SPACE LAUNCH SYSTEM

Exploration, Science, Security

ATK

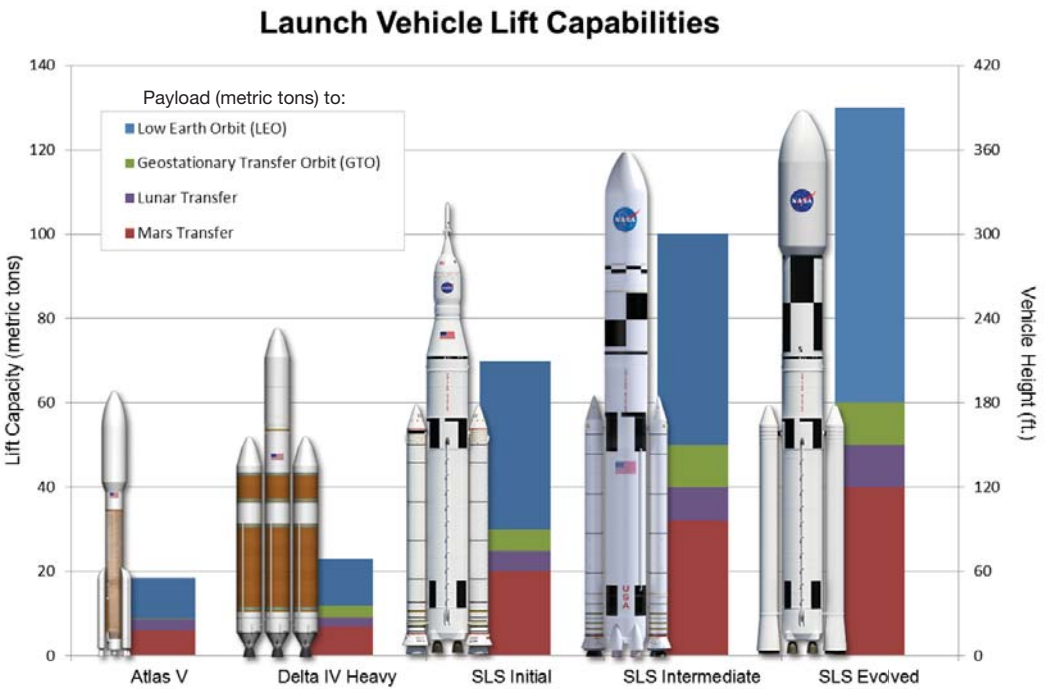
LOCKHEED MARTIN

AEROJET ROCKETDYNE

BOEING

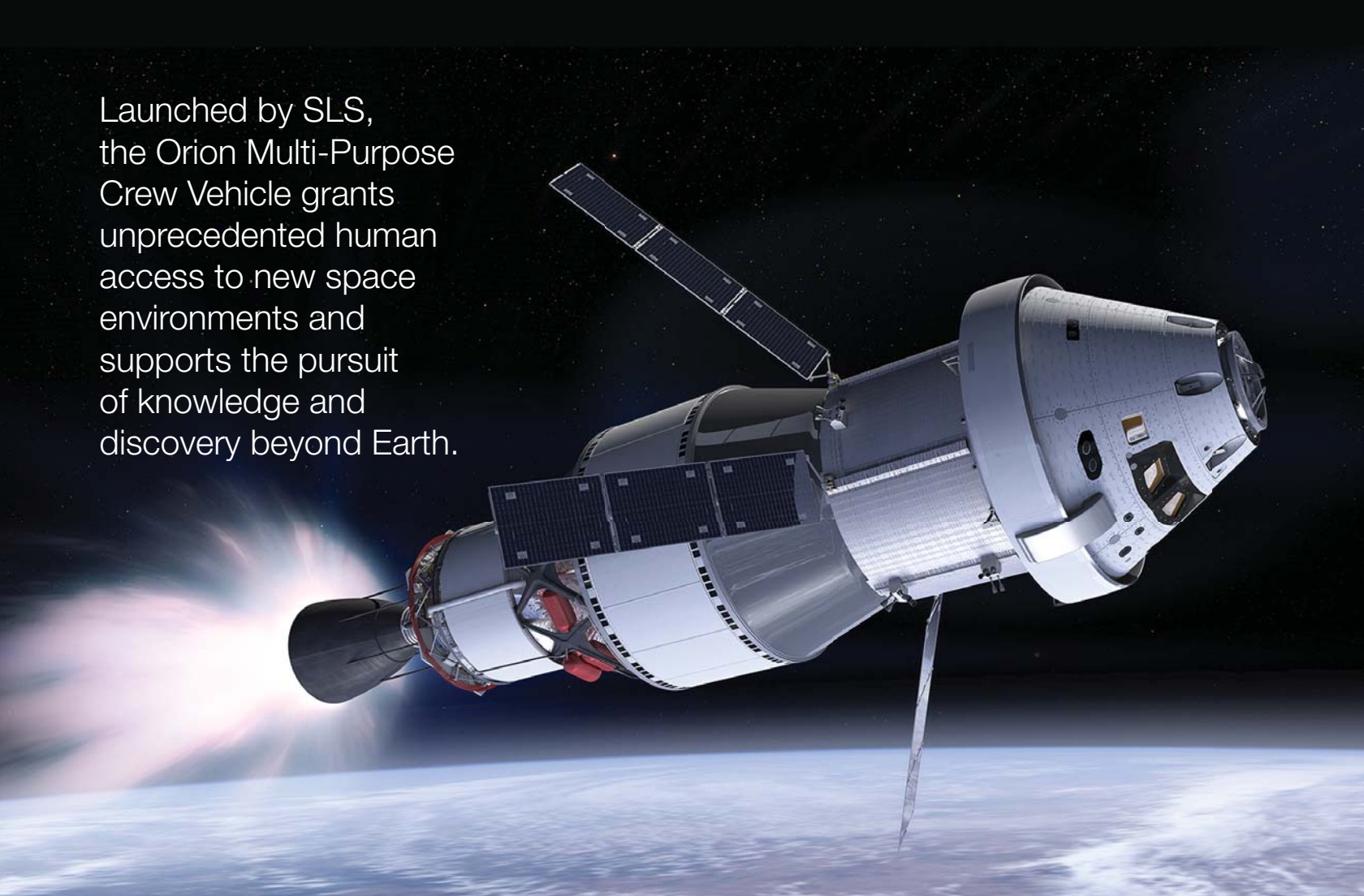
Space Launch System (SLS) is the most powerful rocket ever built and provides a critical heavy-lift launch capability enabling diverse deep space missions. The exploration class vehicle launches larger payloads farther in our solar system, faster than ever before.

SLS is the first rocket and launch system in history capable of powering humans, habitats and space systems beyond our moon and into deep space.



The vehicle's 5 m to 10 m fairing allows utilization of existing systems which reduces development risks, size limitations and costs. SLS lift capacity and superior performance shortens mission travel time.

Enhanced capabilities enable a myriad of missions including human exploration, planetary science, astrophysics, heliophysics, planetary defense and commercial space exploration endeavors.


Launched by SLS,
the Orion Multi-Purpose
Crew Vehicle grants
unprecedented human
access to new space
environments and
supports the pursuit
of knowledge and
discovery beyond Earth.

Orion Multi-Purpose Crew Vehicle (MPCV)

Mission Objective

Deliver the Orion MPCV beyond the moon, launching astronauts to deep space environments

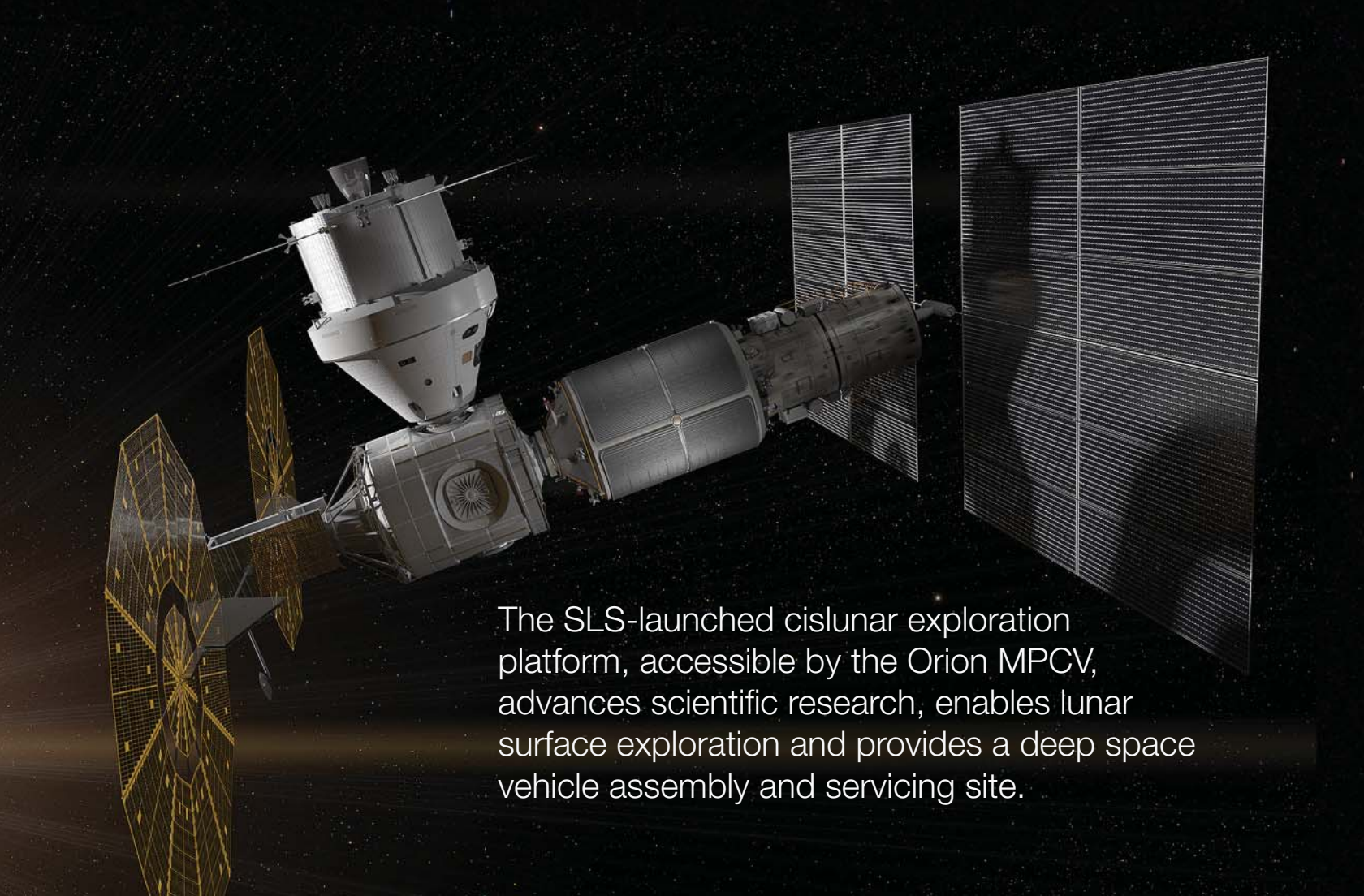
Mission Rationale

Orion is the first spacecraft in history capable of taking humans to multiple destinations beyond our moon. The spacecraft can support four astronauts in deep space for 21 days and return them safely to Earth. Crewed missions advance scientific discovery, strengthen our economy, fuel innovation and inspire the next generation of explorers.

SLS Capabilities

SLS is the first heavy-lift launch vehicle capable of transporting crews beyond low Earth orbit in over four decades. Its design maximizes use of common elements and heritage hardware to provide a low-risk, affordable system. SLS and Orion provide a safe and sustainable deep space pathway to Mars in support of NASA's human spaceflight mission objectives.

SLS Lift Capacity (Crew): 28t to EML2



The SLS-launched cislunar exploration platform, accessible by the Orion MPCV, advances scientific research, enables lunar surface exploration and provides a deep space vehicle assembly and servicing site.

Cislunar Gateway

Mission Objective

Place an assembly site at Earth-Moon Libration Point 2 (EML2)

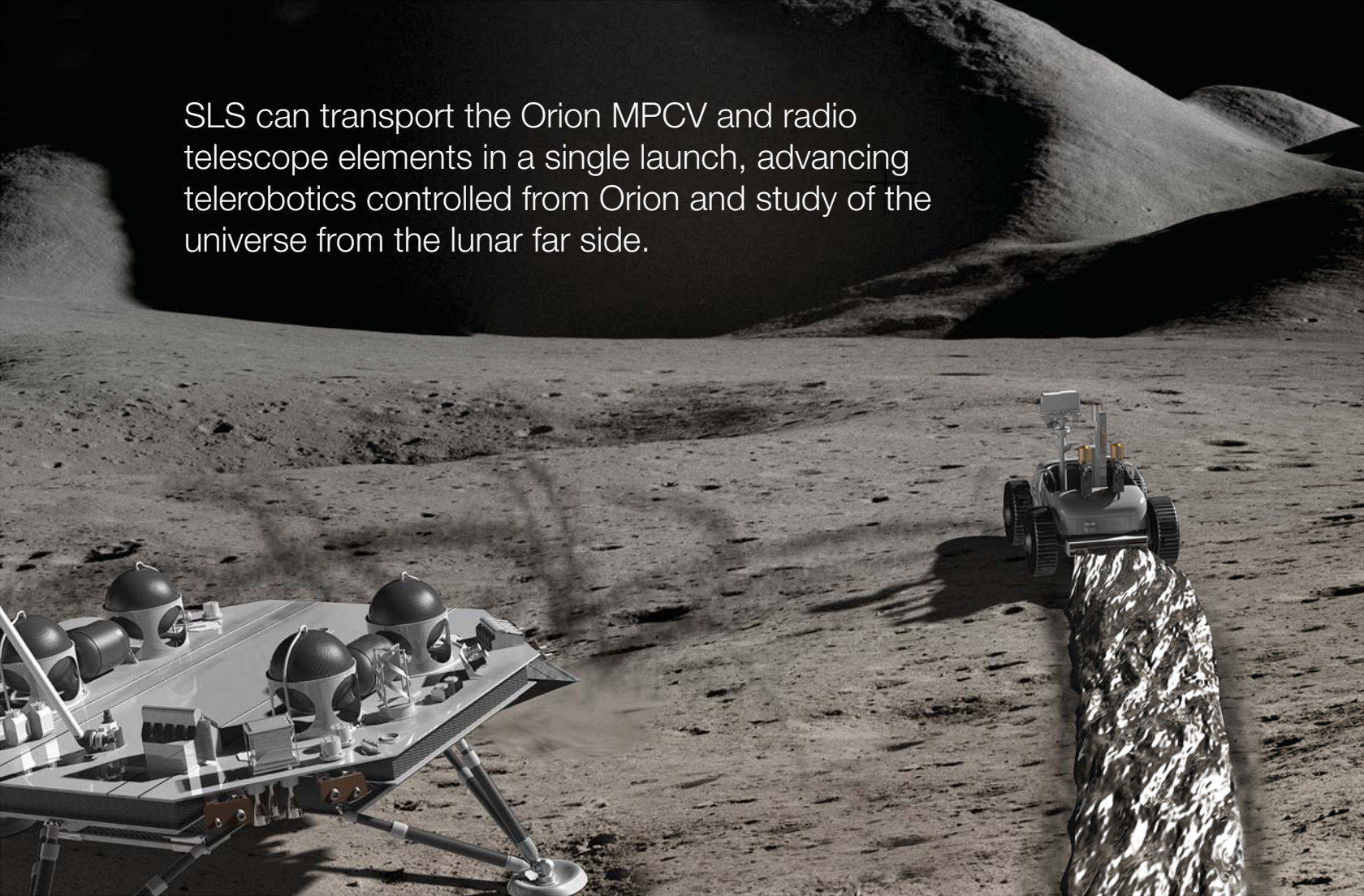
Mission Rationale

The gateway architecture extends the mission duration of the Orion Multi-Purpose Crew Vehicle, enables scientific research of the deep space environment and serves as a transportation node to future human space exploration destinations. Shown here with Orion, a Boeing 702SP-derived utility module and a Russian Scientific-Power Module (SPM), the gateway launched by SLS provides architectural options—each component is a self-sufficient vehicle that can serve as a base for platform expansion.

SLS Capabilities

SLS enables the launch of large gateway elements beyond the moon. Leveraging a low-energy transfer that reduces required propellant mass, components are then brought back to a desired cislunar destination. SLS provides a significant mass margin that can be used for additional consumables or a secondary payload.

SLS Lift Capacity (Cargo): 25t to EML2



SLS can transport the Orion MPCV and radio telescope elements in a single launch, advancing telerobotics controlled from Orion and study of the universe from the lunar far side.

Lunar Radio Telescope

Mission Objective

Telerobotically deploy a radio telescope in the quiet zone on the far side of the moon

Mission Rationale

Radio astronomers could listen to the activity of the early universe before the first stars lit up and even hear nearby giant planets if only they could detect their faint, low frequency signals. Unfortunately, radio noise makes this impossible on Earth. The far side of the moon has long been recognized as the quietest place for a radio telescope. Astronauts on Orion orbiting in an L2 halo orbit can remotely operate a rover on the moon to unroll the radio telescope antennas.

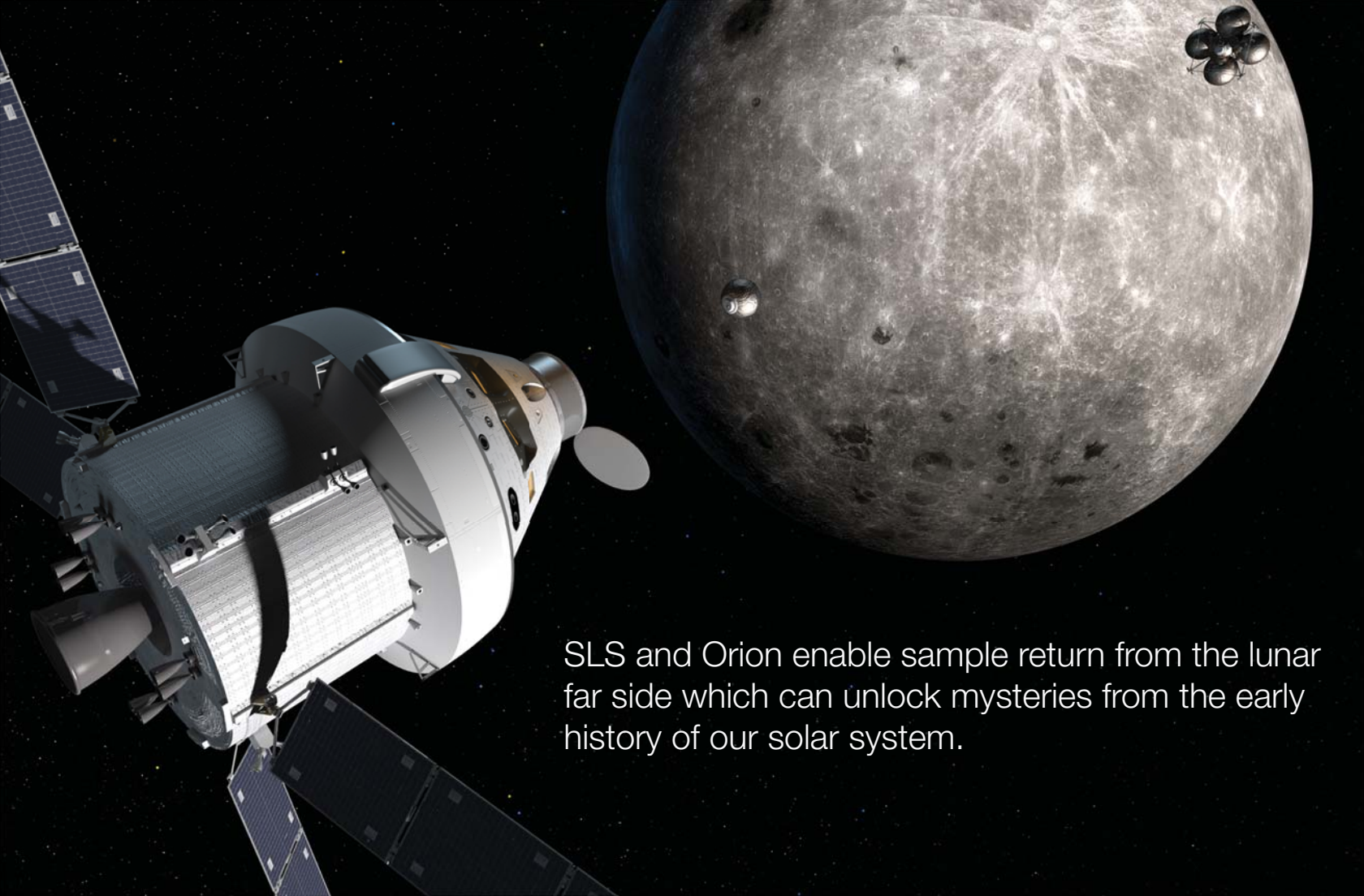
SLS Capabilities

SLS superior lift capacity enables the combined launch of both the Orion MPCV and a radio telescope providing an opportunity to practice human-tended telerobotics techniques. Similar techniques can be used for other deep space missions including Mars.

SLS Lift Capacity: 39.2t to TLI

ASTROPHYSICS

HUMAN EXPLORATION



SLS and Orion enable sample return from the lunar far side which can unlock mysteries from the early history of our solar system.

Human-Assisted Sample Return

Mission Objective

Return geological samples from the unexplored far side or poles of the moon

Mission Rationale

Planetary scientists believe samples from ancient impact craters on the far side will tell us about the migration of early planets and the history of asteroid impacts on Earth. Samples of ice from the moon's poles could illuminate the history of comets and the solar wind as well as determine whether lunar ice can be harvested. Samples collected on the surface will be launched into space and transferred to Orion for return to Earth. The same techniques may later be used for Mars samples.

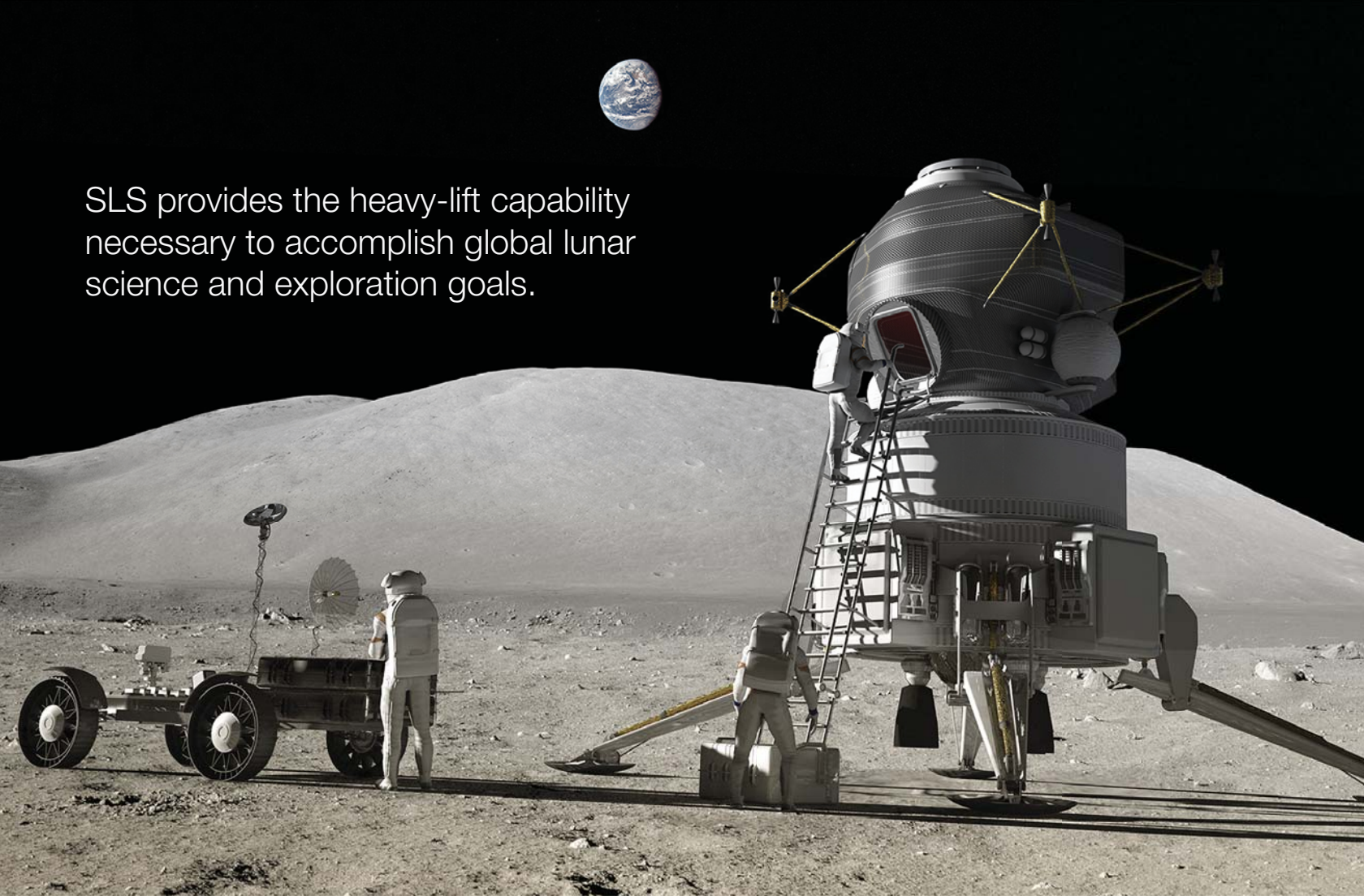
SLS Capabilities

SLS transports Orion and a robotic sample return lander to a high orbit beyond the moon in a single launch.

SLS Lift Capacity: 39.2t to TLI

PLANETARY SCIENCE

HUMAN EXPLORATION


SLS provides the heavy-lift capability necessary to accomplish global lunar science and exploration goals.

Crewed Lunar Surface Mission

Mission Objective

Launch astronauts and a reusable lunar lander to the moon's surface

Mission Rationale

The lunar surface provides a deep space proving ground for crewed exploration technology and systems critical to future Mars missions. Earth's only natural satellite presents an opportunity to investigate and overcome challenges inherent to planetary exploration while the crew remains only days away from a safe return. Lunar exploration will strengthen U.S. leadership in space while promoting international partnerships invaluable to ambitious deep space endeavors.

SLS Capabilities

SLS enables human return to the moon. The intermediate SLS capability allows both Orion and cargo to fly to translunar orbit at the same time, simplifying mission design and reducing launch costs.

Launching both crew and cargo to the surface of Mars, SLS will usher in an extraordinary exploration era defined by international partnerships, technology advancement and scientific discovery.

Mars Surface Mission

Mission Objective

Leverage cislunar gateway architecture to deliver crew and cargo to the Martian surface

Mission Rationale

Scientists believe Mars was once a warmer, wetter world which may have supported primitive life forms. Complementary human and robotic investigations will help researchers better understand climate evolution, extraterrestrial biology, planetary resources and deep space life support systems. For the first time, humans will be a dual-planet species.

SLS Capabilities

A human journey to Mars will require multiple SLS launches transporting Orion and additional mission elements. The fully evolved SLS allows the mission to be completed with the fewest number of launches, thus reducing overall risk and minimizing cost.

SLS Lift Capacity | 130t to LEO
SEP transfer to EML2 for assembly

SLS enables direct injection of the Asteroid Redirect Mission (ARM) spacecraft to a Near-Earth Asteroid (NEA) target, eliminates the outbound SEP spiral trajectory leg and shortens overall mission time by two years.

Asteroid Redirect Mission (ARM)

Mission Objective

Rendezvous, capture and return a NEA to lunar orbit for long-term future human exploration

Mission Rationale

ARM leverages current investments across NASA directorates to develop innovative technologies, provide a scientifically valuable destination for human exploration beyond low-Earth orbit, advance understanding of our solar system and mitigate asteroid impact risks.

SLS Capabilities

SLS lowers risks by reducing mission time and improving mass margin. SLS lift capacity allows for additional propellant enabling a shorter return or the delivery of a secondary payload, such as gateway component to cislunar space.

SLS directly launches the Europa Clipper spacecraft to the Jovian system cutting total flight time in half.

Europa Clipper

Mission Objective

Deliver spacecraft to Jupiter enabling repeatable flybys of Europa

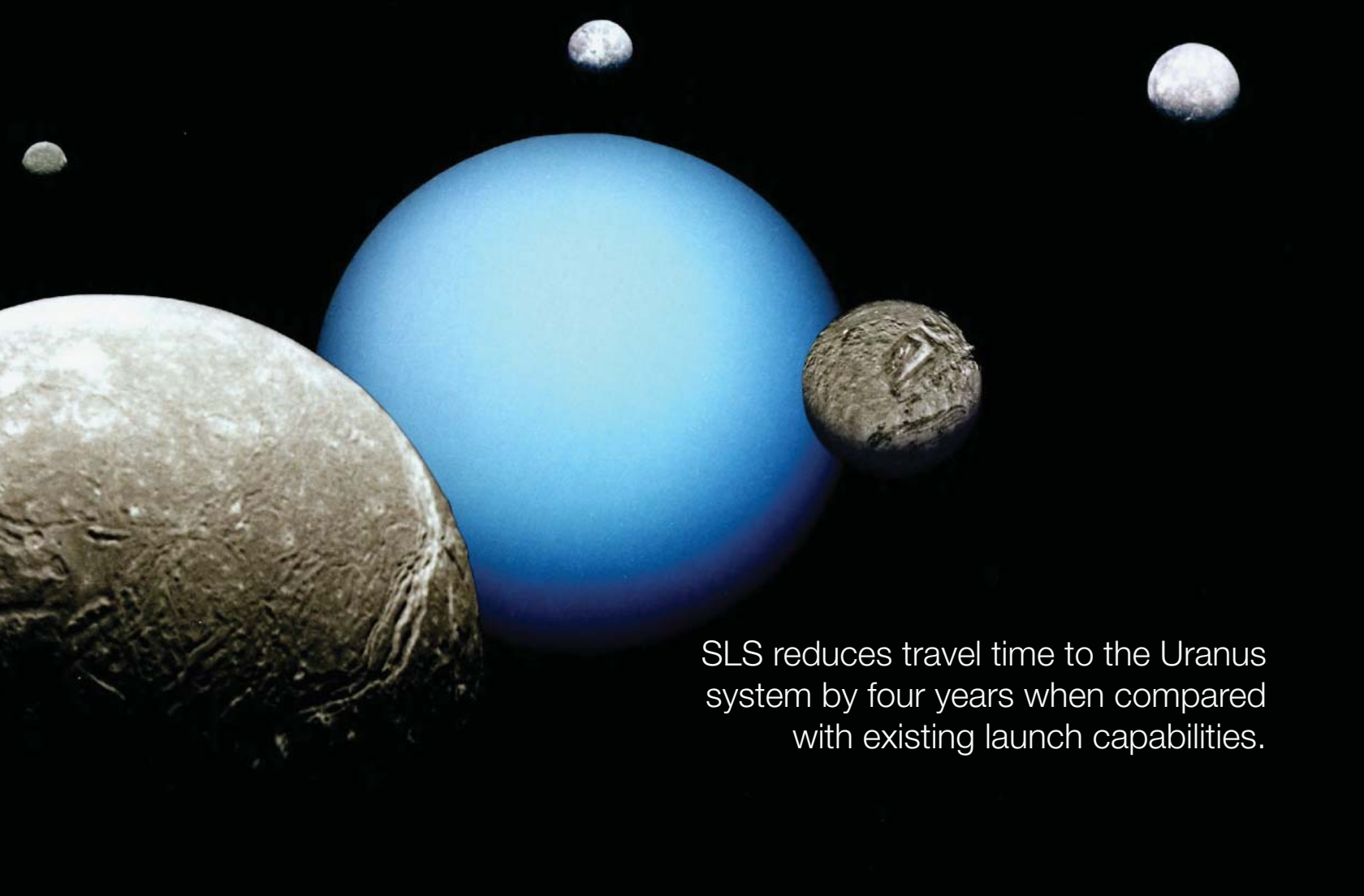
Mission Rationale

The spacecraft will investigate the moon's ice shell, the existence of a subsurface liquid ocean and surface-ice-ocean exchange processes. The Clipper mission will provide data advancing our understanding of Europa's composition, geologic features and chemical make-up.

SLS Capabilities

Eliminating Venus and Earth flybys, SLS provides a direct launch to the Jovian system, arriving four years earlier than missions utilizing existing launch vehicles. This architecture allows mass for radiation shielding, expansion of the science payload and could provide a model for other outer planet missions.

SLS Lift Capacity | 4t to a C3 of 85.4



SLS reduces travel time to the Uranus system by four years when compared with existing launch capabilities.

Uranus Orbiter

Mission Objective

Deliver a small payload into orbit around Uranus and a shallow probe into the planet's atmosphere

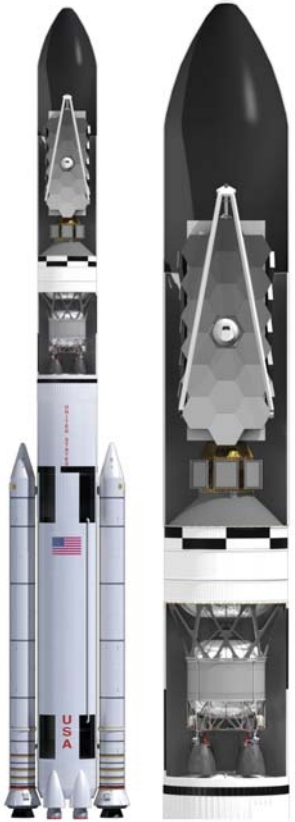
Mission Rationale

Investigate the ice giant system's atmospheric and magnetic properties, determine the distribution of thermal emission from the planet's atmosphere, refine the gravitational harmonics of the planet and conduct close flybys of any large satellites.

SLS Capabilities

SLS mission design shortens travel time, allows for the inclusion of increased mass and removes the need for a solar electric propulsion stage (SEP) simplifying overall spacecraft and mission design.

SLS can launch the Advanced Technology Large-Aperture Space Telescope (ATLAST 16 m) to SEL2, providing researchers 10 times the resolution of the James Webb Space Telescope and up to 300 times the sensitivity of the Hubble Space Telescope.



Advanced Technology Large-Aperture Space Telescope (ATLAST 16 m)

Mission Objective

Deploy an advanced space telescope to Sun-Earth Libration Point 2 (SEL2)

Mission Rationale

The ATLAST 16 m enables the characterization of exoplanets and the search for extrasolar life. It allows scientists to explore the modern universe, investigate super massive black holes (SMBH), reconstruct the stellar history of hundreds of galaxies and measure the mean density profile of dwarf spheroidal galaxies (dSph) to constrain the nature of dark matter.

SLS Capabilities

SLS is the only vehicle capable of deploying telescopes of this mass and size in a single launch. It simplifies mission design and reduces risks by eliminating the need for multiple launches and in-space assembly.

SLS Lift Capacity | 40t to SEL2

ASTROPHYSICS

SLS delivers the Interstellar Explorer spacecraft to 200 AU in 15 years saving 15 years of flight time from original design concepts.

Interstellar Explorer

Mission Objective

Significantly reduce mission travel time and deliver a spacecraft to interstellar space, out to 400 AU.

Mission Rationale

The starship enables exploration of the outer solar system and its origins, investigation of the interstellar medium influence on the solar system, and the characterization of interstellar gas, low-energy cosmic rays, dust and magnetic fields.

SLS Capabilities

SLS greatly shortens interstellar travel time, reaching 200 AU in about 15 years with a maximum speed of 63 km/sec—13.3 AU per year (Neptune orbits the sun at an approximate distance of 30 AU). The use of a Boeing 702SP eliminates technology development required for earlier mission designs.

SLS will launch Solar Probe 2 to unexplored regions of the sun's atmosphere providing researchers the first direct, in-situ measurements of the corona.

Solar Probe 2

Mission Objective

Launch the first spacecraft capable of frequent and close encounters with the sun

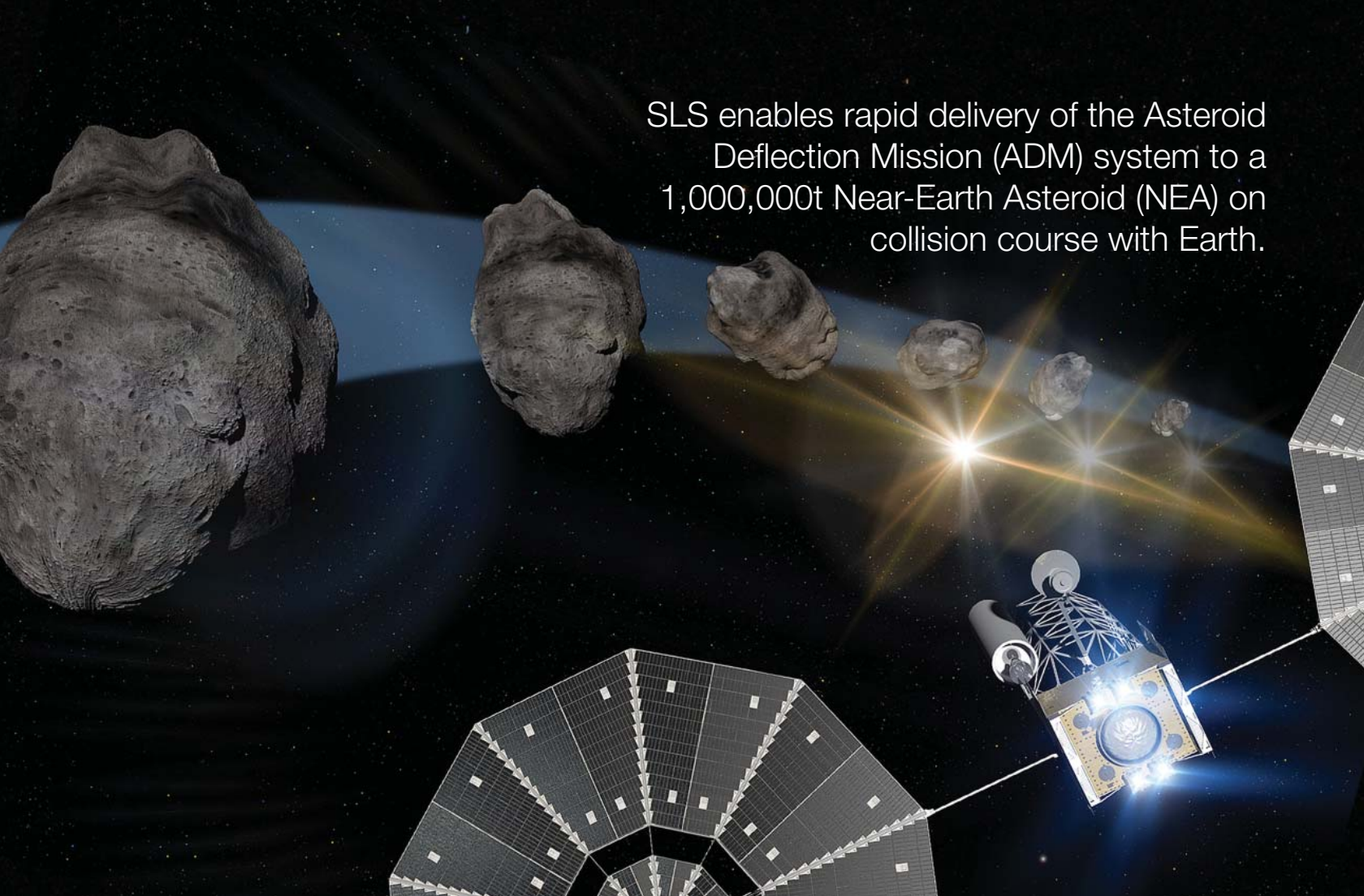
Mission Rationale

Solar Probe 2 will provide researchers both in-situ measurements and imagery supporting corona heating and solar wind acceleration investigations.

It will also be part of the spacecraft fleet charged to develop the critical forecasting capability of the space radiation environment in support of human and robotic exploration.

SLS Capabilities

SLS mission design incorporates the advantages of both the Solar Probe and Solar Probe Plus spacecraft. It provides a low perihelion distance (as low as 5 solar radii) and frequent revisit times without the use of radioisotope thermoelectric generators.


SLS enables rapid delivery of the Asteroid Deflection Mission (ADM) system to a 1,000,000t Near-Earth Asteroid (NEA) on collision course with Earth.

Asteroid Deflection Mission (ADM)

Mission Objective

Eliminate impact hazard by altering the trajectory of an Earth approaching object

Mission Rationale

Asteroid impacts can have catastrophic consequences on Earth, however, they are preventable with a robust search and technology development program. Given proper lead time, there are multiple proposed techniques to adjust the orbit of a potentially hazardous asteroid.

SLS Capabilities

SLS enables required deflection system mass to arrive at the NEA target in the shortest possible time and is the only vehicle capable of a direct injection mission, eliminating outbound spiral trajectory leg required for all other vehicles. The 8t mass margin could be used for additional propellant enabling closer approach to the object as well as the inclusion of additional science instrumentation or a space telescope.

SLS is the only launch vehicle capable of delivering the BA 330 habitation module directly to EML2.

Deep Space Habitat: Bigelow BA 330

Mission Objective

Deliver expandable BA 330 module to cislunar space

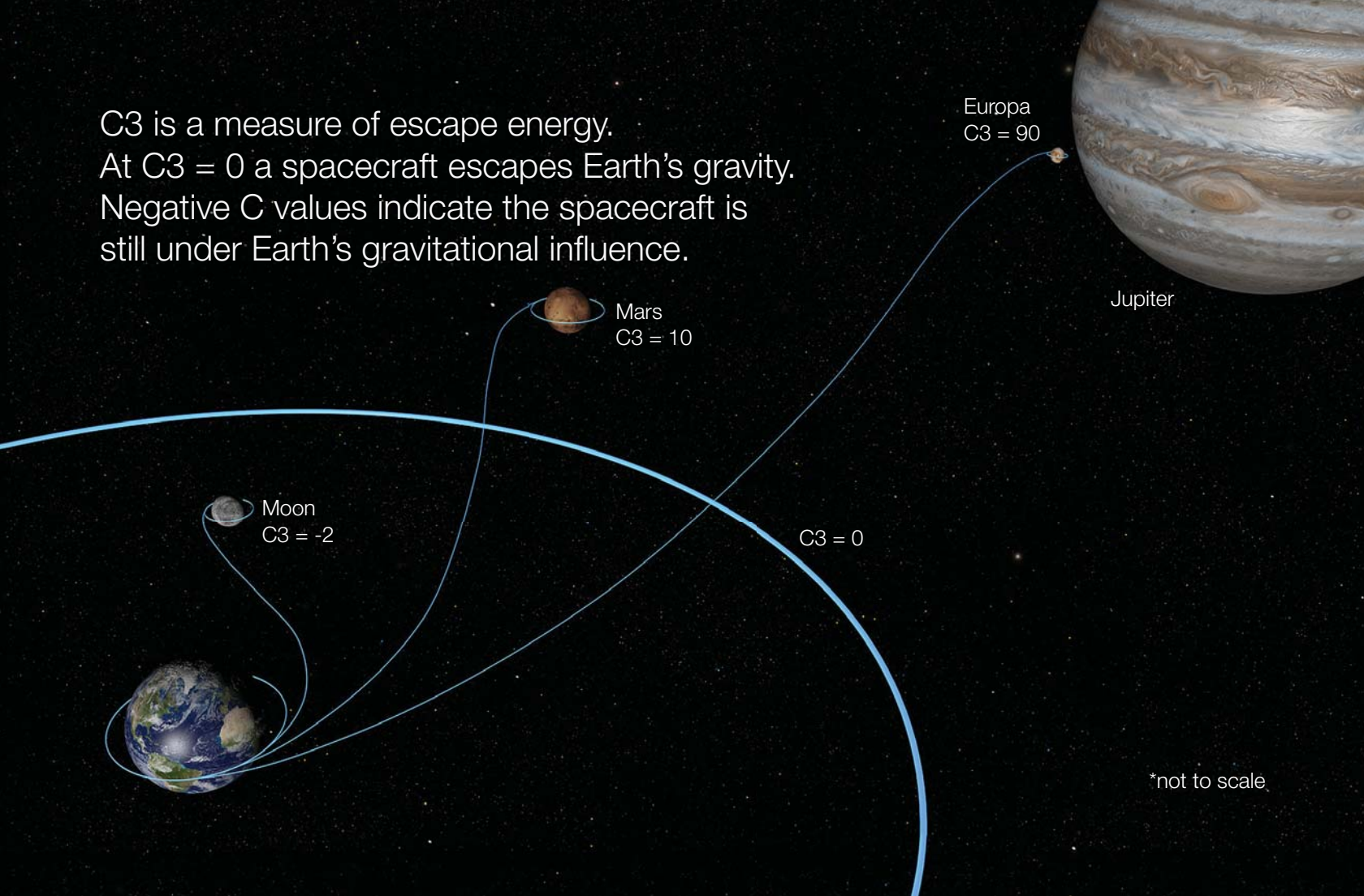
Mission Rationale

SLS supports commercial launch requirements and operations enabling a deep space human presence while extending Orion mission duration. The BA 330 is a stand-alone, self-sufficient module with crew support necessary to sustain long duration human habitation and may serve as a base element for future expansion. It can house up to six people on a long-term basis.

SLS Capabilities

SLS is the only launch vehicle capable of delivering the BA 330 to EML2. The heavy-lift vehicle will transport the habitation module beyond the moon and back to cislunar space via a low-energy transfer that reduces required propellant mass. SLS mass margin allows additional consumables, radiation protection or a secondary payload.

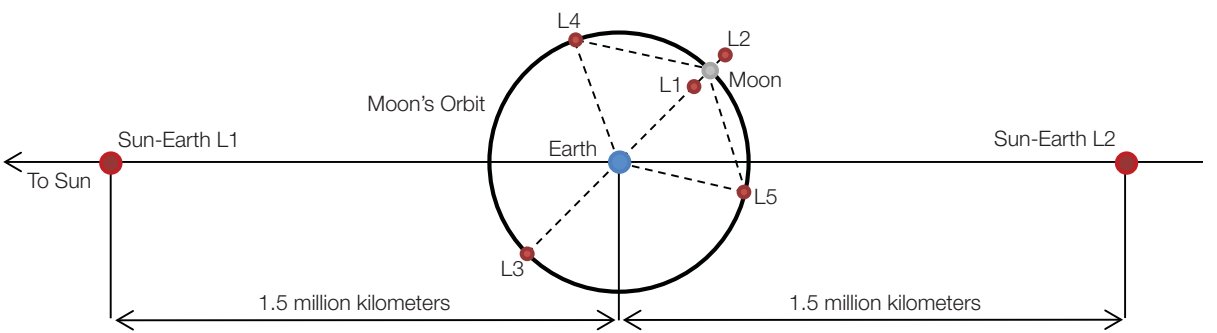
SLS Lift Capacity | 25t to EML2

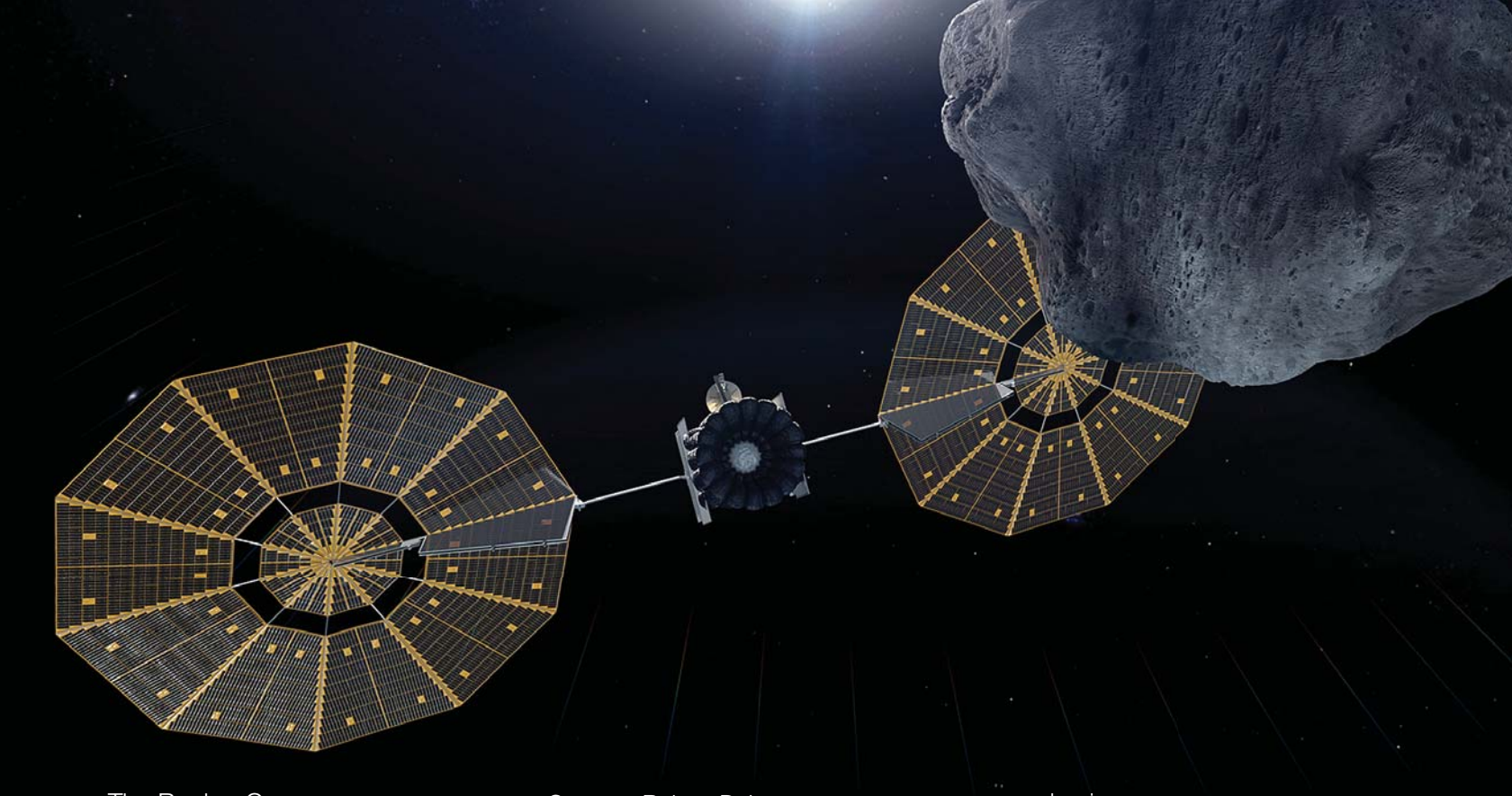

C3 is a measure of escape energy.
At C3 = 0 a spacecraft escapes Earth's gravity.
Negative C values indicate the spacecraft is
still under Earth's gravitational influence.
Europa
C3 = 90
Jupiter
Mars
C3 = 10
Moon
C3 = -2
C3 = 0
*not to scale

Appendix A

Astronomical Unit (AU): Commonly used to measure distance in our solar system, an AU is the mean distance between the Earth and the sun. 1 AU = ~150 million kilometers

Lagrange Point: Positions in space where the gravitational and centripetal forces of two orbiting bodies are in balance. Pictured below, the two bodies are the Earth and the moon, and the sun and the Earth. Lagrange points are like mission parking spots. For example, the cislunar gateway will be placed at Earth-Moon Libration Point 2 (EML2) and ATLAST at Sun-Earth Libration Point 2 (SEL2).





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