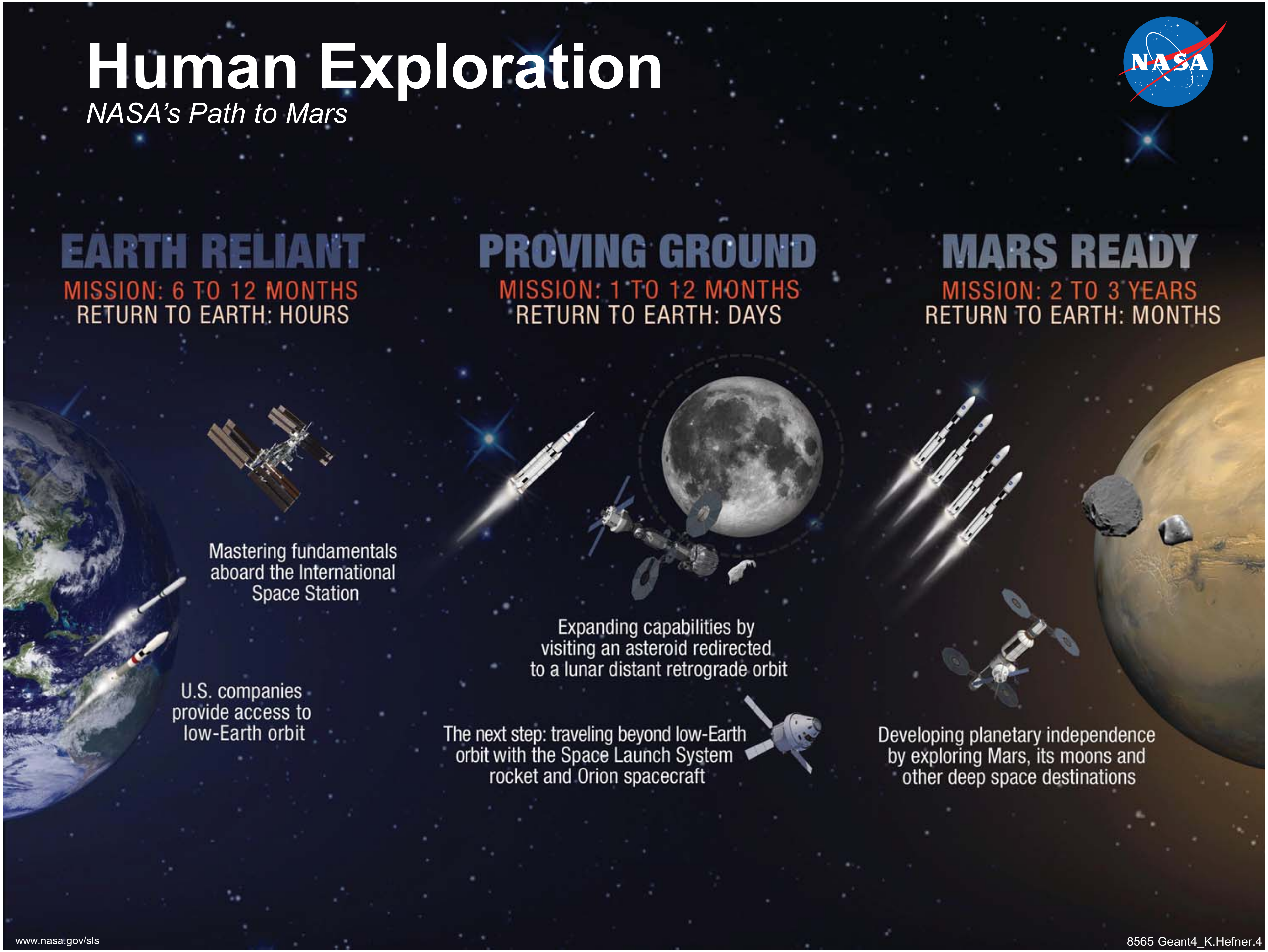
Space Launch System

May 27, 2014

70 Metric Ton Expanded View




70 Metric Ton Challenges
NASA
Solid Rocket Boosters
MPCV/Stage Adapter
Launch Vehicle/Stage Adapter
Orion Multi-Purpose Crew Vehicle
Interim Cryogenic Propulsion Stage
Boosters Avionics
RS-25 Main Engines
Core Stage and Vehicle Avionics
Doing Things Differently — Getting Results
www.nasa.gov/sls
ED/SLS Town Hall.3



Human Exploration
NASA's Path to Mars
NASA
EARTH RELIANT
MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS
PROVING GROUND
MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS
MARS READY
MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS
Mastering fundamentals aboard the International Space Station
U.S. companies provide access to low-Earth orbit
Expanding capabilities by visiting an asteroid redirected to a lunar distant retrograde orbit
The next step: traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft
Developing planetary independence by exploring Mars, its moons and other deep space destinations
www.nasa.gov/sls
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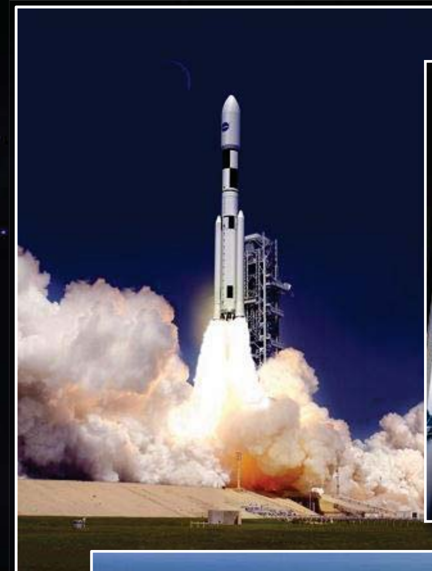
SLS Driving Objectives

- **Safe**
  - Human-rated to provide safe and reliable systems
  - Protecting the public, NASA workforce, high-value equipment and property, and the environment from potential harm
- **Affordable**
  - Maximum use of common elements and existing assets, infrastructure, and workforce
  - Constrained budget environment
  - Competitive opportunities for affordability on-ramps
- **Sustainable**
  - Initial capability: 70 metric tons (t), 2017–2021
    - Serves as primary transportation for Orion and human exploration missions
  - Evolved capability: 105 t and 130 t, post-2021
    - Offers large volume for science missions and payloads
    - Reduces trip times to get science results faster
    - Minimizes risk of radiation exposure and orbital debris impacts



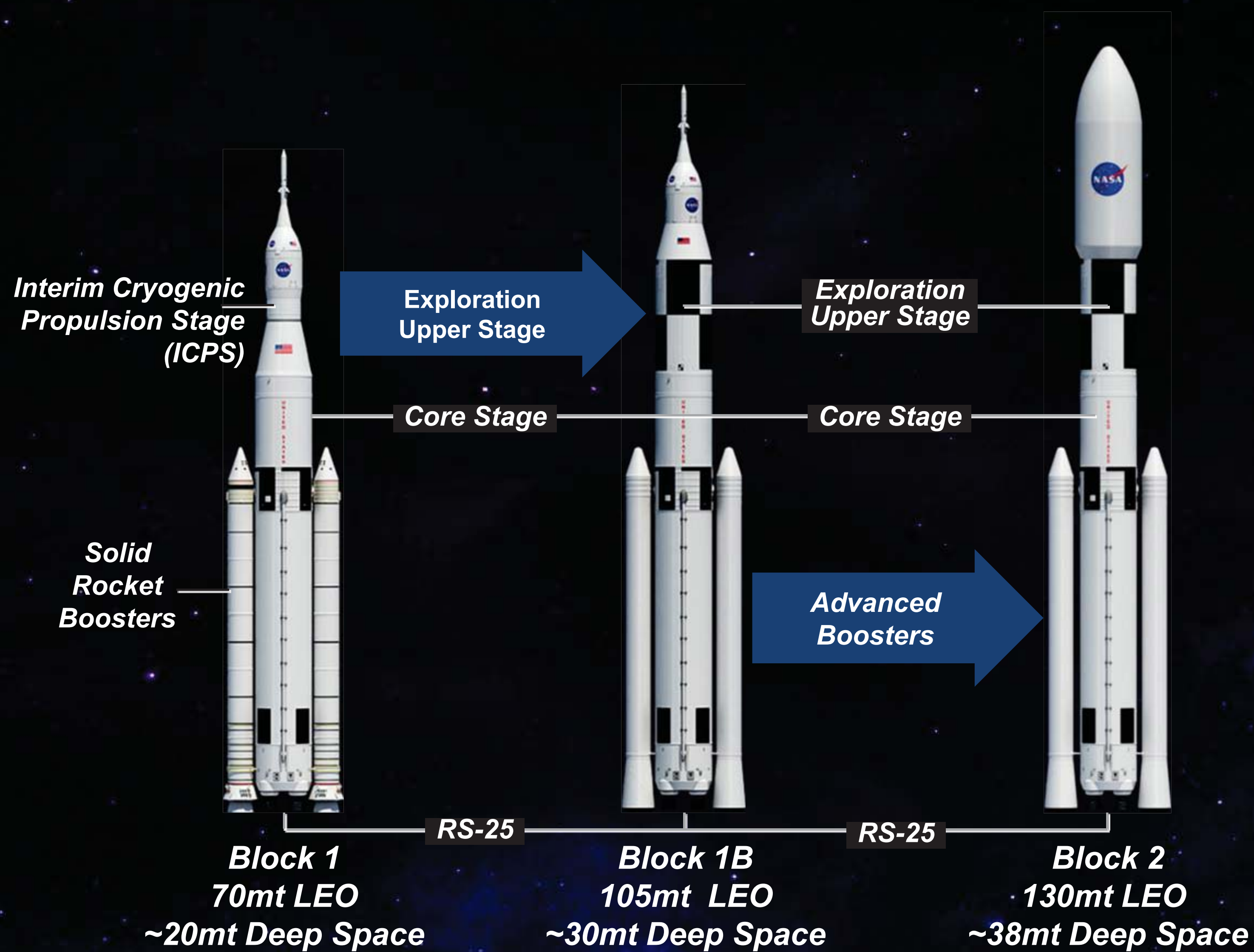
Flexible Architecture Configured for the Mission

Principle of Building SLS Capabilities

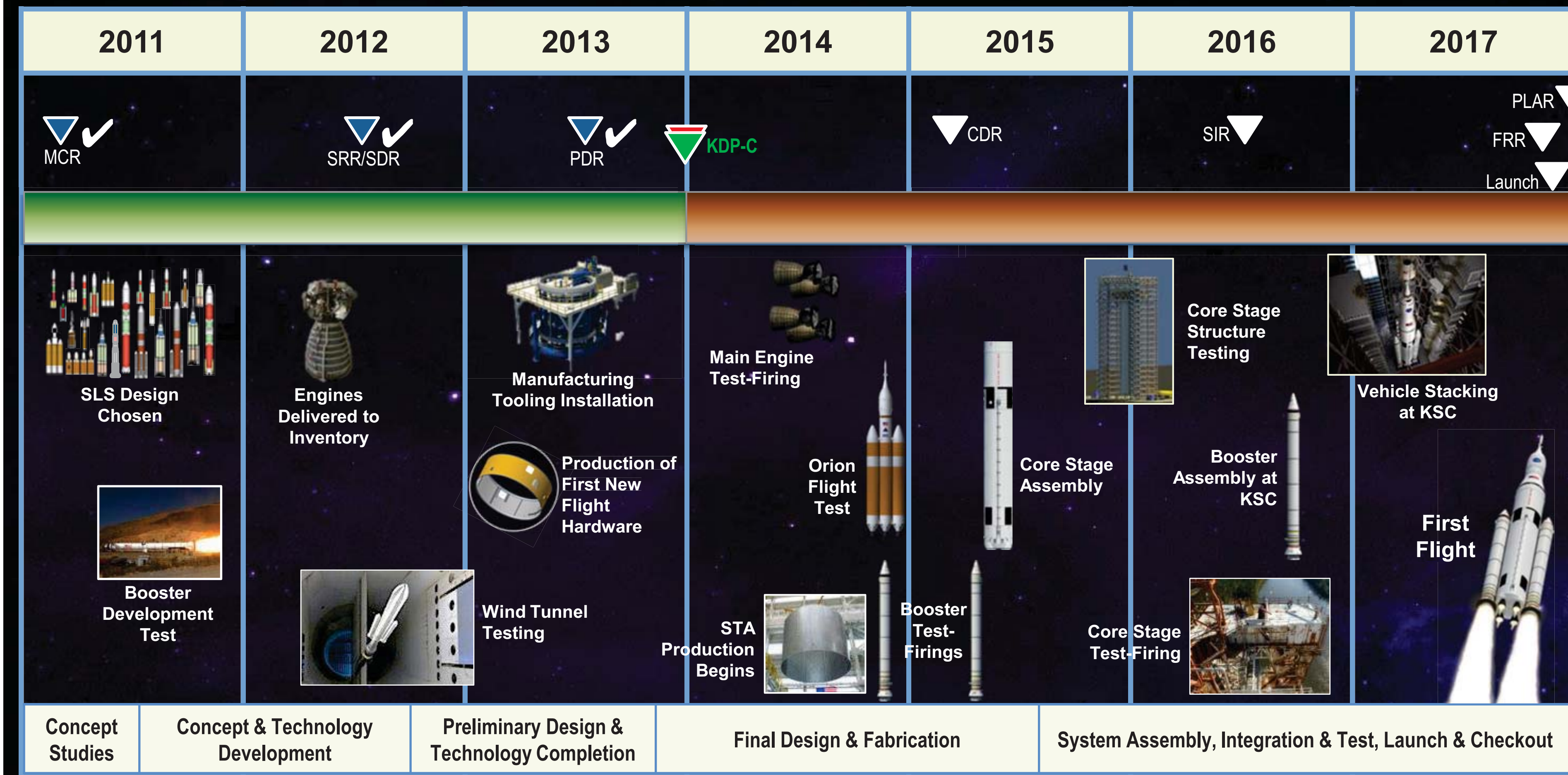
Six key strategic principles to provide a sustainable program:

1. Executable with current budget with modest increases
2. Application of high Technology Readiness Level (TRL) technologies for near term, while focusing research on technologies to address challenges of future missions
3. Near-term mission opportunities with a defined cadence of compelling missions providing for an incremental buildup of capabilities for more complex missions over time
4. Opportunities for US Commercial Business to further enhance the experience and business base learned from the ISS logistics and crew market
5. Multi-use Space Infrastructure
6. Significant International participation, leveraging current International Space Station partnerships

SLS Commonality and Evolution



SLS Development Schedule



MCR: Mission Concept Review	CDR: Critical Design Review
SRR: System Requirements Review	SIR: System Integration Review
SDR: System Definition Review	FRR: Flight Readiness Review
PDR: Preliminary Design Review	PLAR: Post-Launch Asses. Review

SLS Life-Cycle Milestones

NASA Life Cycle Phases	Approval for Formulation	FORMULATION		Approval for Implementation	IMPLEMENTATION		
Program Life Cycle Phases	Pre-Phase A: Concept Studies	Phase A: Concept & Technology Development	Phase B: Preliminary Design & Technology Completion	Phase C: Final Design & Fabrication	Phase D: System Assembly, Int. & Test, Launch & Checkout	Phase E: Operations & Sustainment	Phase F: Closeout
Program Life Cycle Gates and Major Events	Key Decision Point A ✓	KDP B ✓	KDP C	KDP D; EFT-1 Launch	KDP E; EM-1 Launch	KDP F; EM-2 Launch	
Human Space Flight Project Reviews	MCR ✓ 2011	SRR/SDR ✓ 2012	PDR ✓ 2013	CDR 2015	SR 2016; FRR 2017	2021	

FOCUSED TOWARD

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SRR: System Requirements Review	SIR: System Integration Review
SDR: System Definition Review	FRR: Flight Readiness Review
PDR: Preliminary Design Review	PLAR: Post-Launch Asses. Review

Meeting Technical, Budget, and Schedule Commitments

SLS Nationwide Team

- Engaging the U.S. Aerospace Industry
- Strengthening Sectors such as Manufacturing
- Advancing Technology and Innovation for Deep-Space Exploration

NASA Facilities
NASA Centers

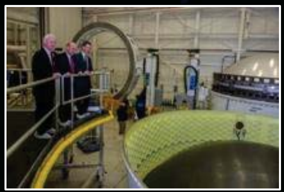
Working with over 400 Contractors in 42 States

Recent Accomplishments

Launch Vehicle Stage Adapter: Contract awarded in Feb. 2014 to Teledyne Brown Engineering.

Avionics: Flight software developed by Boeing tested at Armstrong using F-18 in Nov. 2013; avionics "first light" marked in Jan. 2014 at Marshall.

Boosters: Thrust Vector Control test conducted by ATK in Oct. 2013; preparations under way for first qualification motor test.



Multi-Purpose Crew Vehicle-to-Stage Adapter: First flight hardware delivered to ULA for Exploration Flight Test-1 in Fall 2014.

Core Stage: Initial confidence barrels and domes completed by Boeing; tooling installation to be completed at MAF in July 2014.

Engines: Thrust frame adapter fitted to Stennis A-1 stand; Aerojet-Rocketdyne RS-25 testing begins July 2014.

Substantial Progress Toward Exploration Mission 1

Orion-to-Stage Adapter for EFT-1 and EM-1

First Flight Hardware Delivered for Exploration Flight Test 1

Building to Exploration Mission-1 (EM-1)

ACCOMPLISHMENTS

- **09/2011** Tested Booster Development Motor ✓
- **07/2012** Delivered RS-25 Engines to Inventory ✓
- **07/2013** Competed Preliminary Design Review ✓
- **10/2011 - 12/2013** Tested SLS Wind Tunnel Models ✓
- **07/2013** Completed First Confidence Barrel Section Welding ✓
- **10/2013** Completed Thrust Vector Control Test ✓
- **11/2013** Conducted Adaptive Augmenting Control Flight Test ✓
- **12/2013** Completed LOX Forward Dome Manufacturing Demo ✓
- **1/2014** Conducted Avionics “First Light” in Integration Facility ✓
- **02/2014** Shipped Multi-Purpose Crew Vehicle Stage Adapter for EFT-1 ✓

WHAT’S NEXT

- **07/2014** Complete Manufacturing Tooling Installation
- **07/2014-15** Test Main Engines, Boosters , & Core Stage Structure
- **07/2015** Complete the SLS Critical Design Review
- **06/2016** Assemble the Core Stage Assembly and Test Fire
- **07/2017** Stack the SLS Vehicle
- **12/2017** Transport SLS from the VAB to the Launch Pad

December 2017 EM-1 Launches from KSC

"Man cannot discover
new oceans
unless he has the
courage to lose
sight of the shore."

Join us on the journey

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