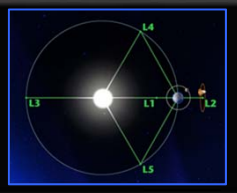
National Aeronautics and Space Administration

Game Changing: NASA's Space Launch System and Science Mission Design

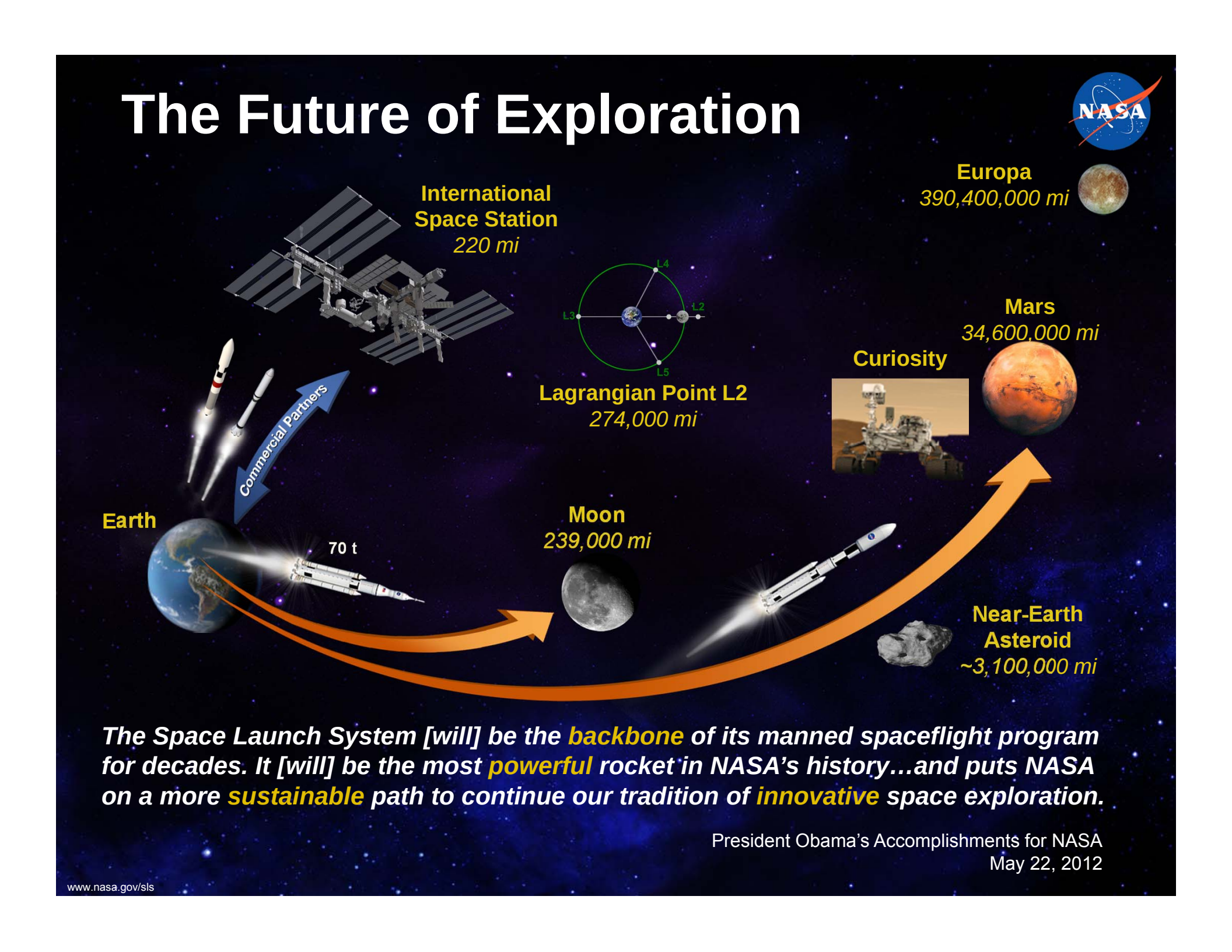
Steven D. Creech
SLS Strategic Development Manager
March 2013







The Future of Exploration



The Space Launch System [will] be the backbone of its manned spaceflight program for decades. It [will] be the most powerful rocket in NASA's history…and puts NASA on a more sustainable path to continue our tradition of innovative space exploration.

President Obama's Accomplishments for NASA
May 22, 2012

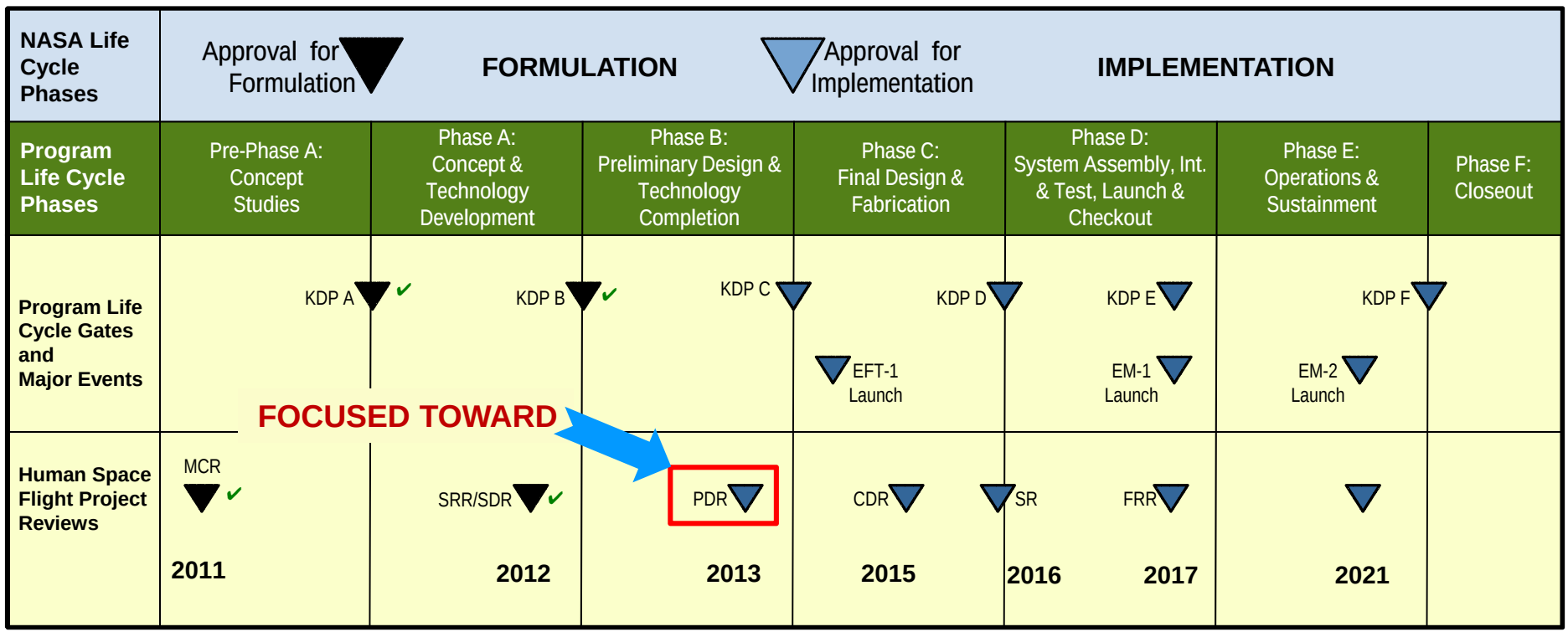
www.nasa.gov/sls

SLS Driving Objectives

- **Safe**
  - Human-rated to provide safe and reliable systems for human missions
  - 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 exploration missions
    - Provides back-up capability for crew/cargo to ISS
  - Evolved capability: 105 t and 130 t, post-2021
    - Offers large volume for science missions and payloads
    - Modular and flexible, right-sized for mission requirements

Flexible Architecture Configured for the Mission of Going Beyond Earth's Orbit

SLS Top-Level Schedule



CDR: Critical Design Review

EM: Exploration Mission

EFT: Exploration Flight Test

FRR: Flight Readiness Review

KDP: Key Decision Point

MCR: Mission Concept Review

PDR: Preliminary Design Review

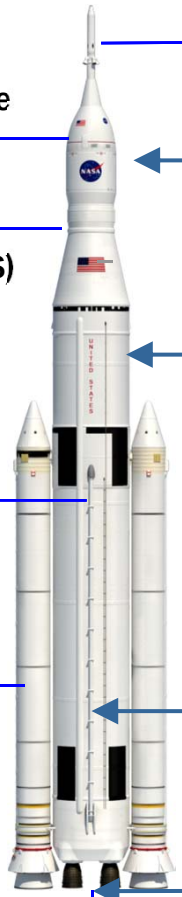
SIR: System Integration Review

SDR: System Definition Review

SRR: System Requirements Review

First Flight 2017

SLS Block Commonality



Launch Abort System
(*Orbital Science Corp.*)

Orion, Multi-Purpose Crew Vehicle (MPCV- LMCO)

Interim Cryogenic Propulsion Stage (ICPS) (EELV 5m DCSS – Boeing/ULA)

Core Stage/Avionics *(Boeing)*

5-Segment Solid Rocket Booster (SRB) *(ATK)*

Core Stage Engines (RS-25) *(PWR)*

30 ft (10 m)

Commonality of Payload Interfaces

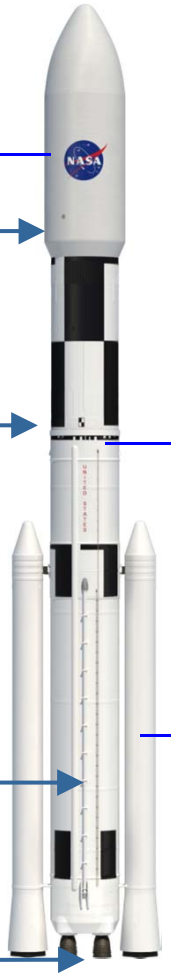
- Mechanical
- Avionics
- Software

Upper Stage & Core Stage Commonality

- Same diameter (27.5 ft.) and basic design
- Manufacturing facilities, tooling, materials, & processes/practices
- Workforce
- Supply chain/industry base
- Transportation logistics
- Ground systems/launch infrastructure
- Propellants

Commonality of Core Stage

Commonality of Engines



Upper Stage

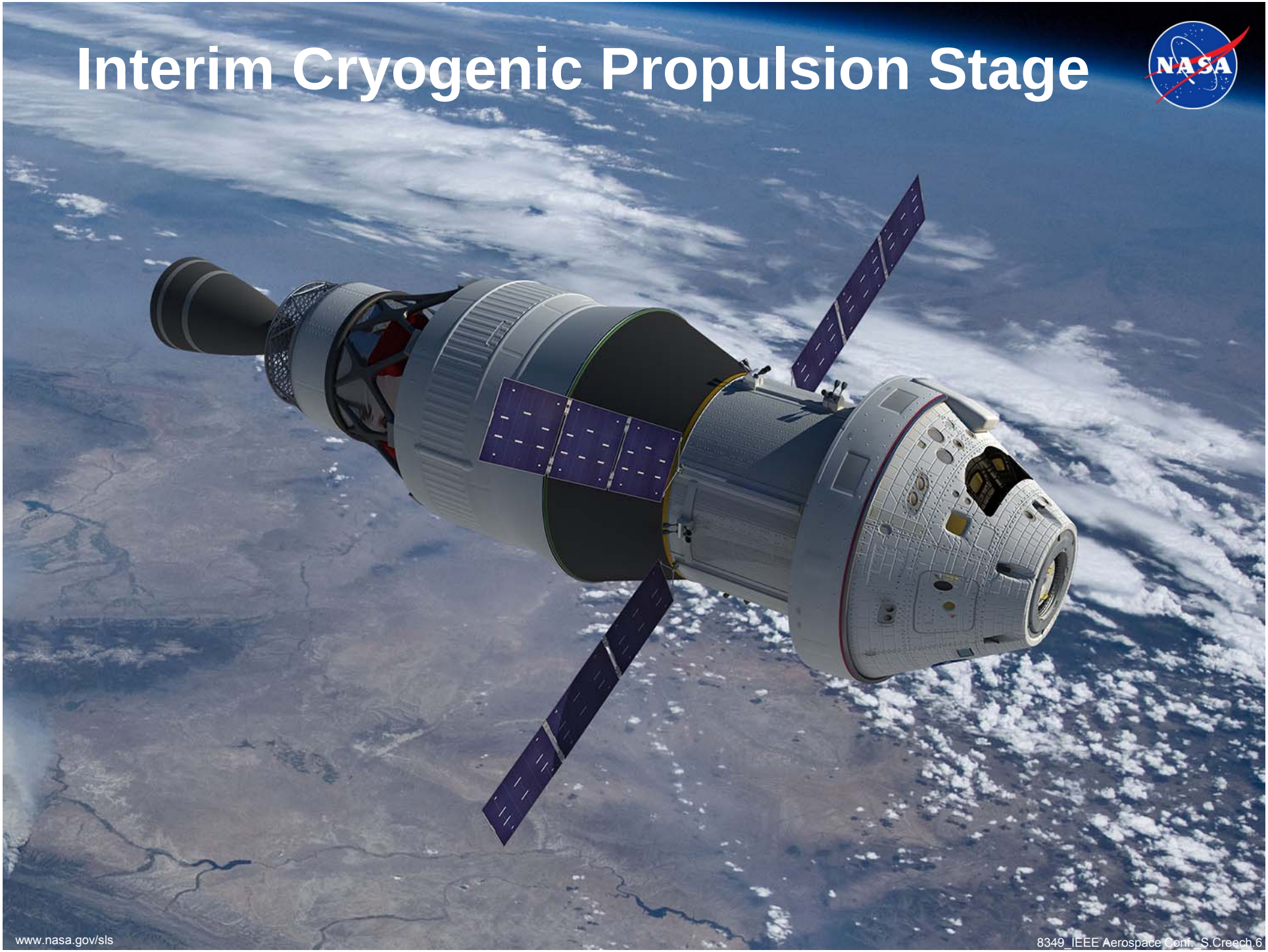
Advanced Solid or Liquid (i.e., RP Engines) Boosters

Block 1
Initial Capability, 2017-21
70 metric ton Payload

Evolutionary Path to Future Capabilities
- **Minimizes unique configurations**
- **Allows incremental development**

Block 2 Capability
130 metric ton Payload

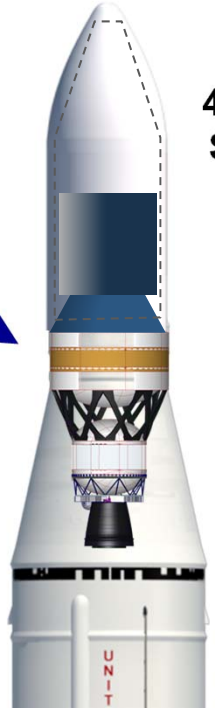
Interim Cryogenic Propulsion Stage



Existing 5m Fairing Option

SLS Block 1
EM1/EM2 Configuration

SLS Block 1
5m Fairing Configuration



4.3 X 3.85m
Spacecraft
Envelope

Spacecraft/ICPS
with Modified Existing Fairing

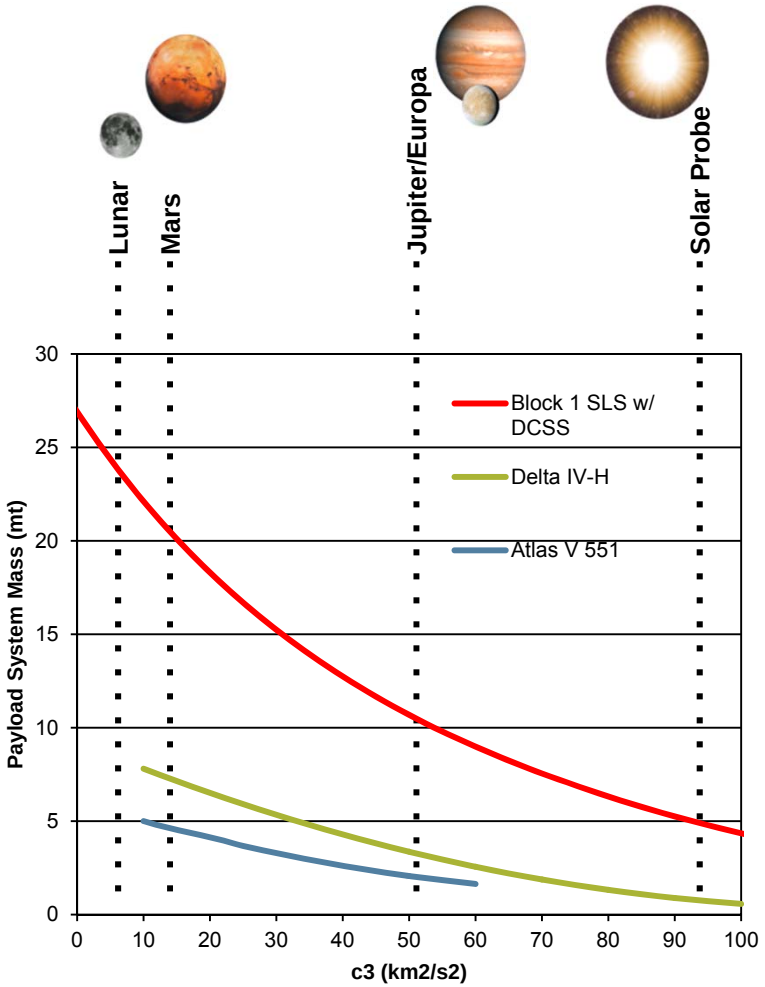
SLS is investigating utilizing existing fairings for early cargo flights
RFI responses received 12/21/12

SLS Performance Supports Deep-Space Operations

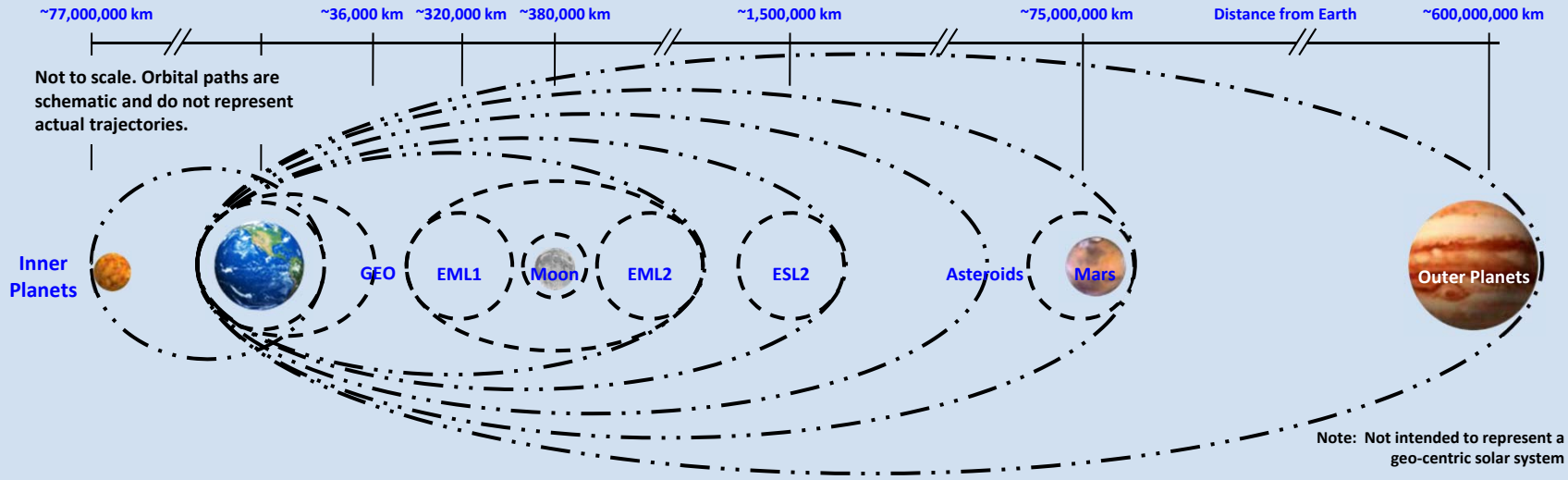
- **SLS Enables Exploration Missions**
  - Greater volume and mass capability/margin
    - Increased design simplicity
    - Fewer origami-type payload designs needed to fit in the fairing
  - Single launch of multiple elements means fewer launches, deployments, and critical operations
    - Simplifies on-orbit operations
    - Reduced risk
  - High-energy orbit and shorter trip times
    - Less expensive mission operations
    - Reduced risk - Maximize mission reliability via Increased lift capacity and payload margin

- **SLS investment can be leveraged for other missions requiring large volume or up mass**
  - Deep Space Exploration
  - Planetary Landers
  - Human Habitats
  - Great Observatories
  - Space Solar Power
  - Outer Planet Missions
  - Department of Defense/NRO Payloads

SLS Block 1 C3 Performance



SLS Mission Capabilities



Exclusive (Missions SLS is designed to enable)	Bigelow BA 2100		Human lunar missions	EM-L2 Waypoint		Human asteroid missions	Human Mars missions	Outer Planet Sample Return
Superior (Mass, volume and trip time make SLS very attractive)	Solar Power Satellites		Depots	Telescopes			Mars Sample Return	JEO / Saturn/Titan System / Ice Giant mission
Competitive (Other approaches exist, e.g., multiple launches)	Mercury robotic missions	Bigelow BA 330	GEO sat servicing					Some robotic planetary missions
Non Competitive (No forseeable benefits from SLS)	Venus robotic orbiters or landers	Comm sats LEO small sats	Lunar robotic orbiters or landers					

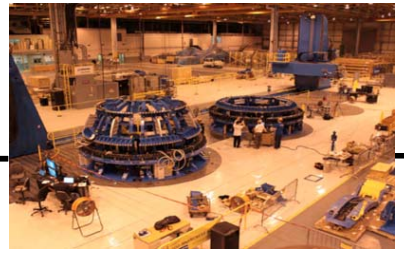
SLS Hardware/Software in Production and Testing in 2012–13


MPCV Stage Adapter Production
Ladish Forging, WI
Major Tool and Machine, IN

Avionics Testbed
Marshall Space Flight Center, AL

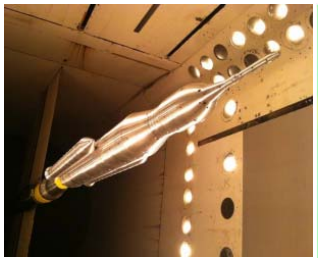
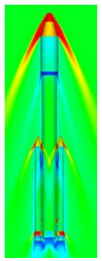
J-2X Engine Testing
Stennis Space Center, MS


Booster Motor
Production and Firing
Promontory, UT



Core Stage Tooling
Michoud Assembly Facility, LA

F-1 Gas Generator Testing
Marshall Space Flight Center, AL

Wind Tunnel Testing and Analysis

RS-25 Consolidation
Stennis Space Center, MS

Launch Complex 39B Preparation
Kennedy Space Center, FL

SLS: A Year of Accomplishments

Systems Engineering and Integration SLS model undergoes wind tunnel testing at Langley Research Center Nov 2012

J-2X power pack assembly hot fire test at Stennis Space Center Nov 2012

Multi-Purpose Crew Vehicle Stage Adapter (MSA) Pathfinder Hardware at Marshall Space Flight Center June 2012

Kennedy Space Center Complex 39B ready for a 2017 SLS launch (artist's concept)

RS-25 Engines at Stennis Space Center Oct 2012, shown with future RS-25 Test Stand A1

F-1 engine gas generator hot fire test at Marshall Space Flight Center, Jan 2013 – technology development for an optional Advanced Booster concept

Qualification Motor 1 casting at ATK Oct 2012

System Requirements Review/System Definition Review Completed

NASA's Space Launch System

- ***Vital to NASA's exploration strategy and the U.S. space agenda***
- **Key tenets: safety, affordability, and sustainability**
- **Provides high mass and volume capabilities for space science missions**
- **Provides unique, mission-enabling benefits for science and exploration**
- **Prime contractors on board, work is in progress**
- **Completed System Requirements Review / System Definition Review**

Preliminary Design Review 2013

Launching in 2017

For More Info:
www.nasa.gov/sls