National Aeronautics and Space Administration

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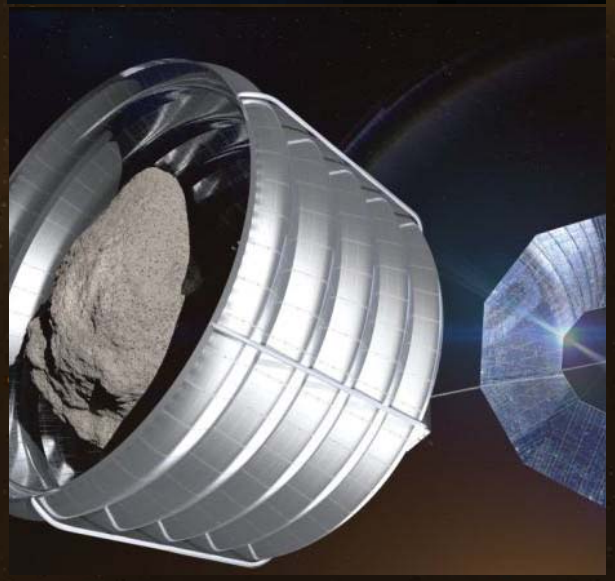
# SPACE LAUNCH SYSTEM

## NASA's FUTURE AND THE ELECTRICAL ENGINEER

**Dr. Fred Bickley**
**Space Launch System Program**

www.nasa.gov/sls

# THE DAWN OF A NEW ERA



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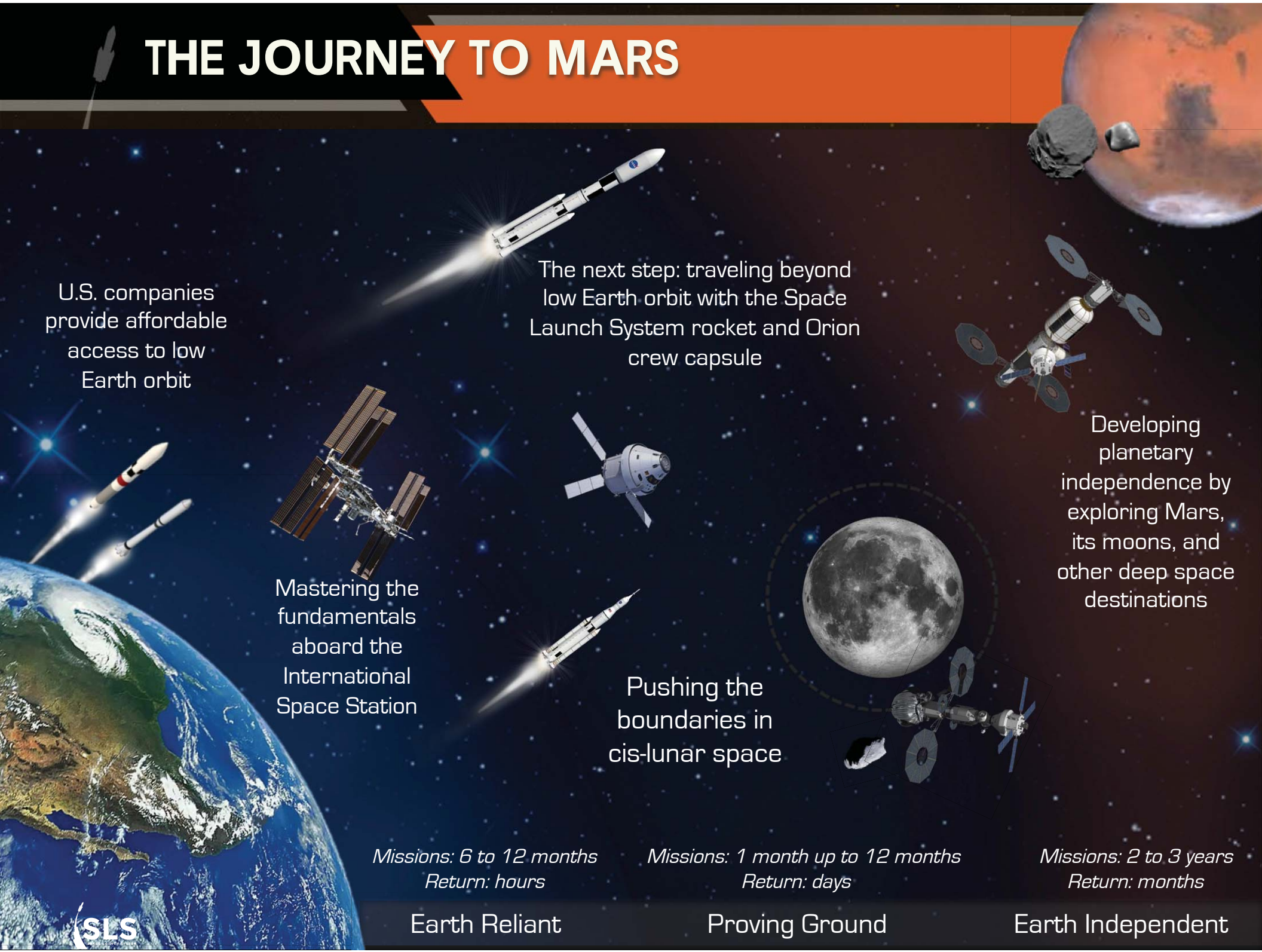
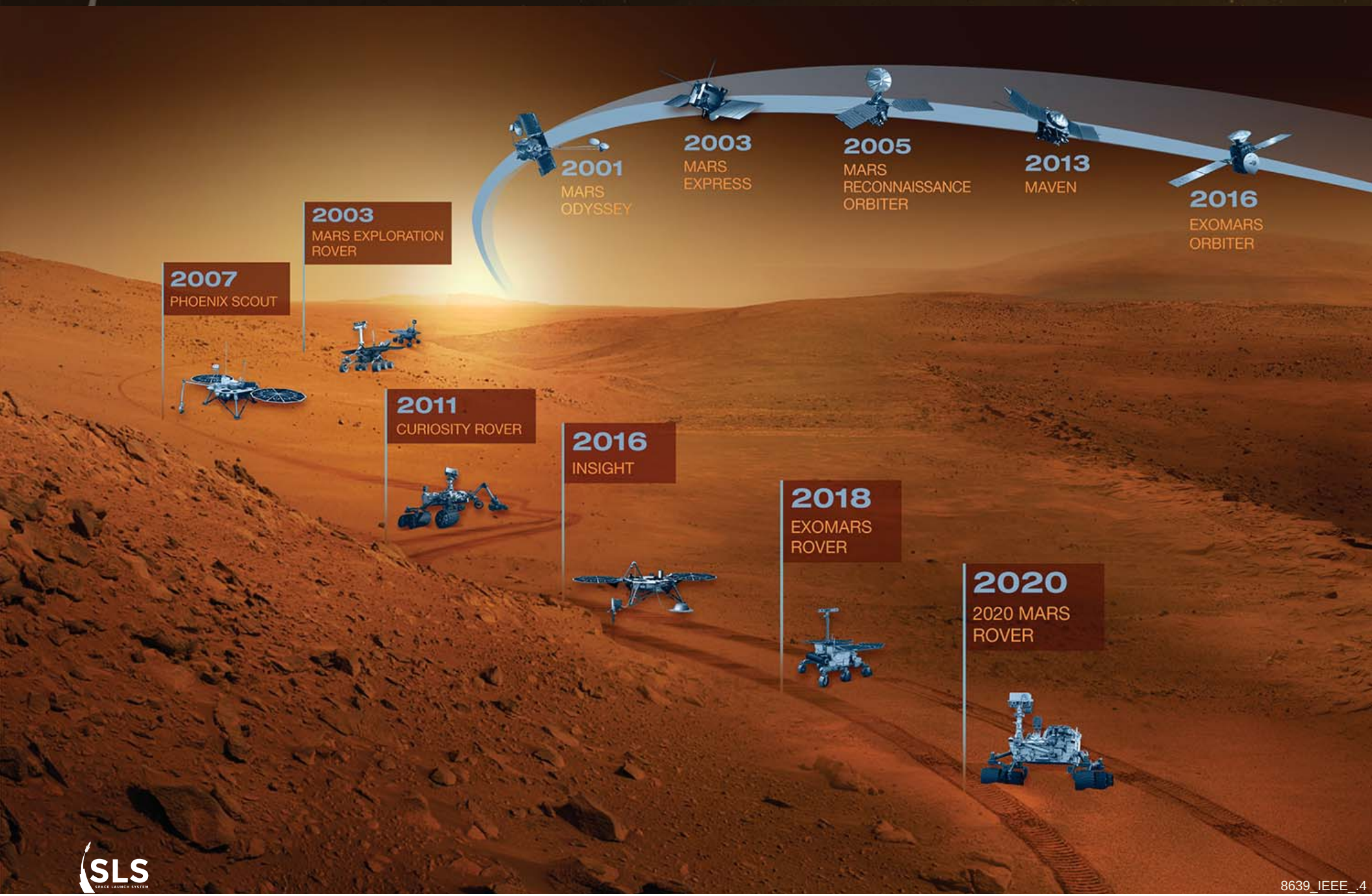
# THE JOURNEY TO MARS



# THE JOURNEY HAS ALREADY BEGUN

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# STEP ONE: HIGHER, FASTER, HOTTER

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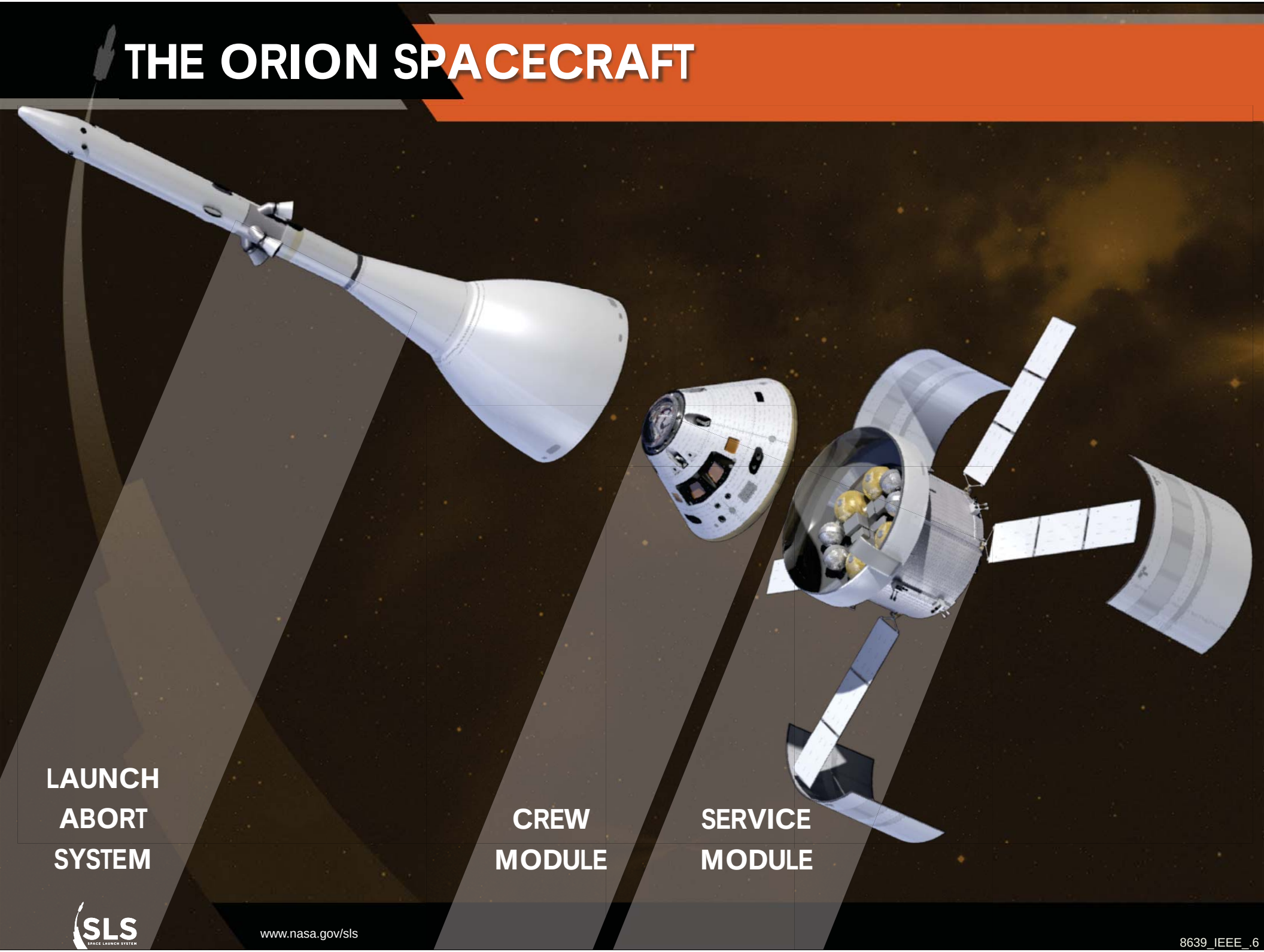
# THE ORION SPACECRAFT

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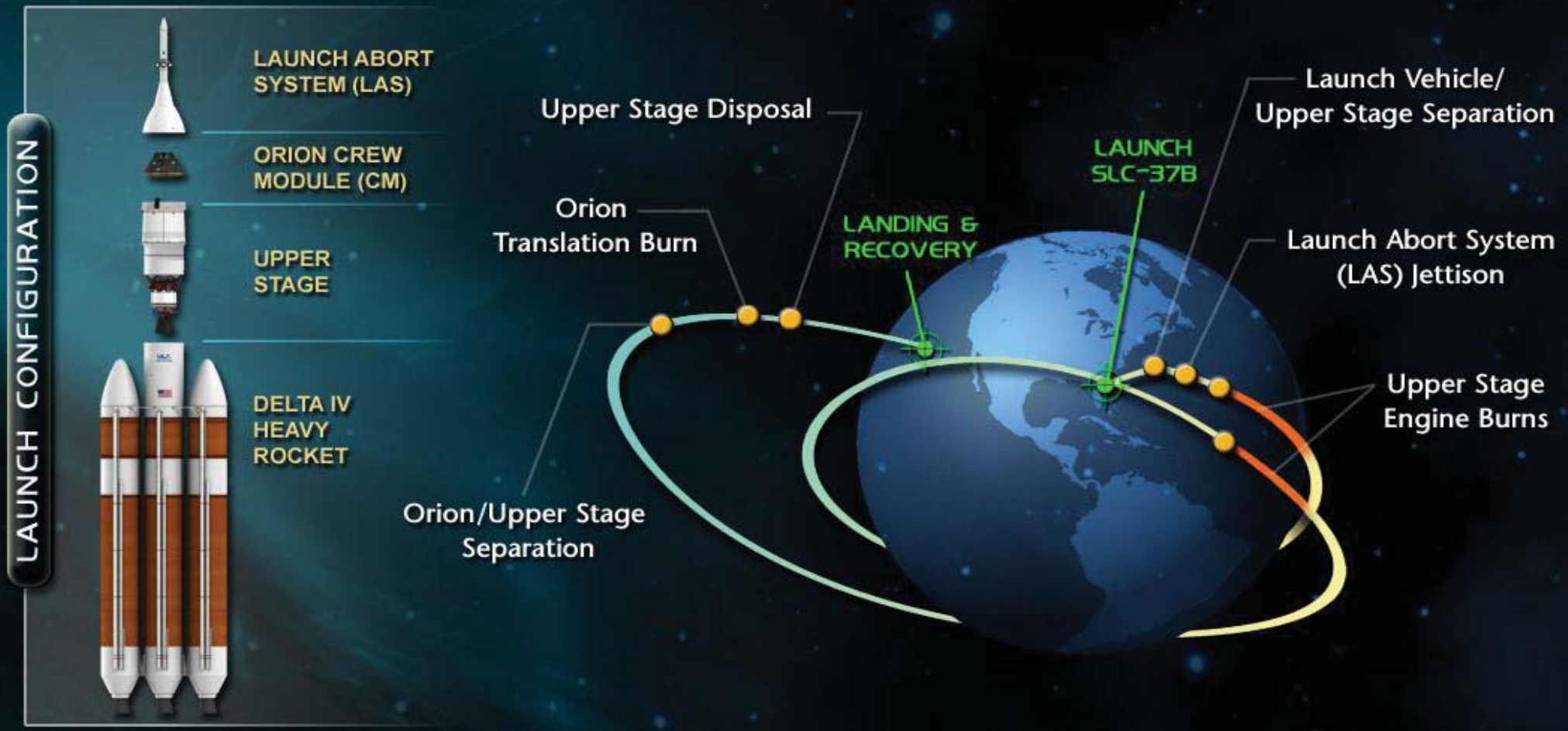
# STEP ONE: EFT-1 IN DECEMBER 2014

## EXPLORATION FLIGHT TEST ONE

OVERVIEW

TWO ORBITS ◎ 20,000 MPH ENTRY ◎ 3,671 MILE APOGEE ◎ 28.6 DEGREE INCLINATION



# STEP TWO: GOING FARTHER THAN APOLLO

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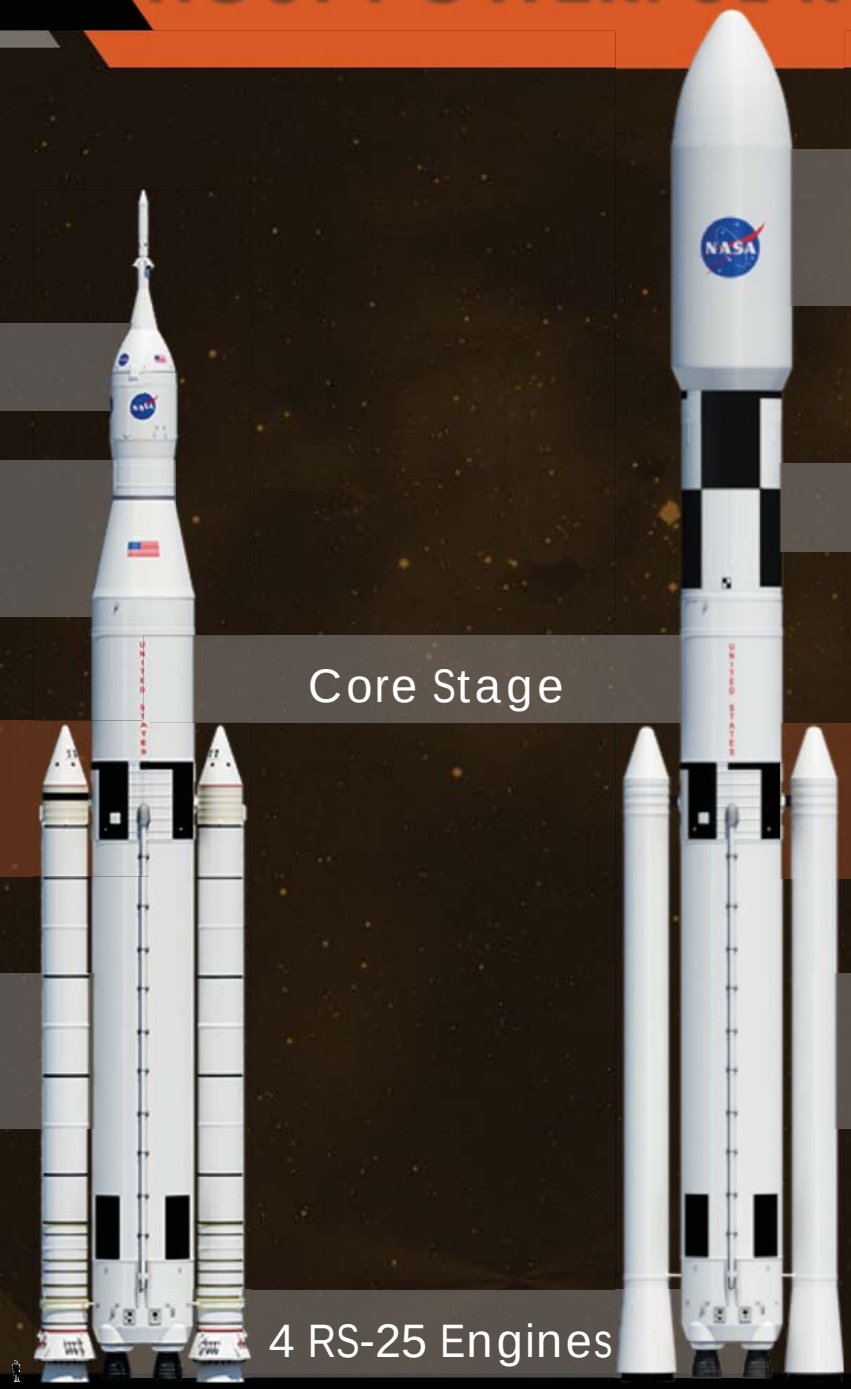
# THE WORLD'S MOST POWERFUL ROCKET




Orion

Interim Cryogenic Propulsion Stage

Block I
70 metric tons

Five-Segment Solid Rocket Boosters

5, 8.4 or 10 Meter Payload Fairings

Upper Stage

Core Stage

Block II
130 metric tons

Liquid or Solid Advanced Boosters

4 RS-25 Engines

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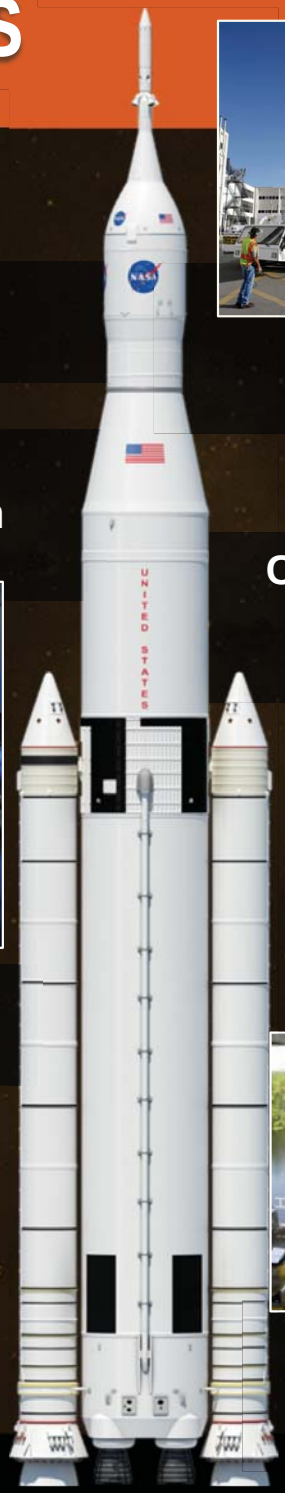
# RECENT PROGRESS

**Launch Vehicle Stage Adapter:** Contract awarded in February 2014.

**MPCV-to-Stage Adapter:** First flight hardware currently in Florida for Exploration Flight Test-1 in Fall 2014.

**Avionics:** Avionics “first light” marked in January 2014; currently testing most powerful flight system computer processor ever.



**Core Stage:** Initial confidence barrels and domes completed; Vertical Assembly Center activation completed in Sept. 2014.

**Boosters:** Forward Skirt test completed May 2014; preparations underway for QM-1.

**Engines:** Preparing for RS-25 testing at at Stennis Space Center; renovations underway to B-2 stand.

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# BUILDING TOWARD FIRST FLIGHT

## ACCOMPLISHMENTS

- 07/2012 Delivered RS-25 Engines to Inventory
- 07/2013 Competed Preliminary Design Review
- 07/2013 Completed First Confidence Barrel Section Welding
- 10/2013 Completed Thrust Vector Control Test
- 11/2013 Conducted Adaptive Augmenting Control Flight Test
- 10/2011 - 12/2013 Tested SLS Wind Tunnel Models
- 01/2014 Conducted Avionics "First Light" in Integration Facility
- 02/2014 Shipped Multi-Purpose Crew Vehicle Stage Adapter for EFT-1
- 09/2014 Core Stage major tooling complete

## WHAT'S NEXT

- Early 2015 Booster Qualification Motor 1 (QM-1)
- 05/2015 RS-25 E0525 test series complete
- 07/2015 Complete the SLS Critical Design Review
- 07/2015 MSFC STA Facilities Complete
- 12/2015 4th EM-1 flight engine delivered to SSC
- 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

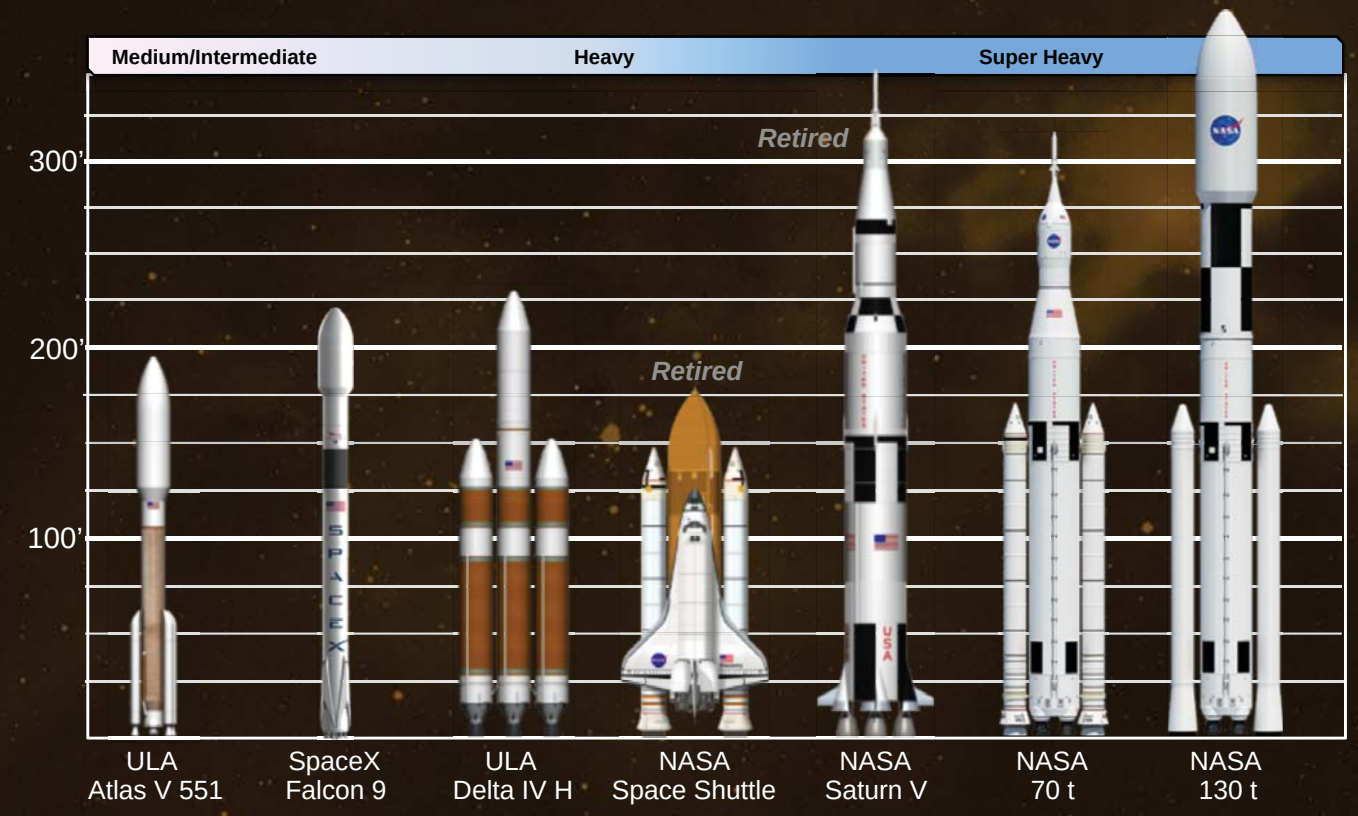
*Last Revision 090914*

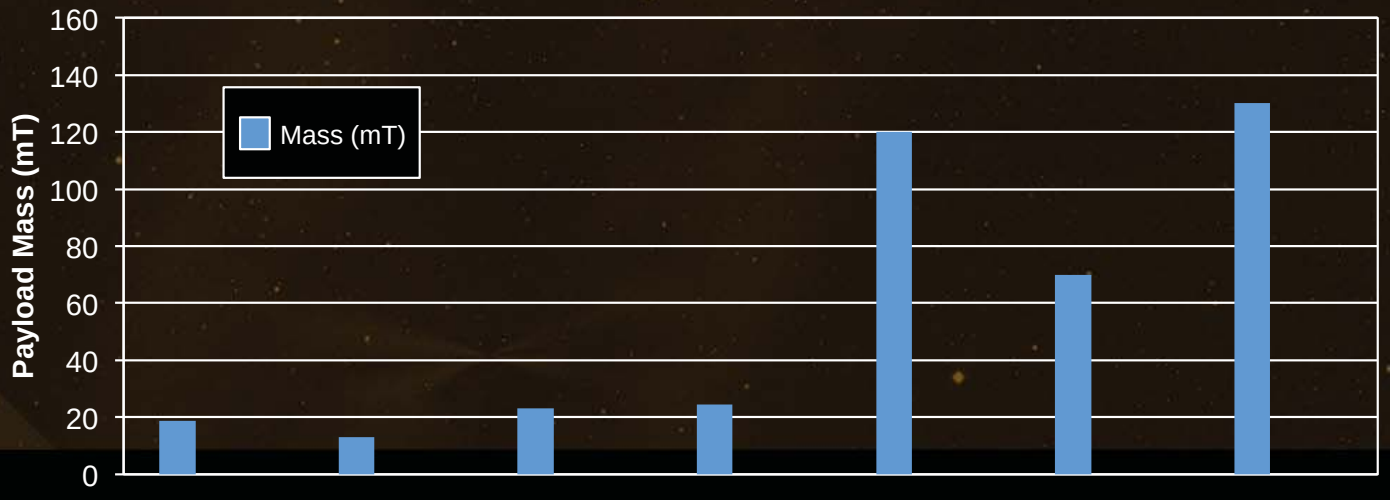
# BENEFIT: SLS MASS LIFT CAPABILITY

**SLS initial configuration offers 70 t to LEO.**

**Future configurations offer 105 t and 130 t to LEO.**

**Mass capability benefits mean larger payloads to any destination.**

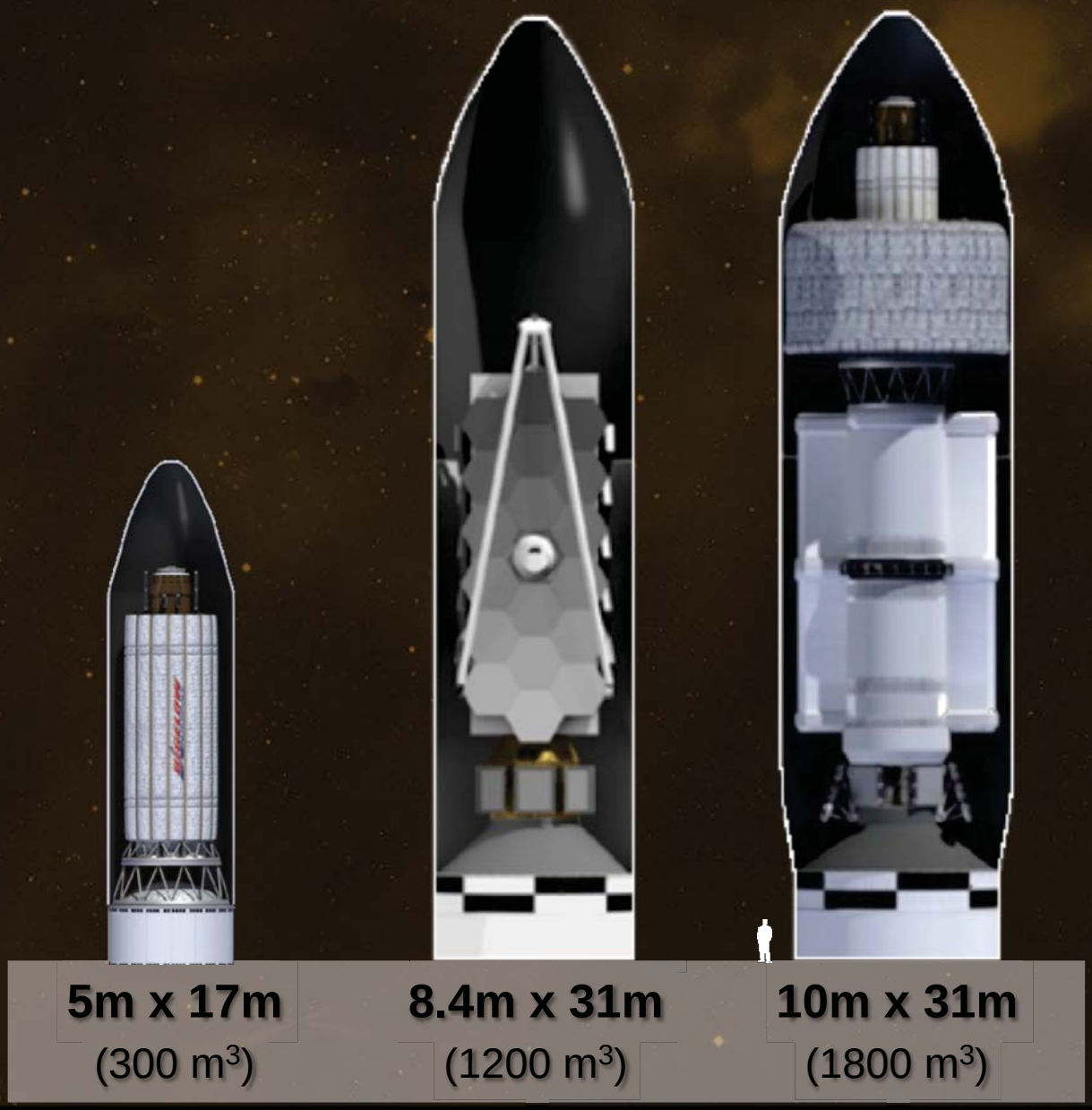


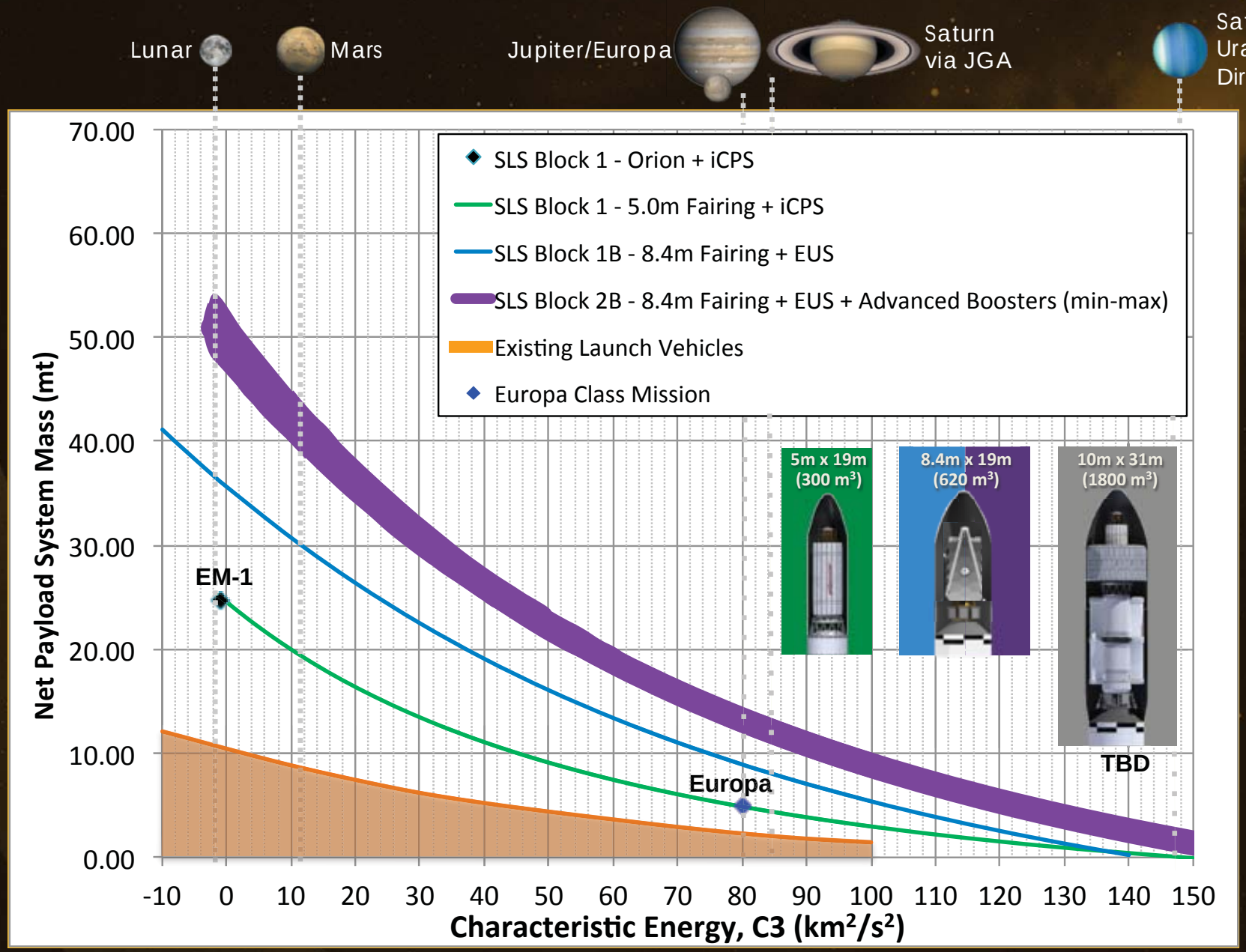
# BENEFIT: UNRIVALED PAYLOAD VOLUME

**SLS is investigating utilizing existing fairings for early cargo flights, offering payload envelope compatibility with design for current EELVs**

**Phase A studies in work for 8.4m and 10m fairing options**



# SLS EVOLVED PERFORMANCE



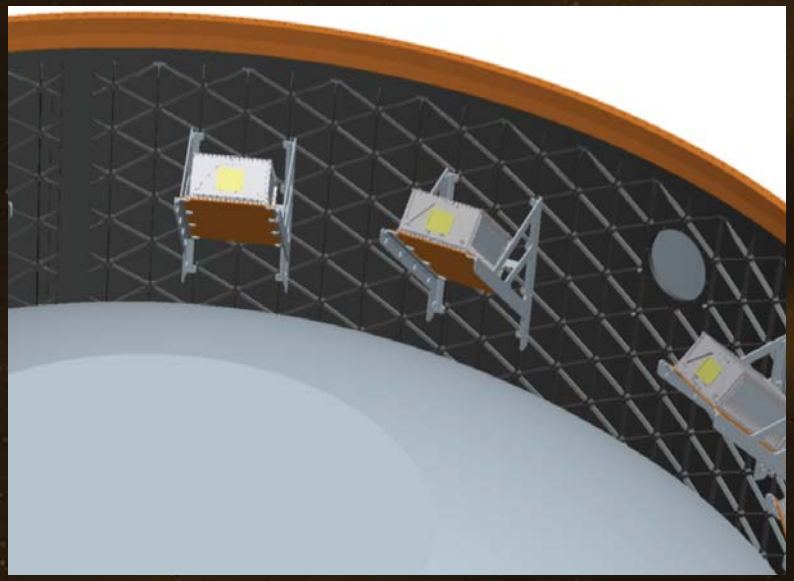
# SECONDARY PAYLOADS

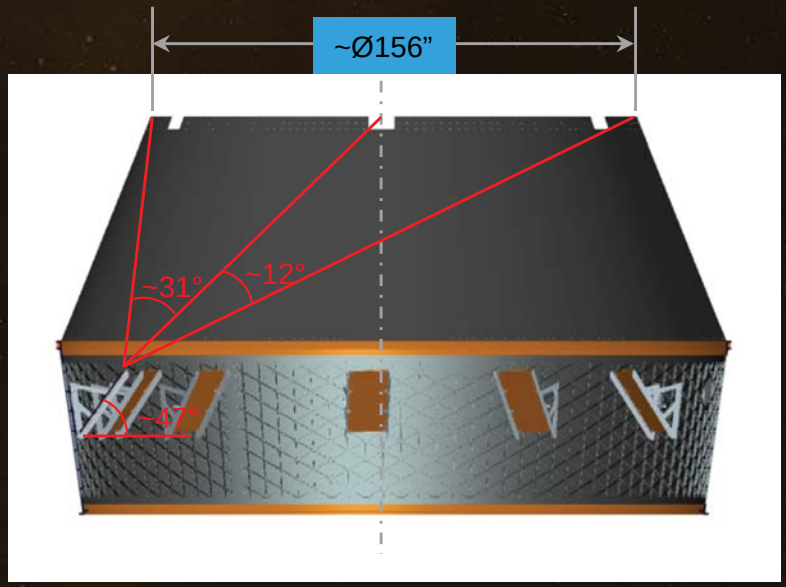
Eleven 6U/12U payload locations.
6U volume/mass is the current standard (14 kg payload mass)

Payloads will be “off” from roll-out through Orion separation and payload deployment

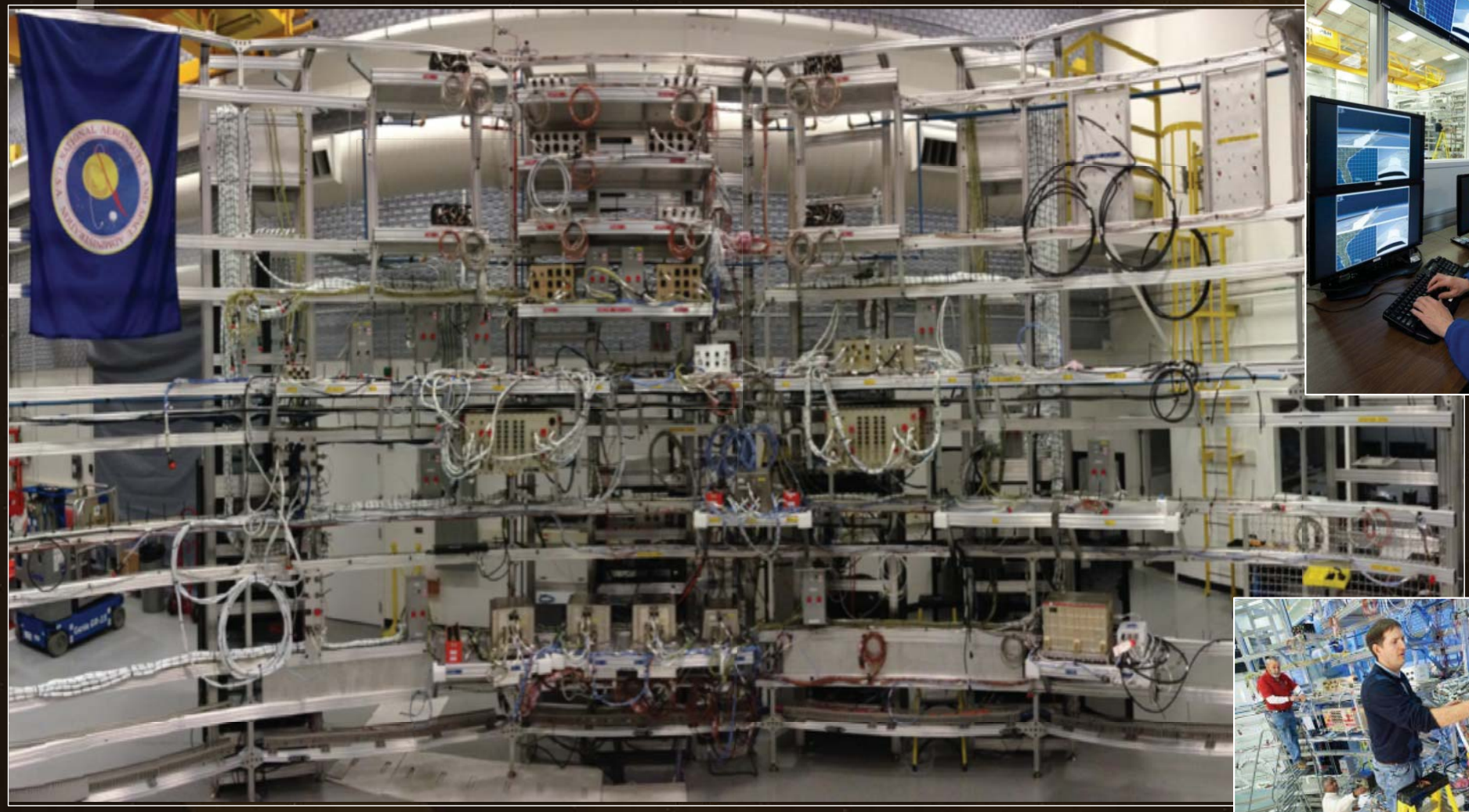
Payload Deployment System Sequencer: payload deployment will begin with pre-loaded sequence following MPCV separation and ICPS disposal burn

Payload requirements captured in Interface Definition and Requirements Document





# ELECTRICAL ENGINEERING: BRAINS OF THE ROCKET



# STEP THREE: EXPLORATION MISSION–1/2

LAUNCH ABORT SYSTEM (LAS)

ORION CREW MODULE (CM)

LAUNCH VEHICLE/ STAGE ADAPTER

CORE STAGE

SOLID ROCKET BOOSTERS (2)

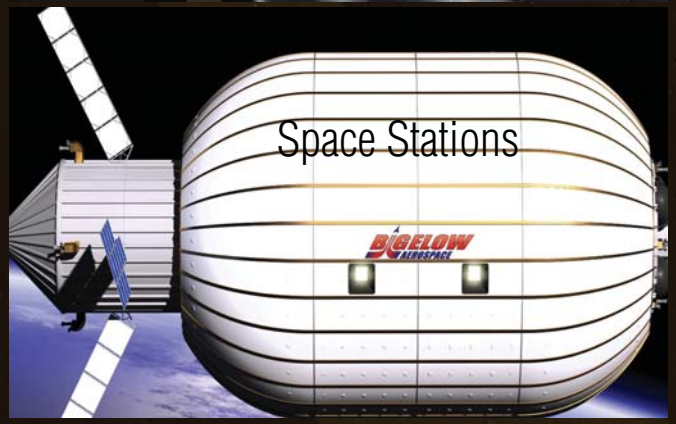
RS-25 ENGINES (4)

Distant Retrograde Orbit

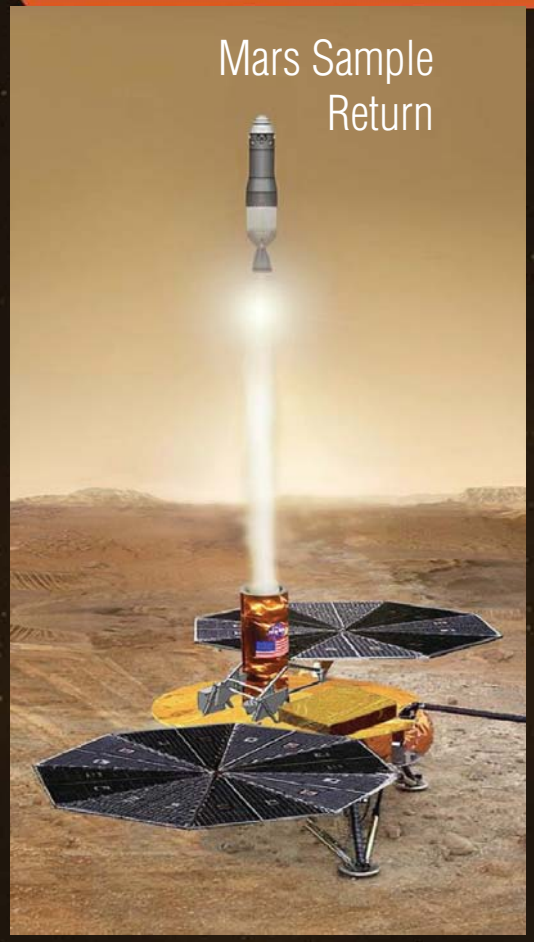
# PROVIDING OPTIONS FOR EXPLORATION


Human Missions to Mars

Asteroid Redirect Mission

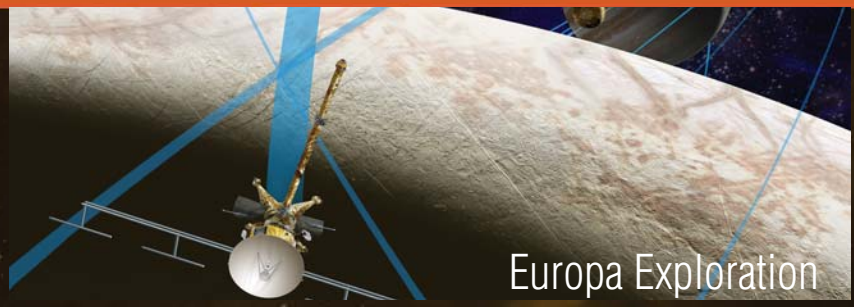



Space Stations

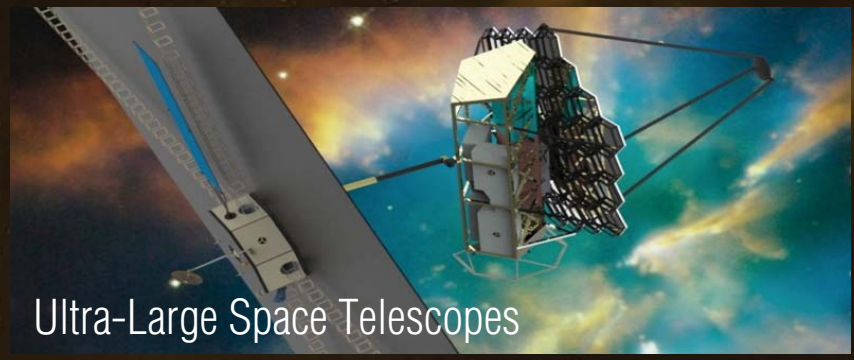


Mars Sample Return

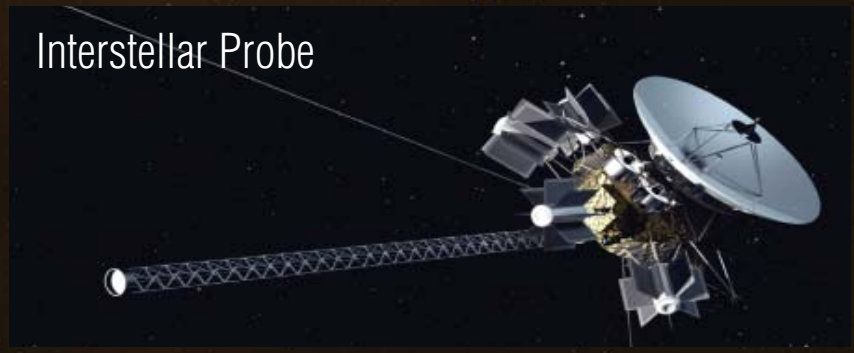
NASA's Space Launch System



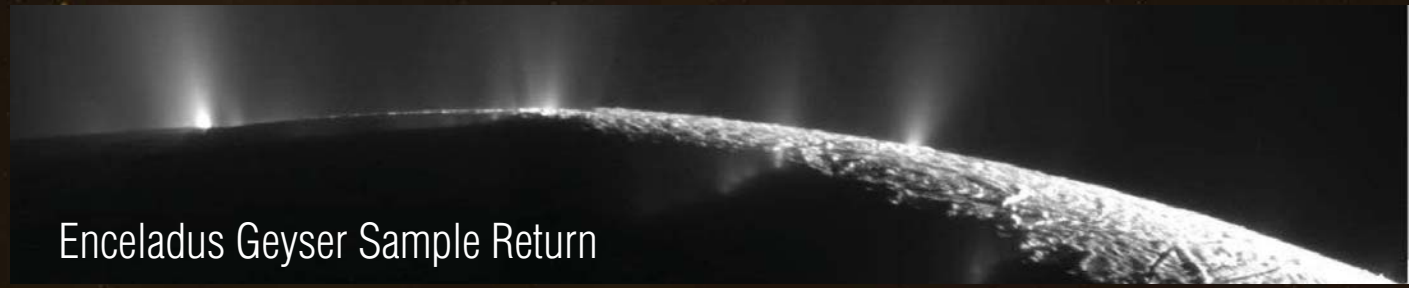
Europa Exploration



Ultra-Large Space Telescopes

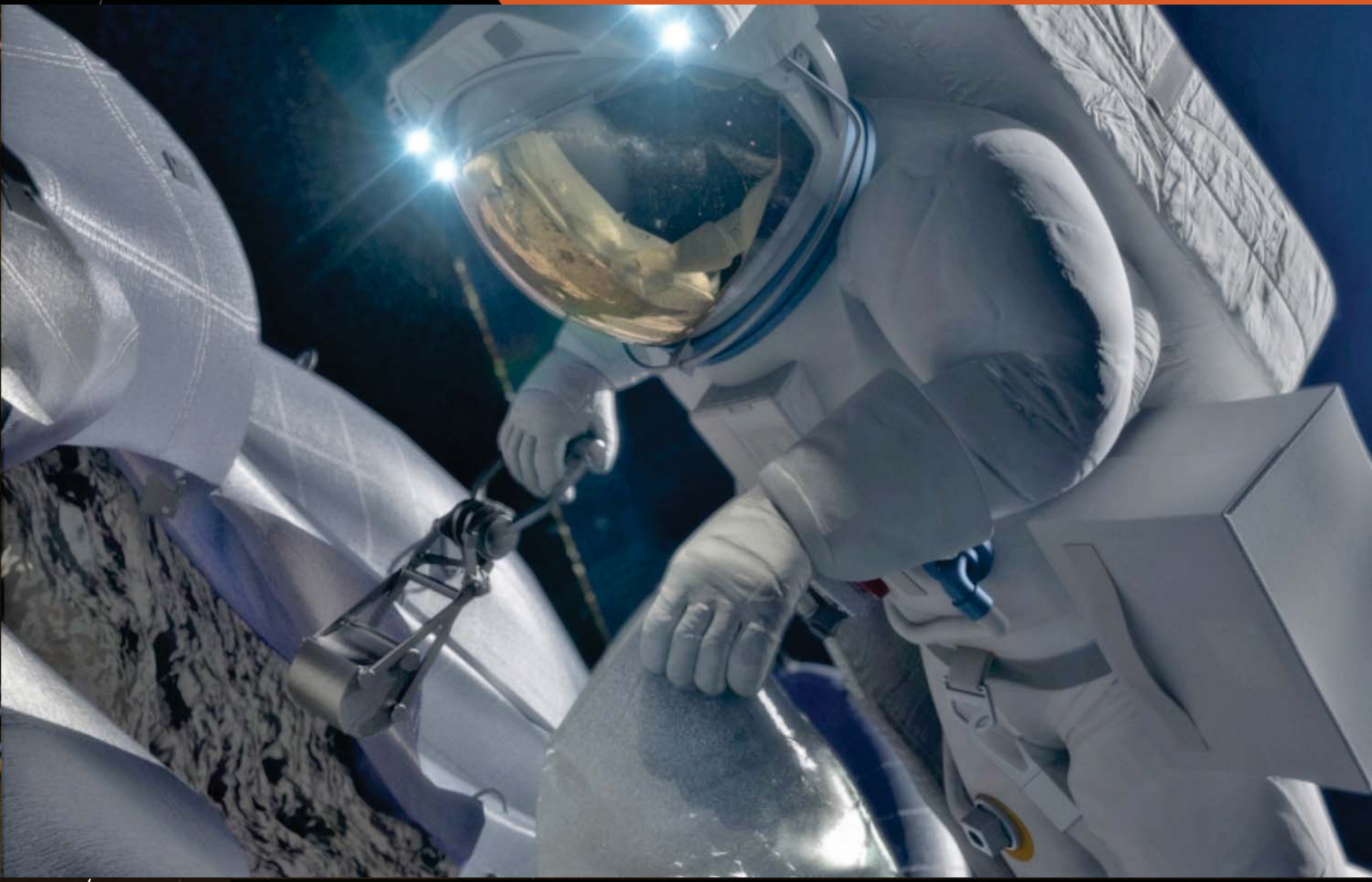


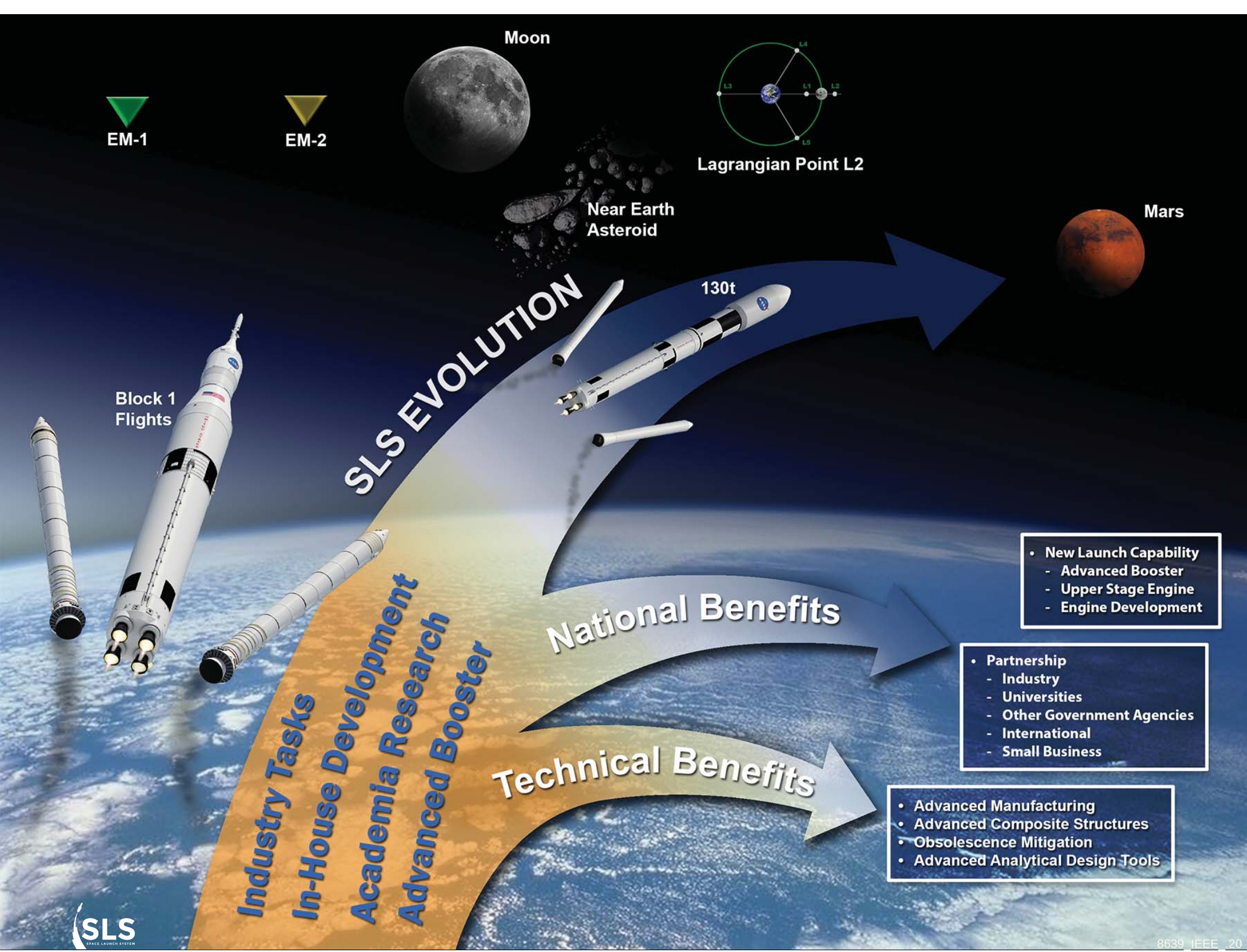
Interstellar Probe



Enceladus Geyser Sample Return

# NEXT STEPS: NEW WORLDS AWAIT




Moon
EM-1
EM-2
Lagrangian Point L2
L4
L3
L1
L2
L5
Near Earth
Asteroid
Mars
SLS EVOLUTION
130t
Block 1
Flights
Industry Tasks
In-House Development
Academia Research
Advanced Booster
National Benefits
Technical Benefits
• New Launch Capability
- Advanced Booster
- Upper Stage Engine
- Engine Development
• Partnership
- Industry
- Universities
- Other Government Agencies
- International
- Small Business
• Advanced Manufacturing
• Advanced Composite Structures
• Obsolescence Mitigation
• Advanced Analytical Design Tools
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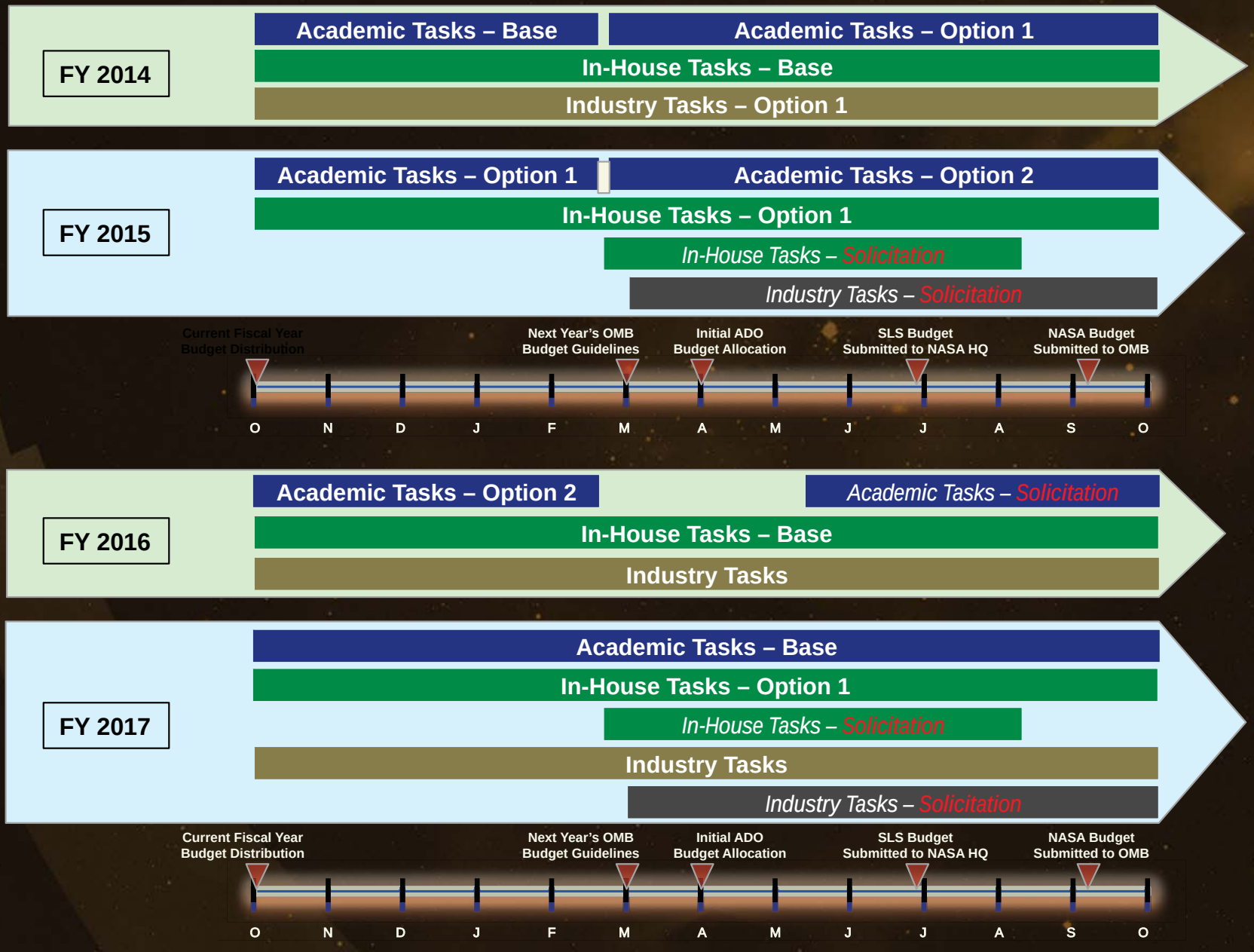
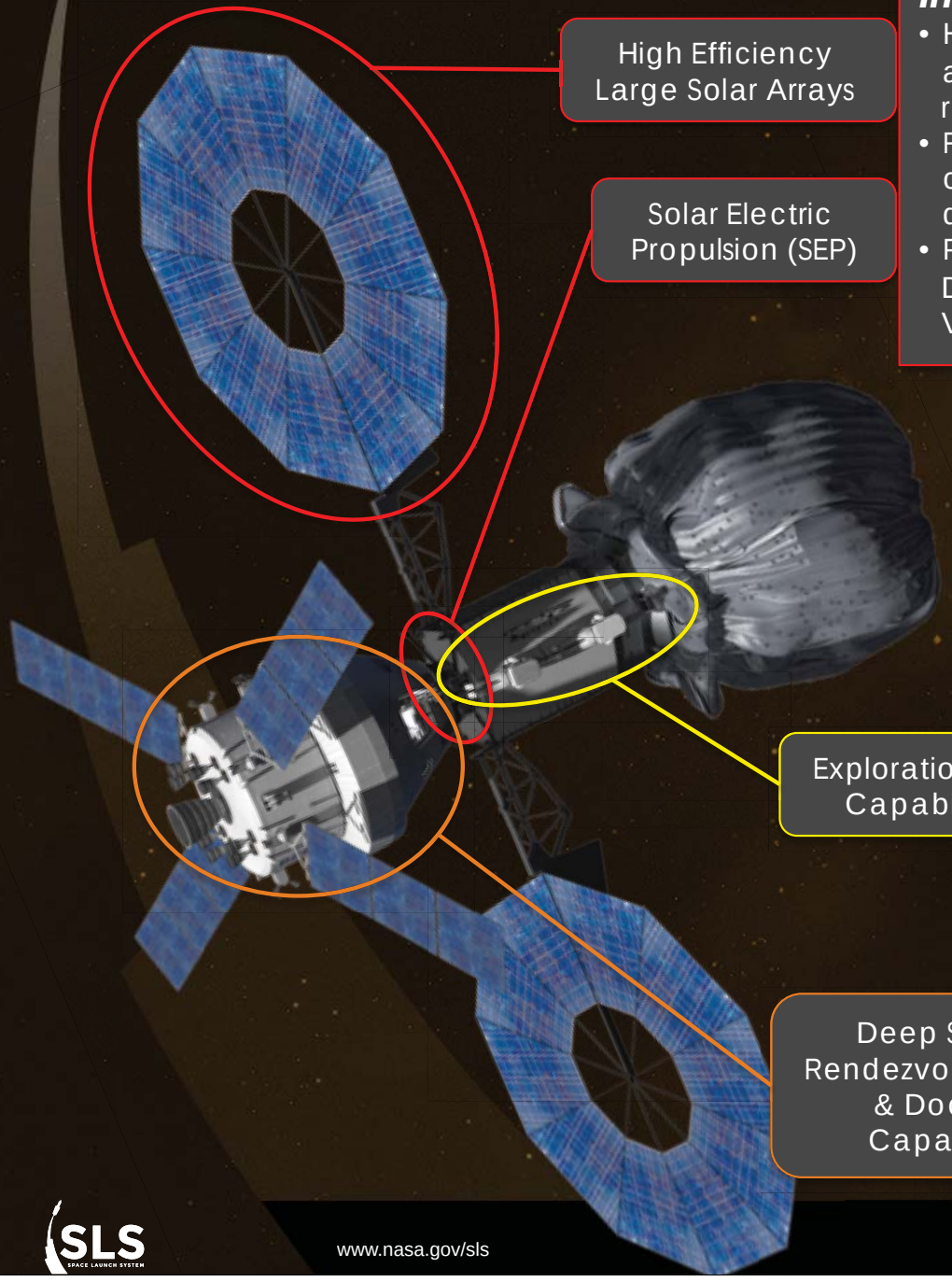
# ADO ANNUAL TASKS PROCESS



# STEP FOUR: ASTEROID



High Efficiency Large Solar Arrays

Solar Electric Propulsion (SEP)

Exploration EVA Capabilities

Deep Space Rendezvous Sensors & Docking Capabilities

## *In-space Power and Propulsion:*

- High Efficiency Solar Arrays and SEP advance state of art toward capability required for Mars
- Robotic ARM mission 50kW vehicle components prepare for Mars cargo delivery architectures
- Power enhancements feed forward to Deep Space Habitats and Transit Vehicles

## *EVA:*

- Build capability for future exploration through Primary Life Support System Design which accommodates Mars
- Test sample collection and containment techniques including planetary protection
- Follow-on missions in DRO can provide more capable exploration suit and tools

## *Crew Transportation and Operations:*

- Rendezvous Sensors and Docking Systems provide a multi-mission capability needed for Deep Space and Mars
- Asteroid Initiative in cis-lunar space is a proving ground for Deep Space operations, trajectory, and navigation.

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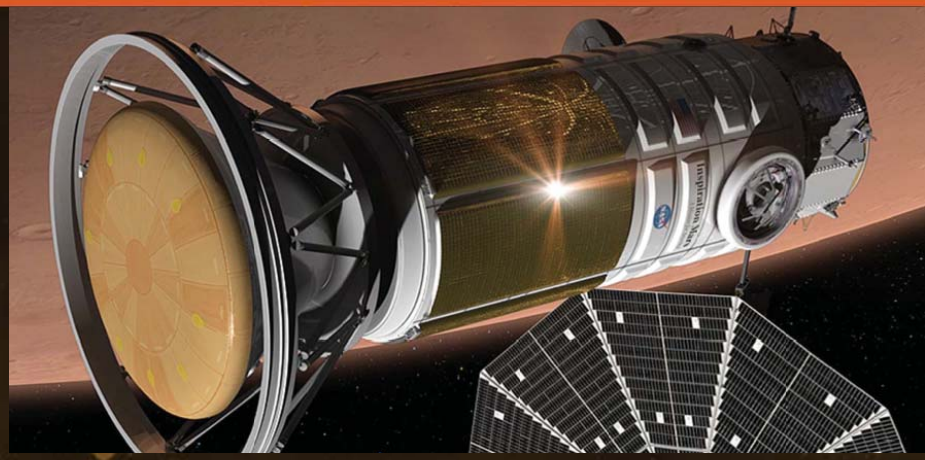
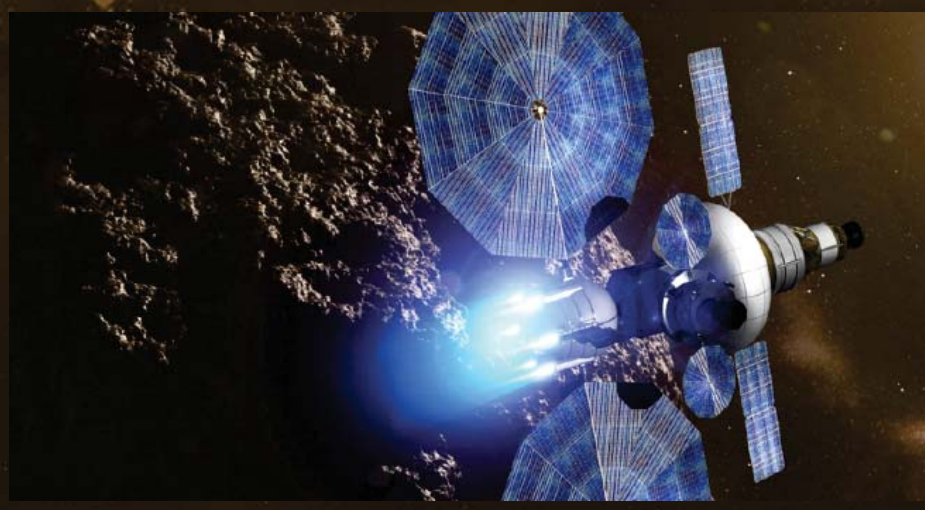
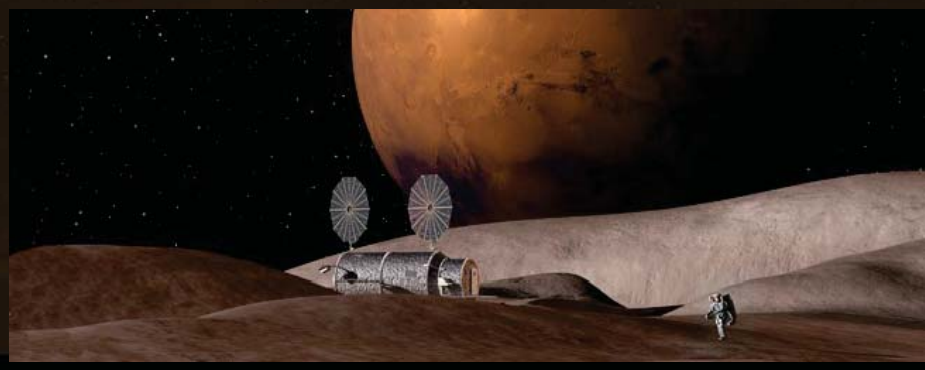
# MANY ROUTES TO THE RED PLANET







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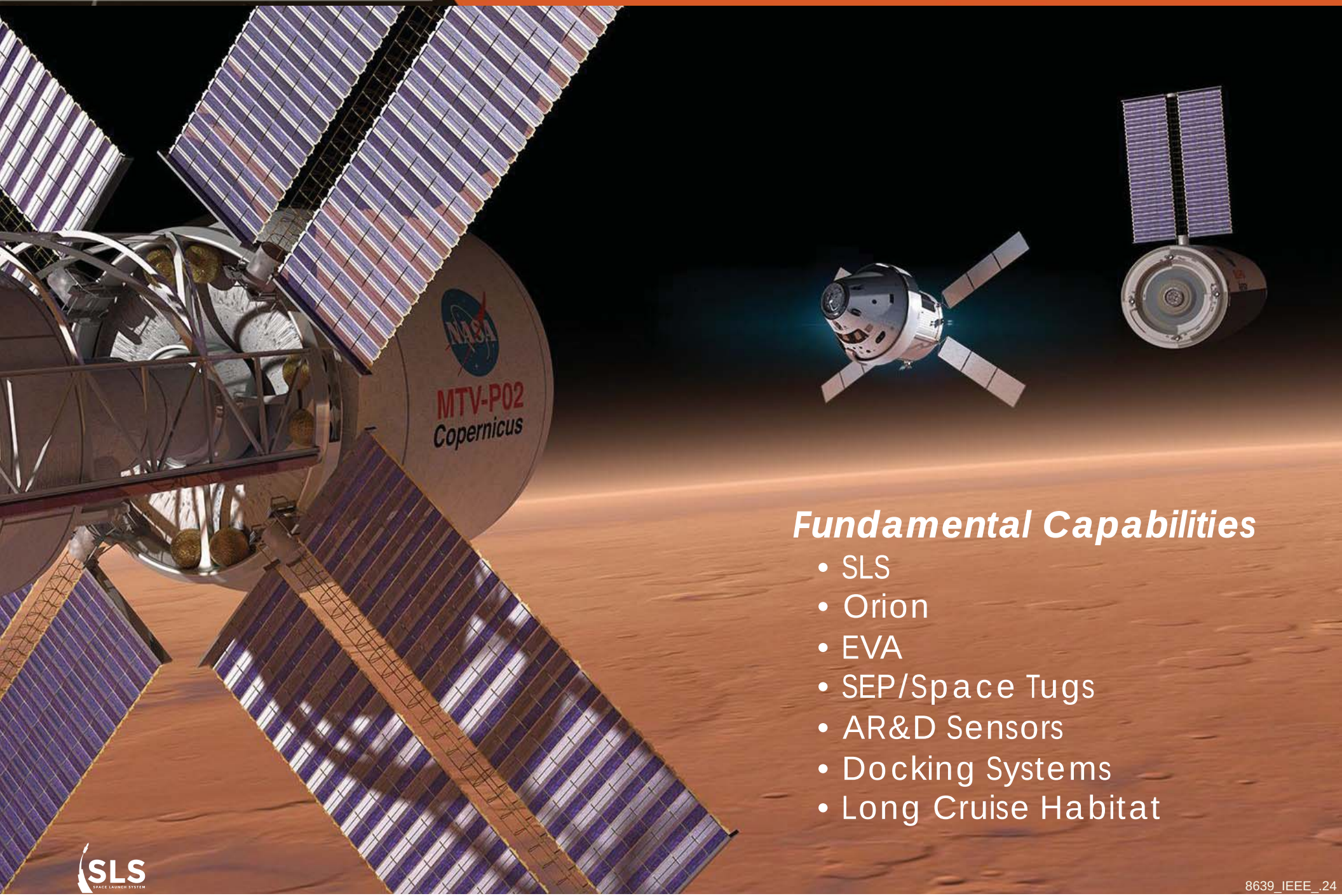
# NEXT STEPS: MARS




***Fundamental Capabilities***

- SLS
- Orion
- EVA
- SEP/Space Tugs
- AR&D Sensors
- Docking Systems
- Long Cruise Habitat

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# GATEWAY TO THE SOLAR SYSTEM

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The Adventure Begins Now
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