What Comes Next

An entire generation grew up with the space shuttle. Under development for most of the 1970s, the space shuttle Columbia made its maiden flight on April 12, 1981. By the time of its retirement in 2011, the space shuttle flew 135 missions and carried more astronauts into space than all other rockets combined. It deployed satellites, sent space probes throughout the solar system, and carried science laboratories and many of the major components of the ISS.

The space shuttle was a complex and versatile space launch system and its flights ended when the ISS was fully assembled. What comes next?

In the decades of exploration that followed its creation in 1958, NASA expanded our perspective of the universe and humanity’s place within it. Many important lessons have been learned, some of them the hard way. It is now time to advance our ability to travel and live in space. Once again, NASA will forge a new era of space exploration.

NASA’s advanced SLS rocket will stand 122 meters (400 feet) tall, with a lift capacity of 130 metric tons (286,000 pounds). Here it is shown configured to carry cargo.
Strategic Goals: 2011-2012 Era

NASA has identified six strategic goals that squarely focuses its efforts on exploration.
1: Extend and sustain human activities across the solar system.
2: Expand scientific understanding of the Earth and the universe in which we live.
3: Create the innovative new space technologies for our exploration, science, and economic future.
4: Advance aeronautics research for societal benefit.
5: Enable program and institutional capabilities to conduct NASA’s aeronautic and space activities.
6: Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation, and contribute to a strong national economy.

In a few years, space travelers will embark on a wide range of space missions near Earth and into the solar system. A new NASA rocket will take them there. NASA’s new SLS rocket will take them there, in the process joining a family of new rockets, some developed by private industry for commercial space transportation involving cargo, astronauts, and tourists. Space will no longer be just the realm of highly trained astronauts.

Yet NASA’s SLS rocket is the most ambitious effort of them all. A modular heavy-lift launch vehicle that can be configured in different ways for different missions, the SLS rocket will carry astronauts into orbit, as well as massive payloads destined for distant places. It will be tested during a series of launches from 2017 to 2021. Then an advanced SLS rocket will take flight, thanks to the best ideas and technology of the past, present, and future.

Destinations in Space

In spite of its great capabilities, the space shuttle was limited to low-Earth orbit, no more than 560 kilometers (about 350 miles) above Earth. Only the Saturn V rocket of the late 1960s and early 1970s carried astronauts higher - all the way to the Moon. The SLS rocket will change all that. It will enable astronauts to travel to the International Space Station, to all points between the Earth and the Moon, to Mars, and to the asteroids.

NASA’s Space Launch System Program has five primary objectives or “stepping stones” that will lead us into the solar system. These objectives evolve through increasingly complex and daring missions from the realm of space we know to the realm of space where only robotic spacecraft have gone before.

The initial objective replaces the space shuttle with a versatile vehicle that resembles a cross between the mighty Saturn V and the space shuttle. It will loft the multi-purpose Orion. It is called multi-purpose because it will serve astronaut crew needs in low-Earth orbit and in missions out to the Moon and beyond.

With the successful first step accomplished, astronaut crews will next be able to expand their reach into cis-lunar space and to the surface of the Moon itself. Cis-lunar space is the volume of outer space between low-Earth orbit and the Moon.

The third step carries astronauts beyond the Moon into interplanetary space and to the near-Earth asteroids. The fourth step takes crews to low-gravity bodies such as the moons of Mars. The fifth step will take crews to the surface of Mars and beyond.

The New Rockets

Designed for great flexibility to serve crew and cargo missions in a safe, affordable, and sustainable manner, the SLS rocket will be the biggest and most capable launch vehicle ever built. This is a tall order, and tall it will be. In fact, staggering comparisons are required just to describe it!

The advanced SLS rocket – when configured to carry cargo – will be almost as tall as a 40-story building. It will:
• Produce 20% more thrust at liftoff than the Saturn V rocket that went to Earth’s moon.
• Generate horsepower equivalent to that produced by 17,400 locomotive engines.
• Provide enough cargo room to carry nine school buses. The space shuttle could only carry the equivalent of a bit less than two
The SLS rocket is modular so that it can be configured in different ways for different missions. NASA is now planning two configurations, each stacked around a common SLS core stage equipped with RS-25 engines and flanked on either side with either solid or liquid rocket boosters. These configurations share many other elements and subsystems, as well – such as engines that use liquid oxygen and liquid hydrogen as fuel – so that each costs less to design, build, and launch, without sacrificing the performance required to get the job done. What will they do?

- One configuration is designed to carry people. Its stack is crowned with the Orion spacecraft, which is larger than the Apollo capsule but otherwise looks similar to it. This configuration also has a rocket tower on top, designed to help the crew escape in case of emergency.
- The other configuration is designed to carry massive amounts of cargo, such as structures, equipment, scientific experiments, and supplies. Its stack includes a fairing enclosure that is placed over the rocket’s nose to protect the payload.
The heart of the SLS rocket is a core stage approximately the size of the combined first and second stages of a Saturn V rocket. It is a cylinder about 35 feet in diameter and 220 feet tall. (Specific dimensions may change as the SLS rocket continues to evolve. Visit www.nasa.gov/sls to keep up with new developments as they happen.)

The lower end of the core stage will feature a cluster of four or five RS-25 rocket engines. These are the same engines that powered space shuttle orbiters. Each burn liquid hydrogen and liquid oxygen propellants that are contained in tanks within the core stage. At full throttle, the power put out by five engines will equal the power output of 12 Hoover Dams.

When configured to carry a crew, the SLS rocket is capped with a sloping interstage that tapers the rocket body diameter to match that of the Orion spacecraft, which looks a bit like the Apollo capsule that went to the moon. However, the Orion spacecraft is larger and can carry more crew and supplies. It is covered with a protective shroud terminated with a pencil-shaped escape rocket system, similar to one that was originally developed, but never used, for the Mercury and Apollo missions. In an emergency, this enhanced escape system will separate the Orion spacecraft from the rocket and parachute it to safety along with its crew.

When configured to carry cargo, the SLS rocket is fitted with an upper stage (instead of the Orion spacecraft and interstage) that carries large payloads into Earth orbit and on to deep space. The upper stage also contains liquid hydrogen and liquid oxygen as fuel for its J-2X engines. Once part of the Saturn V rocket, these engines have been upgraded and improved to produce power equivalent to that of two Hoover Dams.

Test firing of a space shuttle RS-25 engine on a static test stand at the Stennis Space Center in Mississippi. During space shuttle flights, these engines generated almost 2.25 million newtons (500,000 pounds) of thrust in a vacuum.
When configured for cargo, the SLS rocket is capped with its payload fairing, which is a protective shell that encloses large cargo, such as assembly modules for a deep-space mission to an asteroid or Mars. The payload fairing opens when it reaches orbit, exposing the cargo. A crew then retrieves it after they maneuver their Orion spacecraft to rendezvous and dock with the payload.

Much work remains to be done, but combining proven ideas and hardware with the newest technologies will result in a highly versatile, cost-effective, and sustainable rocket that will carry astronauts and payloads into space well into the future. Twelfth NASA Administrator Charles F. Bolden, Jr. put it this way. “The next chapter of America’s space exploration story is being written, right here, right now...tomorrow’s explorers will now dream of one day walking on Mars.”

The J-2X rocket engine is the culmination of 50 years of rocket engine research and flight. The J-2 was originally used for Saturn Moon rockets. This modern engine will produce 1.33 million newtons (300,000 pounds of thrust) in a vacuum.
Orbit, Moon, Mars, Asteroids and All Points Between and Beyond

NASA's SLS heavy-lift rocket is being developed alongside many commercial rockets and spacecraft to open the solar system for exploration. All points are possible. The many benefits to be gained from this endeavor are still coming into view, but one thing is clear. The SLS rocket is bringing advanced capabilities within reach at last, inspiring the next generation of scientists, technicians, engineers, and mathematicians – students in today's classrooms – to greatness.

Potential Benefits

Geosynchronous-Earth Orbit/Lagrange Points
- New microgravity destinations
- Space construction, fueling, repair
- Space telescopes and Earth observatories

The Moon
- Witness to the birth of Earth and the inner planets
- Critical resources

Mars/Phobos/Deimos
- Life beyond Earth?
- Permanent base

Near-Earth Asteroids
- How did the solar system form?
- Where did Earth's water and organics come from?
- Planetary defense - threat of impacts
- Space resources