National Aeronautics and Space Administration

NASA's Space Launch System Takes Shape: Progress Toward Safe, Affordable Exploration

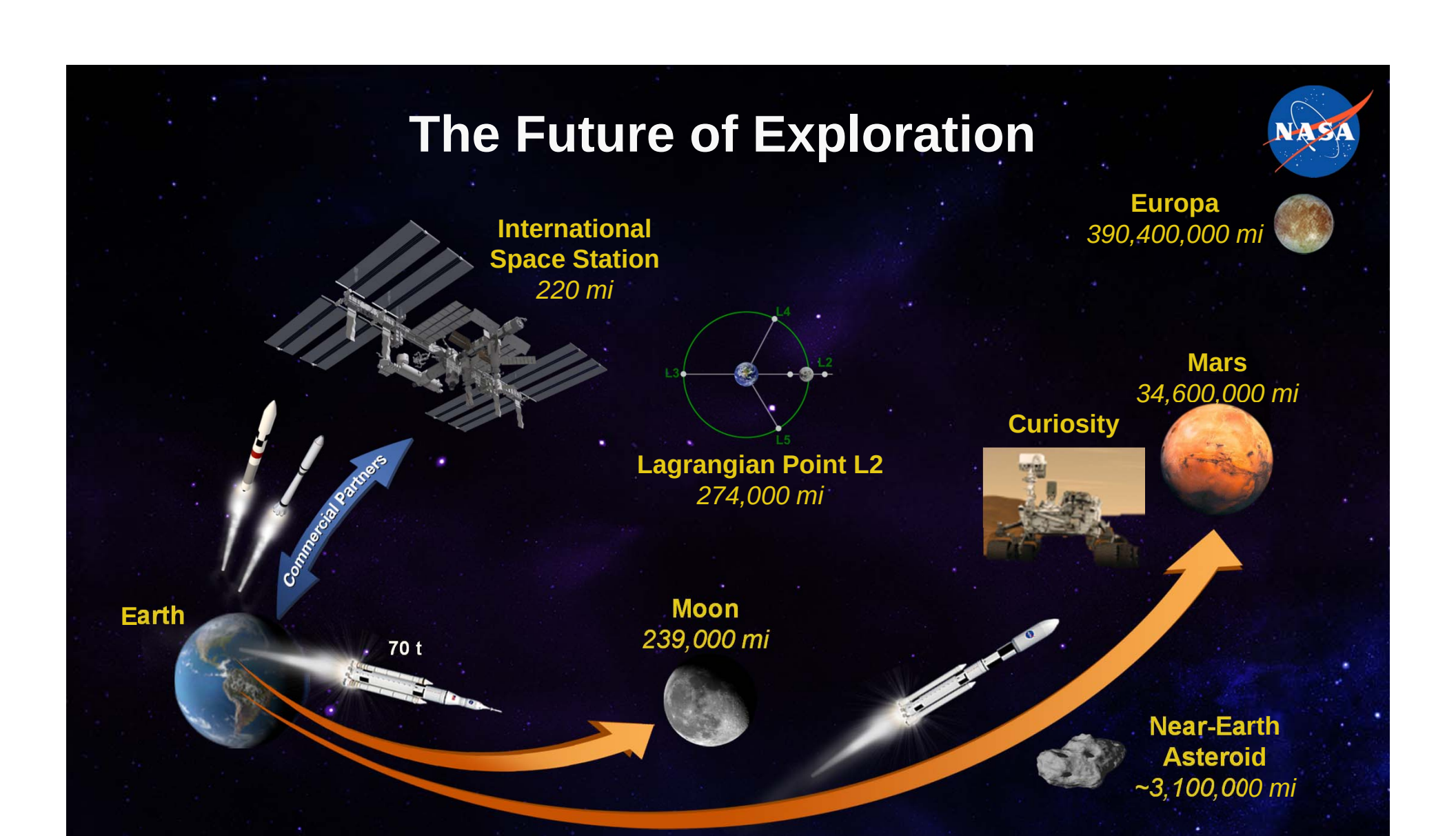
61st JANNAF Propulsion Meeting

May 22, 2014

Bruce R. Askins, Infrastructure Management Lead
Kimberly F. Robinson, Strategic Communications Lead
Space Launch System

marshall

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

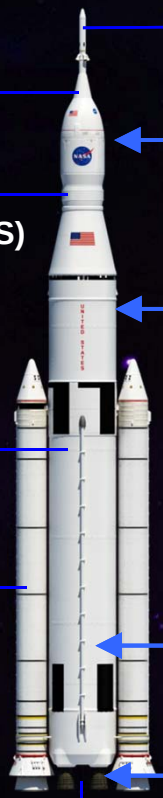
www.nasa.gov/ola

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

Optimum design for BEO missions of national importance

Building on the U.S. Infrastructure



Launch Abort System

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) *(Aerojet Rocketdyne)*

Commonality of Payload Interfaces

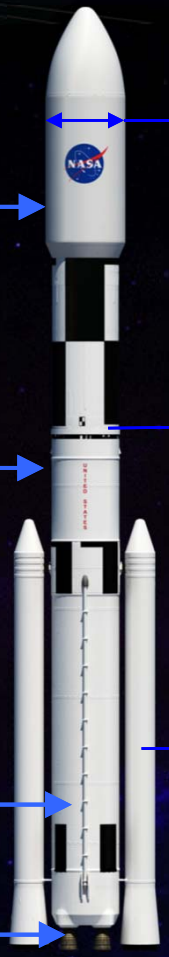
- Mechanical
- Avionics
- Software

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



Cargo Fairing
33 ft (10m)

Upper Stage

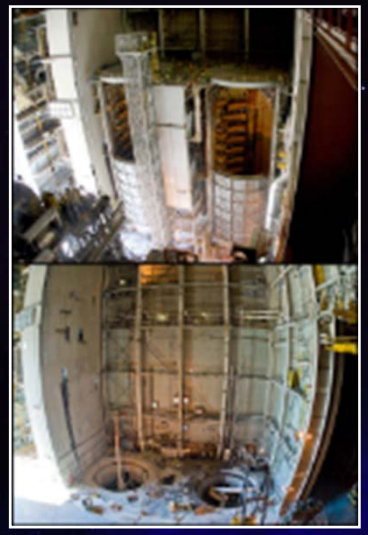
Advanced Solid or Liquid (i.e., RP Engines) Boosters

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

SLS Core Stage Welding Tools Progress



Building the world's largest rocket in a state-of-the-art facility.

Core Stage Vertical Assembly Center Progress

SSC B-2 Test Stand Progress

SLS RS-25 Core Stage Engine Progress

Scheduled for summer 2014 at Stennis Space Center.

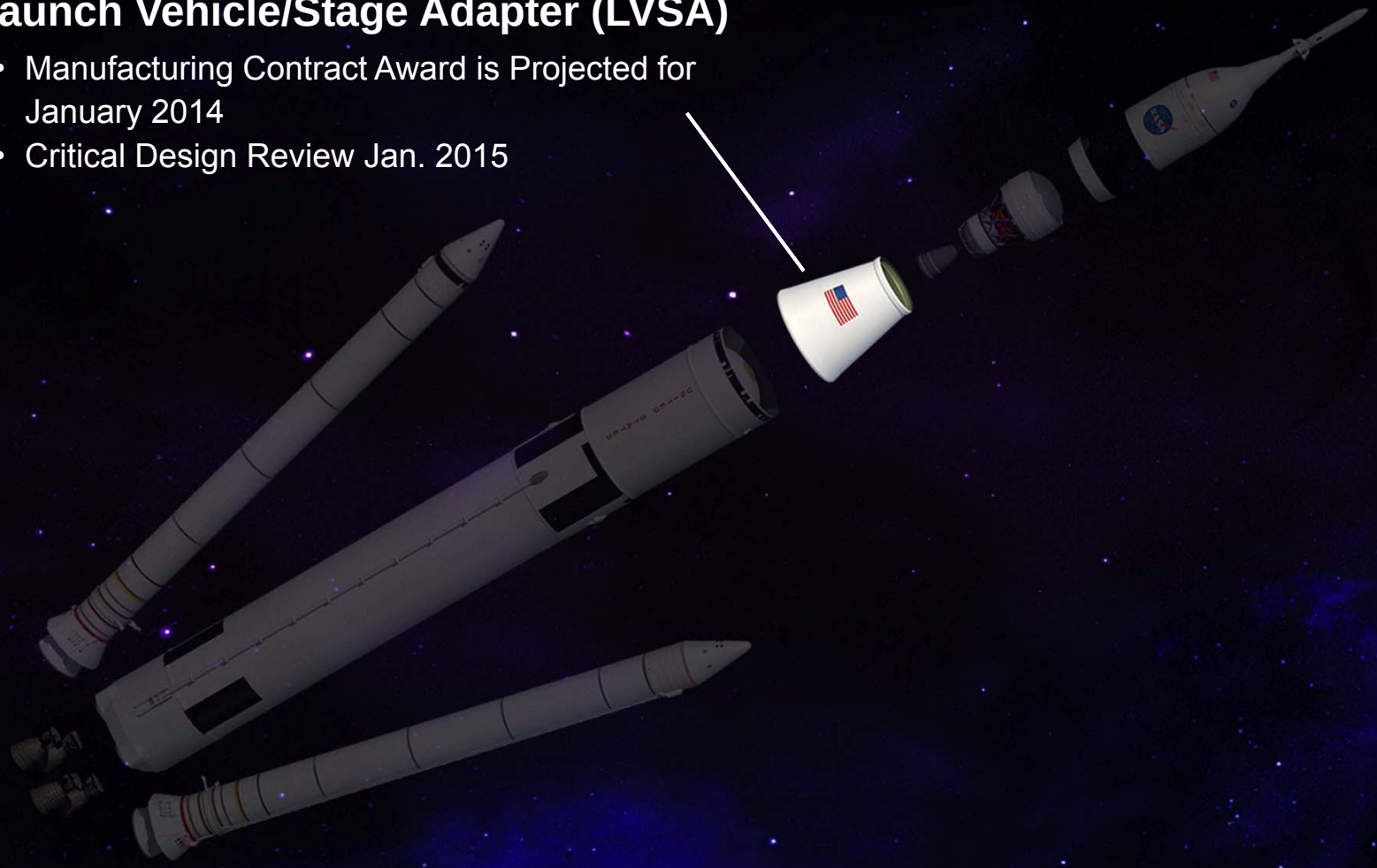
SLS Booster Progress

Testing upgrades for the solid rocket boosters.

Launch Vehicle Stage Adapter

Launch Vehicle/Stage Adapter (LVSA)

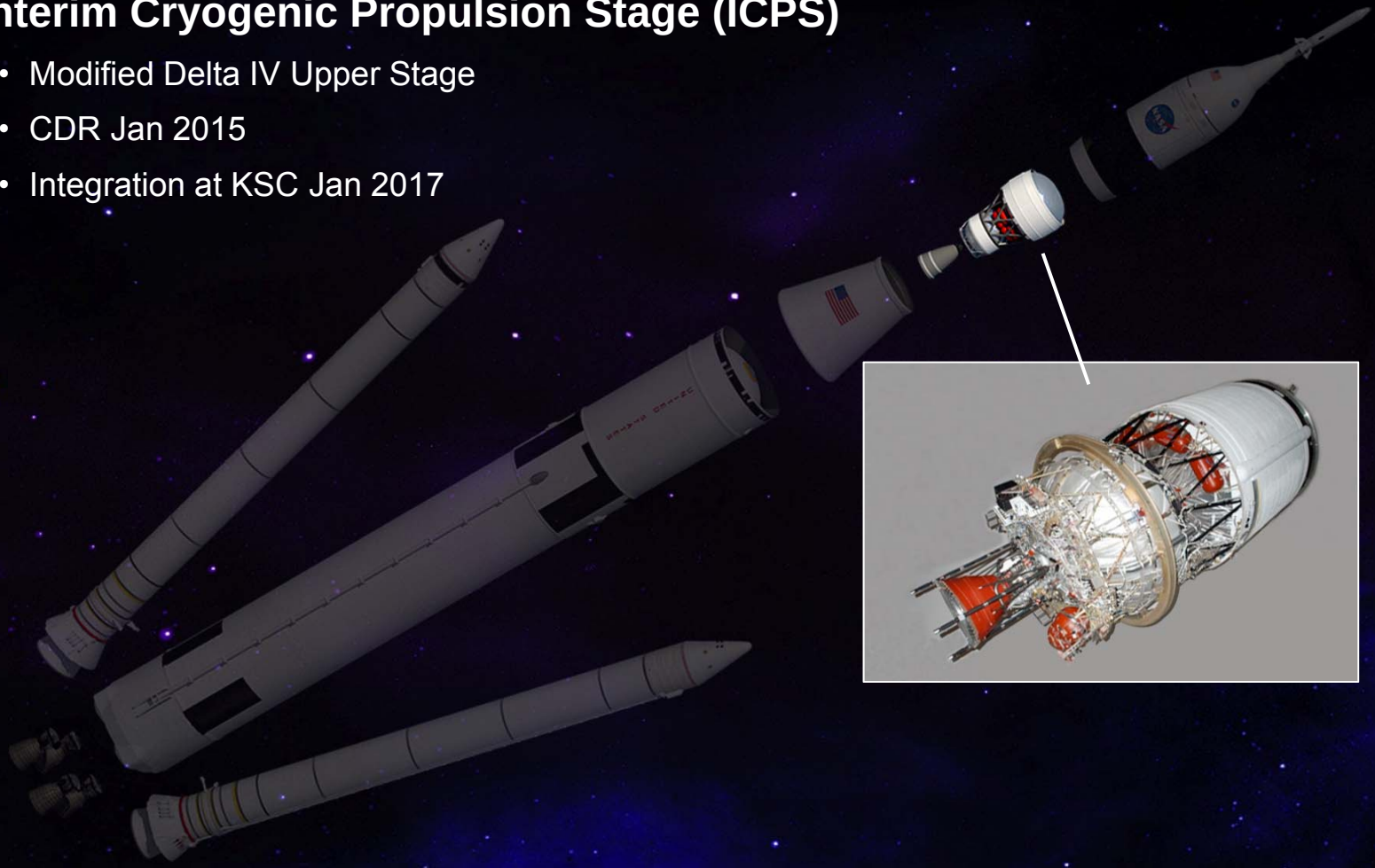
- Manufacturing Contract Award is Projected for January 2014
- Critical Design Review Jan. 2015



Interim Cryogenic Propulsion Stage

Interim Cryogenic Propulsion Stage (ICPS)

- Modified Delta IV Upper Stage
- CDR Jan 2015
- Integration at KSC Jan 2017



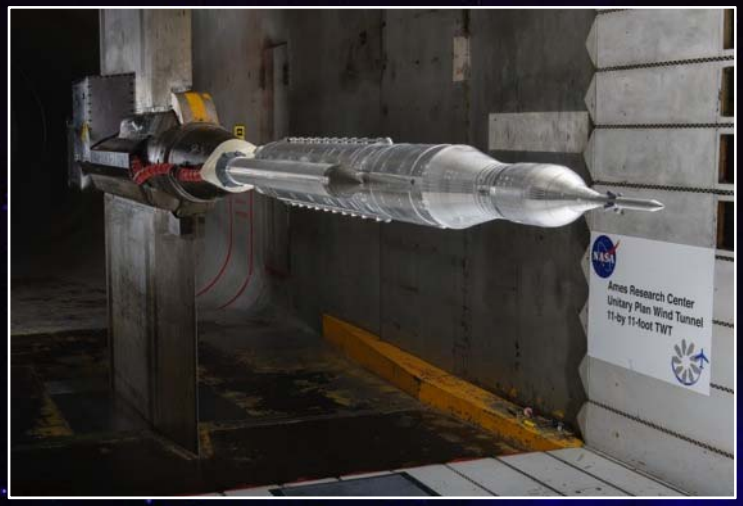
Orion-to-Stage Adapter for EFT-1 and EM-1

Design once. Build and fly many times.

SLS Avionics Progress

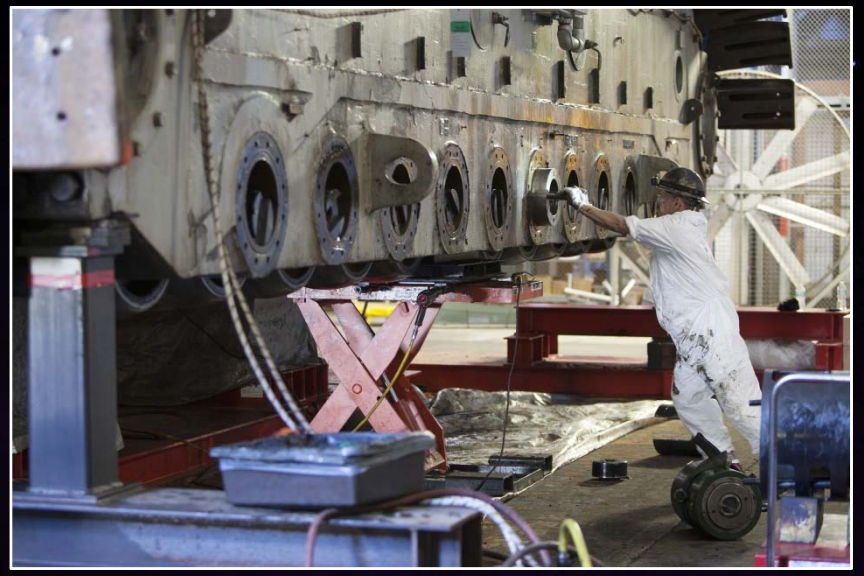
Integrated and powered up hardware, software, and operating systems for an inaugural run.

SLS Systems Engineering and Integration



Conducted thousands of hours of testing across the country.

Ground Operations Liaison Office



SLS Development On Time, Within Budget

2011	2012	2013	2014	2015	2016	2017
MCR ✔	SRR/SDR ✔	PDR ✔		CDR	SIR	PLAR, FRR, Launch

PROGRAM PROGRESS

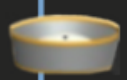
SLS Design Chosen

Booster Development Test

Engines Delivered to Inventory

Wind Tunnel Testing

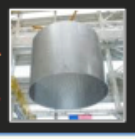
Manufacturing Tooling Installation



Production of First New Flight Hardware

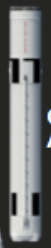
Main Engine Test-Firing

Orion Flight Test



STA Production Begins

Booster Test-Firings

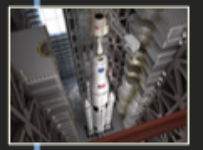


Core Stage Assembly

Core Stage Structure Testing

Core Stage Test-Firing

Booster Assembly at KSC



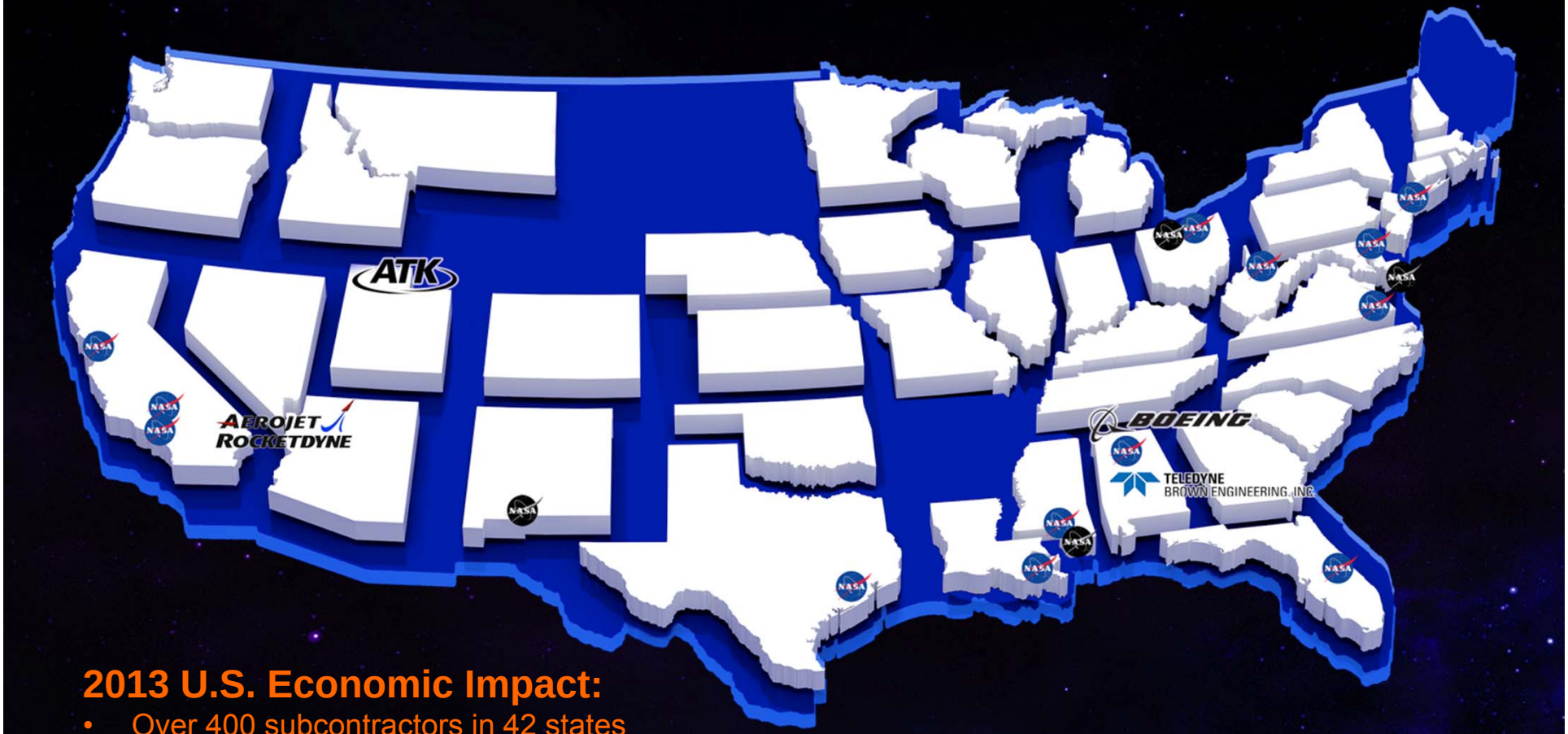
Vehicle Stacking at KSC

First Flight

Concept Studies	Concept & Technology Development	Preliminary Design & Technology Completion	Final Design & Fabrication	System Assembly, Integration & Test, Launch & Checkout

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 Nationwide Team

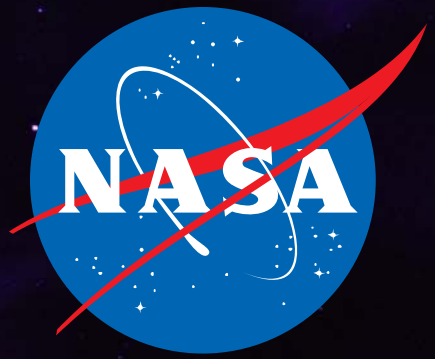


2013 U.S. Economic Impact:

- Over 400 subcontractors in 42 states
- $4.29B
- 25,000 Jobs
- Engaging the U.S. aerospace industry
- Strengthening sectors such as manufacturing
- Advancing technology and innovation

NASA Facilities
NASA Centers

Conclusion



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