SPACE LAUNCH SYSTEM

PROGRESS TOWARD THE PROVING GROUND

Angie Jackman
NASA Space Launch System
June 2017
Exploring Space In Partnership

Now
Using the International Space Station

2020s
Operating in the Lunar Vicinity

2030s
Leaving the Earth-Moon System and Reaching Mars Orbit

Advancing technologies, discovery and creating economic opportunities

Phase 0
Solve exploration mission challenges through research and systems testing on the ISS. Understand if and when lunar resources are available. Develop standards

Phase 1
Conduct missions in cislunar space; assemble Deep Space Gateway and Deep Space Transport

Phase 2
Complete Deep Space Transport and conduct Mars verification mission

Phases 3 and 4
Missions to the Mars system, the surface of Mars
<table>
<thead>
<tr>
<th>Component</th>
<th>Availability</th>
<th>Provides</th>
<th>Enables</th>
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</thead>
<tbody>
<tr>
<td>SLS Block 1</td>
<td>As Early As 2019</td>
<td>Provides Initial Heavy-Lift Capability</td>
<td>Enables Orion Test</td>
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<td>SmallSats to Deep Space</td>
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<tr>
<td>SLS Block 1B Crew</td>
<td>As Early As 2022</td>
<td>Provides 105 t lift capability via Exploration Upper Stage</td>
<td>Enables Deep Space Gateway</td>
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<td></td>
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<td>Larger CubeSat- and ESPA-Class Payloads</td>
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<tr>
<td>SLS Block 1B Cargo</td>
<td>As Early As 2022</td>
<td>Provides 8.4-meter fairings for primary payloads</td>
<td>Enables Europa Clipper/Lander</td>
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<td></td>
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<td>Deep Space Transport</td>
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<td>Large-Aperture Space Telescopes</td>
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<td>Ice or Ocean Worlds Missions</td>
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<td></td>
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<td>Interstellar Medium</td>
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<tr>
<td>SLS Block 2</td>
<td>As Early As 2028</td>
<td>Provides 130 t lift capability via advanced boosters</td>
<td>Enables Crewed Mars Orbit-Missions</td>
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<tr>
<td></td>
<td></td>
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<td>Crewed Mars Surface Missions</td>
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For more information, visit [www.nasa.gov/sls](http://www.nasa.gov/sls).
Benefits of Space Launch System

**Volume**
- Space Launch System will be able to offer payload accommodations with five times more volume than any contemporary launch vehicle.
- Payload fairings of up to 10-meter diameter are planned.

**Mass**
- Space Launch System will offer an initial capability of greater than 70 metric tons to low Earth orbit; current U.S. launch vehicle maximum is 28 t.
- Evolved version of SLS will offer greatest-ever capability of greater than 130 t to LEO.

**Departure Energy**
- SLS offers reduced transit times to the outer solar system by half or greater.
- Higher characteristic energy (C3) also enables larger payloads to destination.

www.nasa.gov/sls
• Deep Space Gateway provides ability to support multiple NASA, U.S. commercial, and international partner objectives in Phase 1 and beyond

• The Gateway is designed for deep space environments
  • Supports (with Orion docked) crew of 4 for total mission up to 42 days
  • Supports buildup of the Deep Space Transport
  • Open trade for compatibility for operations in Low Lunar Orbit
# Phase 1 Development

## Deep Space Gateway Buildup

<table>
<thead>
<tr>
<th></th>
<th>EM-1</th>
<th>Europa Clipper</th>
<th>EM-2</th>
<th>EM-3</th>
<th>EM-4</th>
<th>EM-5</th>
<th>2026</th>
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<tbody>
<tr>
<td>Year</td>
<td>SLS Block 1</td>
<td>SLS Block 1B Cargo</td>
<td>SLS Block 1B</td>
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<td>SLS Block 1B</td>
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<tr>
<td></td>
<td>Crew: 0</td>
<td>Crew: 4</td>
<td>Crew: 4</td>
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<td>Crew: 4</td>
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<tr>
<td></td>
<td>Europa Clipper (subject to approval)</td>
<td>CMP Capability: 8-9T</td>
<td>CMP Capability: 10mT</td>
<td>CMP Capability: 10mT</td>
<td>CMP Capability: 10mT</td>
<td>CMP Capability: 10mT</td>
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<tr>
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<td>2018 - 2025</td>
<td>40kW Power/Prop Bus</td>
<td>Habitation</td>
<td>Logistics</td>
<td>Airlock</td>
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<td></td>
<td>Distant Retrograde Orbit (DRO)</td>
<td>Jupiter Direct</td>
<td>Multi-TLI Lunar Free Return</td>
<td>Near Rectilinear Halo Orbit (NRHO)</td>
<td>NRHO, w/ ability to translate to/from other cislunar orbits</td>
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<td></td>
<td>26-40 days</td>
<td>8-21 days</td>
<td>16-26 days</td>
<td>26-42 days</td>
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**Known Parameters:**
- Gateway to architecture supports Phase 2 and beyond activities
- International and U.S. commercial development of elements and systems
- Gateway will translate uncrewed between cislunar orbits
- Ability to support science objectives in cislunar space

**Open Opportunities:**
- Order of logistics flights and logistics providers
- Use of logistics modules for available volume
- Ability to support lunar surface missions

These essential Gateway elements can support multiple U.S. and international partner objectives in Phase 1 and beyond.
• Deep Space Transport provides habitation and transportation needs for transporting crew into deep space including supporting human Mars-class missions
• The Transport system life will be designed for:
  • Reuse for 3 Mars-class missions with resupply and minimal maintenance
  • Crew of 4 for 1,000 day-class missions in deep space
  • Launched on one SLS 1B cargo vehicle - resupply and minimal outfitting to be performed in cislunar space
PROGRESS TOWARD LAUNCH

Core Stage production at Michoud

Booster testing at Orbital ATK

Engine testing at Stennis Space Center

Upper stage prep at Cape Canaveral

Structural testing at Marshall

Ongoing work for Block 1B