NASA’S SPACE LAUNCH SYSTEM: PAYLOAD OPPORTUNITIES FOR LUNAR EXPLORATION, SCIENCE MISSIONS

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STEVE CREECH
Manager, Spacecraft/Payload Integration & Evolution
NASA’s Space Launch System
SLS EVOLVABILITY
FOUNDATION FOR A GENERATION OF DEEP SPACE EXPLORATION

- **Payload to TLI/Moon**
- **355 ft.**
  - 8.4m Fairing
  - 8.4m Fairing Long (Up to 90')
  - Evolved Boosters
  - RS-25 Engines

- **365 ft.**
  - Universal Stage Adapter
  - Exploration Upper Stage
  - Interstage

- **325 ft.**
  - Universal Stage Adapter
  - Exploration Upper Stage
  - Interstage

- **322 ft.**
  - Launch Abort System
  - Orion
  - 5m Class Fairing (up to 63')

- **Up to 313ft.**
  - Interim Cryogenic Propulsion Stage
  - Launch Vehicle Stage Adapter

- **Interstage**

- **Evolved Boosters**

- **Solid Rocket Boosters**

- **Core Stage**

- **Exploration Upper Stage**

- **Universal Stage Adapter**

- **Payload to TLI/Moon**

- **Stage Adapter**

- **Interim Cryogenic Propulsion Stage**

- **Launch Vehicle Stage Adapter**

- **Launch Abort System**

- **Orion**

- **5m Class Fairing (up to 63')**

- **RS-25 Engines**

- **SLS Block 1**
  - > 26 t (57k lbs)

- **SLS Block 1 Cargo**
  - > 26 t (57k lbs)

- **SLS Block 1B Crew**
  - 34–37 t (74k–81k lbs)

- **SLS Block 1B Cargo**
  - 37–40 t (81k–88k lbs)

- **SLS Block 2 Crew**
  - > 45 t (99k lbs)

- **SLS Block 2 Cargo**
  - > 45 t (99k lbs)
SLS C3 PERFORMANCE

SLS performance is optimized for lunar destinations (C3= -0.99 km²/s²)
BLOCK 1 PAYLOAD ACCOMMODATIONS

SLS Block 1 Crew
- Orion Spacecraft
- ISPE
- Orion Stage Adapter (OSA)
- Interim Cryogenic Propulsion Stage (ICPS)
- Launch Vehicle Stage Adapter (LVSA)

Up to 17 places ≤ 12U

SLS Block 1 Cargo
- CubeSats
- 5m Fairing
- Primary Fairing
- Integrated Spacecraft/Payload Element (ISPE)
- Payload Adapter

229 m³ available volume

Interim Cryogenic Propulsion Stage (ICPS)
- 6U 14 kg
- 12U 20 kg

Primary Payload

Payload Adapter

Integrated Spacecraft/Payload Element (ISPE)

Launch Vehicle Stage Adapter (LVSA)
**BLOCK 1B PAYLOAD ACCOMMODATIONS**

**SLS Block 1B Crew**
- Orion Spacecraft
- Stages (EUS)
- Universal Stage Adapter (USA) 286 m³, ≤10 t lbm

**SLS Block 1B Cargo**
- Fairing diameter x length
  - 8.4 m x 19.1 m
  - 8.4 m x 27.4 m
- Available volume
  - 621 m³
  - 988 m³

**Payload Accommodations**
- 8.4m Fairing
- Co-Manifested Payload
- Primary Payload
- CubeSats up to 21 places ≤12U
- Payload Adapter (PLA)
- CubeSats up to 7 places ≤12U

**Payload Types**
- CubeSats
  - Up to 7 places ≤12U
- Up to 21 places ≤12U

**Payload Characteristics**
- 6U
- 12U
SLS ENABLES LUNAR, MARTIAN MISSIONS

- **CubeSats**: Smallsat access to deep space, propulsive capabilities
- **Orion with short-duration hab module**: 286 m³, 10 t lbm capability
- **10m fairing w/notional Mars payload**: 1,320 m³, >45 t lbm capability
SLS ENABLES SCIENCE MISSIONS

- Europa Clipper and Lander
- Dual spacecraft to the Ice Giants
- Interstellar probe
- Large-aperture space telescopes
SLS PROGRESS TOWARD ARTEMIS I:
FLIGHT ARTICLES
SLS PROGRESS TOWARD ARTEMIS II & BEYOND

- All booster motor segments cast; seven complete
- All Artemis II core stage components manufactured
- Five RL-10s complete
- LVSA, OSA, ICPS panels machined
- Two RS-25s complete, controllers green run
- Payload adapter manufacturing demonstration article
MORE TECHNICAL INFORMATION

SLS MISSION PLANNER’S GUIDE

• SLS Mission Planner’s Guide (ESD 30000)
  • Google or email: NASA-slspayloads@mail.nasa.gov
  – www.nasa.gov/opportunities for payload opportunities and announcements
NASA’S SPACE LAUNCH SYSTEM
UNIQUE CAPABILITY FOR HUMAN AND ROBOTIC EXPLORATION

VOLUME

• Block 1B: **Double the volume** of any contemporary heavy lift vehicle

• **Only vehicle** that can carry the Orion and a co-manifested payload to the Moon

MASS

• Block 1B: Can launch **50% more mass** than any contemporary launch vehicle

• Block 2: Mars-enabling capability of **greater than 45 metric tons** to Trans Lunar Injection

DEPARTURE ENERGY

• **Reduce transit times by half or greater** to the outer solar system

• Enables larger payloads to **deep space destinations**
SLS BLOCK 1 CONFIGURATION

- **Launch Abort System (LAS)**
  - Utah, Alabama, Florida

- **Orion Stage Adapter**
  - California, Alabama

- **5 Segment Solid Rocket Booster (2)**
  - Northrop Grumman, Utah, KSC

- **Orion Multi-Purpose Crew Vehicle**
  - Boeing/United Launch Alliance, California, Alabama

- **Interim Cryogenic Propulsion Stage (ICPS)**
  - Boeing/United Launch Alliance, California, Alabama

- **Launch Vehicle Stage Adapter**
  - Teledyne Brown Engineering, Alabama

- **Core Stage & Avionics**
  - Boeing, Louisiana, Alabama

- **RL10 Engine**
  - Aerojet Rocketdyne, Florida

- **RS-25 Engine (4)**
  - Aerojet Rocketdyne, California, Mississippi

- **P** = In Progress
- **= Completed**

0689
UNMATCHED VOLUME FOR PAYLOADS

### Enclosure

<table>
<thead>
<tr>
<th>Payload Type</th>
<th>5.1m PLF</th>
<th>5.1m PLF</th>
<th>OSA</th>
<th>8.4m USA</th>
<th>8.4m USA PLF</th>
<th>8.4m USA PLF, Short</th>
<th>10m PLF Short</th>
<th>10m PLF Long</th>
<th>10m PLF Long</th>
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</thead>
<tbody>
<tr>
<td>Length</td>
<td>47.9 ft</td>
<td>62.7 ft</td>
<td>47.9 ft</td>
<td>62.7 ft</td>
<td>62.7 ft</td>
<td>62.7 ft</td>
<td>62.7 ft</td>
<td>62.7 ft</td>
<td>62.7 ft</td>
</tr>
<tr>
<td>Diameter</td>
<td>14.3 m</td>
<td>19.1 m</td>
<td>14.3 m</td>
<td>19.1 m</td>
<td>19.1 m</td>
<td>19.1 m</td>
<td>19.1 m</td>
<td>19.1 m</td>
<td>19.1 m</td>
</tr>
<tr>
<td>Internal Diameter</td>
<td>16.7 ft</td>
<td>16.7 ft</td>
<td>17.7 ft</td>
<td>17.7 ft</td>
<td>27.6 ft</td>
<td>27.6 ft</td>
<td>33.8 ft</td>
<td>27.6 ft</td>
<td>33.0 ft</td>
</tr>
<tr>
<td>Available Volume</td>
<td>5,708 ft³</td>
<td>8,119 ft³</td>
<td>5,166 ft³</td>
<td>10,101 ft³</td>
<td>11,260 ft³</td>
<td>21,680 ft³</td>
<td>32,470 ft³</td>
<td>34,710 ft³</td>
<td>46,610 ft³</td>
</tr>
<tr>
<td>Potential Availability (No Faster Than)</td>
<td>COTS</td>
<td>COTS</td>
<td>2023</td>
<td>2024</td>
<td>2025</td>
<td>2025</td>
<td>2029</td>
<td>2029</td>
<td>2029</td>
</tr>
</tbody>
</table>

COTS: Commercial Off-the-Shelf  
CFL: Co-manifested Payload  
OSA: On-Stage Adapter  
PPL: Primary Payload  
PLF: Payload Fairing
ARTEMIS I
The first uncrewed, integrated flight test of NASA's Orion spacecraft and Space Launch System rocket, launching from a modernized Kennedy spaceport

1. LAUNCH
SLS and Orion lift off from pad 39B at Kennedy Space Center

2. JETTISON ROCKET BOOSTERS
Solid rocket boosters separate

3. JETTISON LAUNCH ABORT SYSTEM (LAS)
The LAS is no longer needed, Orion could safely abort

4. CORE STAGE MAIN ENGINE CUT OFF (MECO) and separation

5. ENTER EARTH ORBIT
Perform the perigee raise maneuver

6. EARTH ORBIT
Systems check and solar panel adjustments

7. TRANS LUNAR INJECTION (TLI) BURN
Burn lasts for approximately 20 minutes

8. INTERIM CRYOGENIC PROPULSION STAGE (ICPS) SEPARATION
The ICPS has committed Orion to TLI

9. OUTBOUND TRANSIT
Requires several attitude maneuvers

10. OUTBOUND TRAJECTORY CORRECTION (OTC) BURNS
As necessary adjust trajectory for Lunar flyby to DRO

11. OUTBOUND POWERED FLYBY (OPF)
62 miles from the Moon; targets DRO insertion

12. ORBIT INSERTION
Enter Distant Retrograde Orbit for next 6-23 days

13. DISTANT RETROGRADE ORBIT (DRO)
Orbit Maintenance burns and solar panel adjustments; 38,000 nmi from the surface of the Moon

14. DRO DEPARTURE
Leave DRO and start return to Earth

15. RETURN POWER FLY-BY (RPF)
RPF burn prep and return coast to Earth initiated

16. RETURN TRANSIT
Return Trajectory Correction (RTC) burns as necessary to aim for Earth’s atmosphere; travel time 3-11 days

17. FINAL RETURN TRAJECTORY CORRECTION (RTC) BURN
Precision targeting for Earth entry

18. ENTRY INTERFACE (EI)
Enter Earth’s atmosphere

19. SPLASHDOWN
Pacific Ocean landing within view of the U.S. Navy recovery ships

Total distance traveled: 1.3 million miles – Mission duration: 26-42 days – Re-entry speed: 24,500 mph (Mach 32) – 13 CubeSats deployed
ARTEMIS I
FULL SYSTEMS CHECKOUT PRIOR TO CREWED MISSIONS
SLS MASS TO DESTINATIONS

Diagram showing the mass capabilities of SLS Block 1B, SLS Block 2, and SLS Block 1 for various destinations such as Lunar, Mars, Jupiter/Europa, Saturn via JGA, Saturn/Uranus/Neptune Direct.
SLS MASS TO DESTINATIONS

Note: assumes SLS B1B EUS with addition of a 3rd and/or 4th stage.
REMAINING STEPS TO FINAL INTEGRATION

BOOSTERS: Deliver forward & aft assemblies, ship motor segments; crews maneuvering pathfinders in RPSF

CORE STAGE: Engine installation, shipping to SSC, Green Run test campaign, shipping to KSC

LAUNCH VEHICLE STAGE ADAPTER: Install DFI, quick disconnects & cable runs; final checkout; shipping

SYSTEMS ENGINEERING & INTEGRATION: DCR, flight software delivery, Software Integration Lab (SIL) certification, CoFR, training
THIRD FLIGHT AND BEYOND

Five RL-10s complete
Booster processing
Payload adapter manufacturing demonstration article
Tooling for USA
RS-25 HIP-bonded main combustion chamber
EUS weld confidence articles
Additively manufactured pogo accumulator
SLS CAN ENABLE BREAKTHROUGH SCIENCE MISSIONS

• SLS is America’s heavy-lift vehicle for strategic human exploration and scientific missions

• Manufacturing is complete for the first flight; SLS is nearing the integration phase

• SLS has a flexible architecture and an evolvable upgrade path

• Discussions with the science community are ongoing to determine how SLS can enable breakthrough science missions, such as sending a probe to interstellar space
ARTEMIS II
Crewed Hybrid Free Return Trajectory, demonstrating crewed flight and spacecraft systems performance beyond Low Earth Orbit (LEO)

1. LAUNCH
2. ENTER EARTH ORBIT
   Perigee Raise Maneuver (PRM) by Interim Cryogenic Propulsion Stage (ICPS) into 100x1545 nmi orbit
3. APOGEE RAISE BURN TO HIGH EARTH ORBIT
   Followed by ICPS separation and Orion systems checkout
4. ORION TRANS-LUNAR INJECTION (TLI) BY ORION'S MAIN ENGINE
5. TRANS-LUNAR OUTBOUND
   4 days with Outbound Trajectory Correction (OTC) Burns by Orion Aux Engines
6. LUNAR FLYBY
   4,000 nmi (mean)
7. TRANS-EARTH RETURN
   4 days Return Trajectory Correction (RTC) Burns by Orion Aux Engines
8. CREW MODULE/SERVICE MODULE SEPARATION
9. ENTRY, DESCENT, AND LANDING
10. CREW AND ORION CAPSULE RECOVERY
11. ICPS DISPOSAL TO HELIOCENTRIC ORBIT

SLS Configuration (Block 1) with Human Rated ICPS | 15x1200 nmi (27.8x2222.4 km) insertion orbit | 28.5 deg inclination
4 astronauts | Mission duration: 10 Days | Re-entry speed: 24,500 mph (Mach 32)
# SLS Lift Capabilities

## Foundation for a Generation of Deep Space Exploration

### Maximum Thrust

<table>
<thead>
<tr>
<th>SLS Block</th>
<th>Max Thrust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td>8.8M lbs</td>
</tr>
<tr>
<td>Block 1B</td>
<td>8.8M lbs</td>
</tr>
<tr>
<td>Block 2</td>
<td>11.9M lbs</td>
</tr>
</tbody>
</table>

### Payload Volume

<table>
<thead>
<tr>
<th>SLS Block</th>
<th>Payload Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td>N/A**</td>
</tr>
<tr>
<td>Block 1B</td>
<td>9,030 ft³ (256m³)</td>
</tr>
<tr>
<td>Block 2</td>
<td>10,100 ft³ (286m³)**</td>
</tr>
</tbody>
</table>

### Payload to LEO

<table>
<thead>
<tr>
<th>SLS Block</th>
<th>Payload Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td>95 t (209k lbs)</td>
</tr>
<tr>
<td>Block 1B</td>
<td>105 t (231k lbs)</td>
</tr>
<tr>
<td>Block 2</td>
<td>130 t (287k lbs)</td>
</tr>
</tbody>
</table>

### Payload to TLI/Moon

<table>
<thead>
<tr>
<th>SLS Block</th>
<th>Payload Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td>&gt; 26 t (57k lbs)</td>
</tr>
<tr>
<td>Block 1B</td>
<td>34–37 t (74k–81k lbs)</td>
</tr>
<tr>
<td>Block 2</td>
<td>&gt; 45 t (99k lbs)</td>
</tr>
</tbody>
</table>

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**Low Earth Orbit (LEO)** represents a typical 200 km circular orbit at 28.5 degrees inclination.

**Trans-Lunar Injection (TLI)** is a propulsive maneuver used to set a spacecraft on a trajectory that will cause it to arrive at the Moon. A spacecraft performs **TLI** to begin a lunar transfer from a low circular parking orbit around Earth.

The numbers depicted here indicate the mass capability at the Trans-Lunar Injection point.

**Not including Orion/Service Module volume**