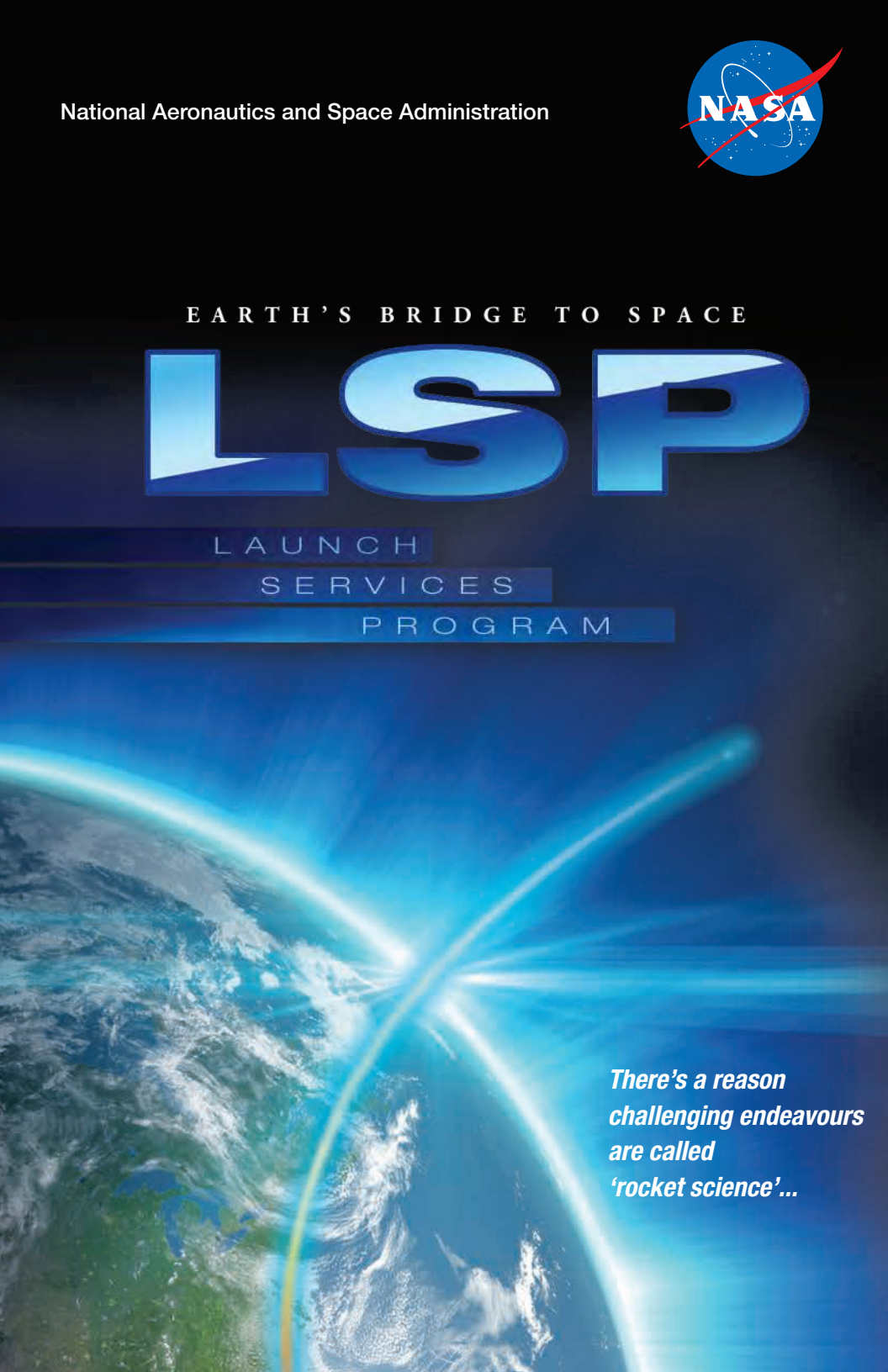
National Aeronautics and Space Administration



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Introduction

NASA's Launch Services Program (LSP) assists customers who need specialized, high-technology support world-wide, and enables some of NASA's greatest scientific missions and technical achievements. Let's explore LSP's 'earth's bridge to space.'

Objective

This portfolio is intended to educate and connect you to some of NASA's most significant unmanned missions, and to highlight the contributions made by LSP. Through enriching your understanding of LSP's benefit to NASA, you may also realize its benefit to you and all of humankind.

Rocket Science 411 ~ Take 1

When a satellite, or payload, needs a ride to space to carry out a science mission, it needs a launch vehicle, or rocket, as its source of transportation. Although launch vehicles may appear similar, they are extremely complex devices with millions of pieces and systems that must be calculated and constructed to work together, and no two launch vehicles are alike. Likewise, every spacecraft is unique to the specific mission. Furthermore, the spacecraft and launch vehicle must be compatible. Every mission presents unique opportunities and complexities … thus, the reason we refer to challenging endeavors as 'rocket science.' To name a few, just imagine:

- Launch vehicles and spacecrafts are unique in mass and volume.

- Spacecrafts have different destination requirements (the location in space where the spacecraft is being sent). That trajectory destination may be a unique orbit or another planet which is a moving target. There could even be a specific time the satellite must reach its planetary orbital destination, as in the case of planetary missions. This could be compared to a quarterback in a football game that has to use judgement when throwing a football to a receiver while the receiver is moving. The quarterback accounts for the thrust and speed of the ball in order to reach the intended target at the right time and place. Likewise, when sending a spacecraft to space, the farther away from Earth, the faster a rocket's speed needs to be.

- The launch vehicle and spacecraft must also survive ground handling and launch environments. This includes stressful environments such as vibration, contamination, electromagnetic, thermal, and structural loads along the way. For example, consider the vibration felt during take-off when flying in an airplane. It's also important for the launch vehicle and spacecraft to be controlled in a clean environment and at the proper temperatures, and to be protected from external environments such as lightning. Also, during flight, rockets are subjected to forces of weight, thrust, and aerodynamics.

For more 'Rocket 411' visit: https://public.ksc.nasa.gov/LspEducation/LSP-Education/Rocket%20411

Strategy

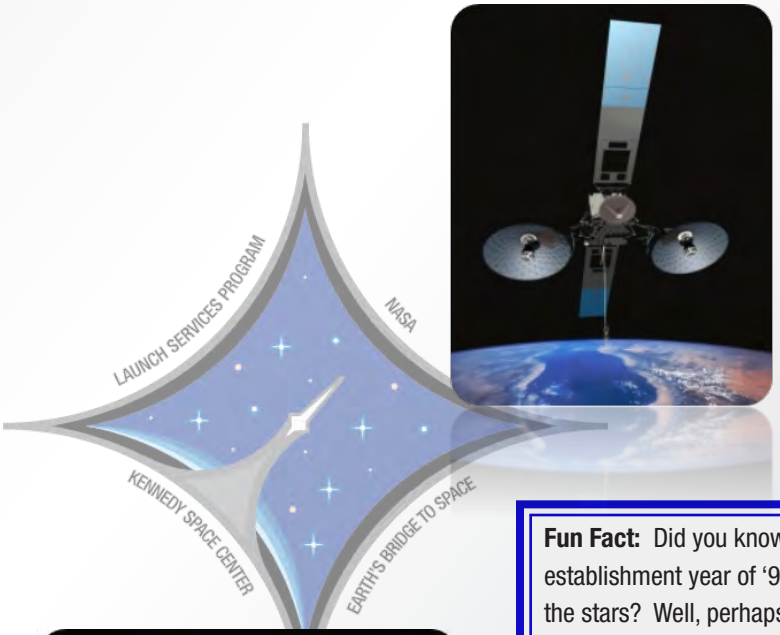
Origin & Purpose

In 1998, NASA's Launch Services Program (LSP) was established to support NASA's science and robotic missions with commercial launch vehicles. The Program was established at the Kennedy Space Center to centralize technical and management support to spacecraft customers. LSP brings together technology, procurement, engineering best practices, strategic planning, studies, and cutting-edge techniques—all instrumental components for the United States to have a dependable and secure Earth-to-space bridge that is dedicated to launching all types of spacecraft.

The principal objectives of LSP are to provide safe, reliable, cost-effective and on-schedule processing, mission analysis, spacecraft integration and launch services for payloads seeking transportation to space on commercial launch vehicles. LSP acts as a broker, matching spacecraft with optimal launch vehicles. Once the right vehicle is selected, LSP buys that spacecraft a ride to space and works to ensure mission success by delivering a healthy spacecraft to the correct orbit or destination. LSP provides support throughout the journey, from pre-mission planning to the post-launch phase of the spacecraft.

As such, LSP provides NASA's acquisition and program management of commercial launch vehicles missions. This is accomplished through a skillful NASA/contractor team providing leadership, expertise and cost-effective services in the commercial launch arena to satisfy space transportation requirements and maximize the probability of mission success.

The work of LSP is considered earth's bridge to space!



Vision & Mission

Vision:

Science and discovery through unlimited access to the universe

Mission:

Uniting customers, capabilities, and culture to explore space through unparalleled launch services

Fun Fact: Did you know LSP's establishment year of '98 is written in the stars? Well, perhaps not, but what is revealed is LSP's logo depicting the following:

- The compass star represents LSP's direction and leadership in launch services.
- The four points represent LSP's four strategic goals.
- There are nine stars to the left of the rocket and eight stars to the right of the rocket, which represents 1998, the year the Program began.
- The rocket in the center represents the fleet of vehicles used for launch services.
- The trail connecting the rocket to Earth is representative of the LSP motto "Earth's Bridge to Space."

Services

There are many pieces that make up the 'big picture' of the Launch Services Program. The services that LSP provides are based on the spacecraft customer's mission requirements. Represented here are LSP's primary 'end-to-end' services, from advance planning through post launch. LSP also offers tailored approaches to serve a wide variety of customers, including one-of-a-kind launch contracts, and advisory services.

Advanced Planning

- Supports spacecraft design
- Conducts launch vehicle trade studies

Business

- Procures commercial launch services, payload processing facilities, and support contractors
- Manages multi-year budgets from the spacecraft customer for specific missions, and from NASA's Human Exploration Operations Mission Directorate for infrastructure aspects of the LSP

Technical

- Provides insight and approval of launch vehicle fleets
- Verifies and validates mission engineering and analysis
- Certifies launch systems
- Integrates spacecraft to launch vehicles

Launch Site Operations

- Supports spacecraft standalone testing, propellant loading, payload encapsulation, and integrated testing in clean facility
- Provides infrastructure to communicate with spacecraft

Launch Operations

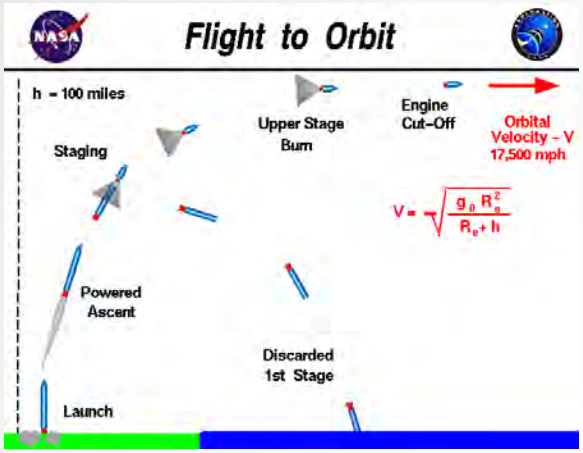
- Provides communications and telemetry data
- Participates in countdown
- Gives 'go for launch'
- Ensures liftoff and orbital insertion through separation

Post Launch

- Determines mission success
- Reviews and assesses data

Rocket Science 411 ~ Take 2

Expendable launch vehicles use the same basic technology to get into space - two or more rocket-powered stages, which fall away when their engine burns are completed, as pictured right. Reusable launch vehicles allow for recovery of part of the launch system for later use. Whatever a rocket carries above the final discarded stage is considered the payload.



When we talk about how Earth and planets travel around the Sun, we say they orbit the Sun. Likewise, satellites also orbit Earth, and there are multiple orbits to choose from - all determined by the purpose of the mission.

- Low Earth Orbit (LEO) is between 49 and 1,242 miles (80 and 2,000 km) above the earth. This is the easiest orbit to reach, and is where the International Space Station resides. Satellites travel approximately 17,000 miles per hour to stay in LEO. At that speed, you could get from the Kennedy Space Center to Orlando in about 13 seconds. Any satellite with an orbital path going over or near the poles maintains a polar orbit, which is usually in LEO.
- Medium Earth Orbit (MEO) is between 1,242 and 22,236 miles (2,000 and 35,786 km) above the earth.
- Geosynchronous Orbit (GEO) is from 22,236 miles (35,786 km) above the earth. Satellites headed for GEO first go to an elliptical orbit with an apogee about 37,015 km. Firing the rocket engines at apogee then makes the orbit round.

Launch Fleet

Vehicle Class	Small		Medium	Intermediate / Heavy				
Launch Vehicle	Pegasus XL	Taurus-XL (Minotaur-C)	Antares 2XX	Falcon 9 Full Thrust	Atlas V 4XX	Atlas V 5XX	Delta IV Heavy	Falcon Heavy
Offeror	OSC	OSC	OSC	SpaceX	ULS	ULS	ULS	SpaceX
Launch Sites	CCAFS WFF KWAJ VAFB	CCAFS WFF VAFB	WFF	CCAFS VAFB	CCAFS VAFB	CCAFS VAFB	CCAFS VAFB	CCAFS

The LSP offers a mixed-fleet approach to support science, Earth-orbit and interplanetary missions under the contractual mechanism known as NASA Launch Services (NLS) II. This provides multiple types of vehicles, to ensure the optimal launch vehicle is chosen to support the spacecraft's mission requirements, and to ensure competitive prices prevail among the launch vehicle providers. Generally speaking, missions with smaller satellites use smaller, less expensive vehicles, and the larger flagship missions utilize the larger, higher performance and more reliable vehicles. This could be compared to purchasing an automobile. There are various vehicle classes ranging from a compact car to a large van, all meeting diverse requirements and budgets.

Pictured above is the current fleet of launch vehicles that are used to launch payloads into low-Earth orbit or deep space missions - all possessing unique capabilities. The NLS II contract also offers the option to on-ramp new launch vehicles each year.

Launch Vehicle Capabilities, Primary Missions

Atlas V

The United Launch Alliance (ULA) offers multiple configurations of the Atlas V rocket to carry payloads ranging from four- to five-meter-diameter fairing in size. That is more volume than an average single-family home. Up to five solid rocket boosters can be added to the rocket to increase its performance. The Atlas V can carry a payload weighing up to 41,570 pounds (18,850 kilograms) to low-Earth orbit. To identify the specific configuration of the Atlas V 400 and 500 series, a three-digit (XYZ) naming convention is used to identify (1) the payload fairing size; (2) the number of solid rocket boosters; and (3) the number of Centaur engines.

Fun Fact: To put payload weights into perspective, the average U.S. car weighs 4,000 pounds and a school bus weighs 29,000 pounds. So NASA's LSP is doing some heavy lifting!

ULA®
United Launch Alliance

Delta II, Delta IV & Delta IV Heavy

Since 1960, the Delta family of vehicles has been upgraded several times throughout the years. The Delta II and the Delta IV, including the Heavy configuration most recently produced by ULA, has solid motors, liquid-fueled first and second stages, and a solid-propellant third stage. A four-digit system is used to identify specific Delta rocket configurations. The final two launches of the Delta II will be for LSP. They are the Joint Polar Satellite System-1 (JPSS-1), and the Ice, Cloud and land Elevation Satellite-2 (ICESat-2). The Delta IV Heavy will be used to launch the Parker Solar Probe. The Delta IV can carry payloads weighing up to 30,440 pounds (13,810 kilograms) to geostationary transfer orbit. The Delta IV Heavy can carry payloads weighing 62,520 pounds (28,370 kilograms) into low-Earth orbit, depending on vehicle configuration.

ULA®
United Launch Alliance

Launch Vehicle Capabilities, Primary Missions

Falcon 9

Falcon 9 is a reusable two-stage rocket designed and manufactured by SpaceX for the safe reliable transport of satellites and the Dragon spacecraft into orbit. Falcon 9 is capable of carrying payloads weighing up to 50,265 pounds (22,800 kilograms) into low-Earth orbit, and up to 18,300 pounds (8,300 kilograms) into geostationary transfer orbit.

SPACEX

Pegasus XL

Orbital ATK produces the Pegasus XL, a small expendable rocket that attaches beneath the company's L-1011 Stargazer aircraft, is carried to 39,000 feet, and released for launch. It is the only airborne-launched rocket. The Pegasus XL can carry a payload up to 992 pounds (450 kilograms) to low-Earth orbit. The rocket weighs about 51,000 pounds (23,133 kilograms), and measures 55.4 feet (16.9 meters) in length and 50 inches (1.27 meters) in diameter. Pegasus has a wing span of 22 feet (6.7 meters).

Orbital ATK

Small Satellite Missions

As part of the mixed-fleet approach supporting the spacecraft customer's mission requirements, the Launch Services Program also manages small satellite missions, known as CubeSats, which are selected by NASA's CubeSat Launch Initiative (CSLI).

- CSLI provides access to space for small satellites developed by the NASA Centers and programs, educational institutions and non-profit organizations. This gives CubeSat developers access to a low-cost pathway to conduct research in the areas of science, exploration, technology development, education or operations.
- By providing a progression of educational opportunities including CSLI for students, teachers, and faculty, NASA assists the Nation in attracting and retaining students in STEM disciplines.
- The CSLI also promotes and develops innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects. NASA thus gains a mechanism to use CubeSats for low-cost technology development or pathfinders.
- CubeSats, also called nanosatellites, are small enough in size to fit in the palm of your hand, measuring 10X10X10 cm.
- CubeSats can complete a lot of research once in orbit, so NASA makes room for them on the same rockets that take much larger payloads into space. In these instances, the CubeSats are essentially 'hitchhiking' to space and are considered secondary payloads to the primary satellites being launched.

For more information and cool videos on NASA's Small Satellite Missions visit:
https://www.nasa.gov/mission_pages/smallsats/elana/index.html

Small Satellite Missions ~ Cont'd.

Venture Class Launch Services (VCLS)

Some rockets have been designed for CubeSat missions under NASA's Venture Class Launch Services (VCLS) contract. VCLS offers faster launch services than traditional launch services for primary missions. This is because smaller satellites are more agile, flexible, and affordable, thereby warranting a higher risk tolerance and reduced requirement for insight and approval.

VCLS was borne out of customer feedback, which drove LSP's strategy to demonstrate contracting flexibility.

The current launch vehicles under the contractual mechanism of VCLS are listed below and pictured to the right. They are:

- Rocket Lab, Electron
- Virgin Orbit, LauncherOne

The future of small class vehicles is one to watch, as it is anticipated that the number of small class launch vehicles will increase in number, thereby further reducing costs.

Electron

Rocket Lab's Electron launch vehicle has a height of 17 m, with a diameter of 1.2 m, and has 2 stages. It can carry a maximum payload weighing 225 kilograms. Additional information on the Electron is on Rocket Lab's website at: https://www.rocketlabusa.com/electron/

LauncherOne

Virgin Orbit's LauncherOne is an expendable, two stage launch vehicle. It is capable of carrying a payload of up to 300 kilograms into sun-synchronous orbit, and 500 kilograms into Low Earth Orbit. Additional information on the LauncherOne is on Virgin Orbit's website at: https://virginorbit.com/

LSP Launch Sites

Location, Location, Location

Another important consideration in space science is determining the physical location of where a rocket will launch from. The decision on the proper launch site location is based on the type of science needed, and what orbital destination the satellite will need to reach in order to gather the science.

Primary launch sites for NASA's launch vehicles are Cape Canaveral Air Force Station in Florida, and Vandenberg Air Force Base in California.

Cape Canaveral Air Force Station, Florida

- Located adjacent to Kennedy Space Center, Cape Canaveral Air Force Station is ideal for spacecraft requiring a west-east orbit. Missions requiring equatorial orbits are typically launched from this location due to its closer proximity to the equator.

Vandenberg Air Force Base, California

- Located between Los Angeles and San Francisco, Vandenberg is preferred for spacecraft requiring a north-south orbit, and is best for missions requiring polar orbits.

Wallops Island Flight Facility, Virginia

- Located on the Eastern Shore of Virginia is Goddard Space Flight Center's principal facility for suborbital research programs and launch of the Antares launch vehicle for International Space Station resupply.

Reagan Test Site, Kwajalein Atoll, Republic of the Marshall Islands

- The Kwajalein site was chosen for the launches of HETE-2, IBEX, and NuSTAR because of their required inclinations.

Kodiak Island, Alaska

- This serves as one of the best locations in the world for polar launch operations, providing a wide launch azimuth and unobstructed downrange flight path. This location was the launch site of Kodiak Star.

Partnerships & Collaboration

The reach of the Launch Services Program is far and wide. LSP is able to successfully carry out its mission with the support of numerous partners and collaboration with NASA Programs/Centers, Department of Defense, Inter-Agency, Commercial Providers, Foreign Governments, Start-ups, and more.

Spacecraft Customers

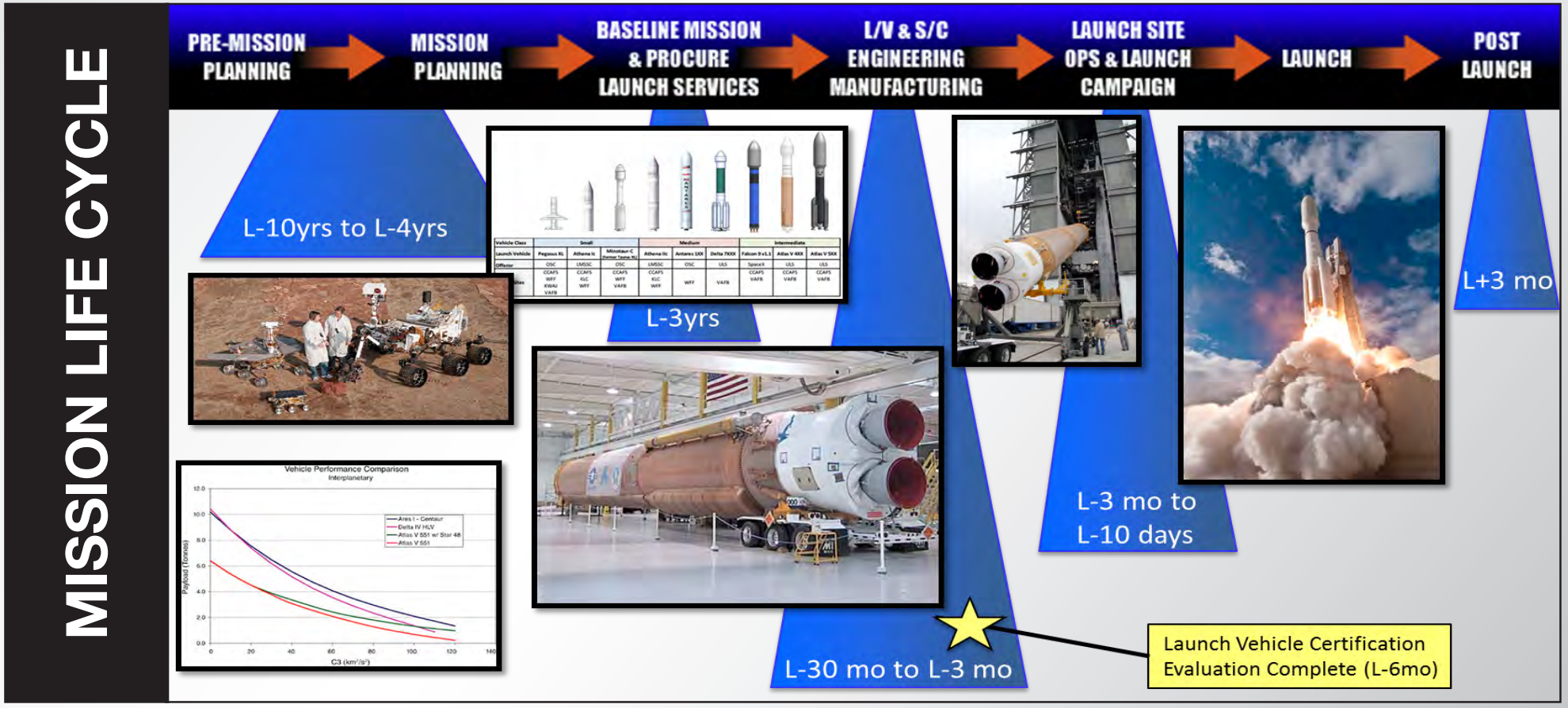
The work performed by the Launch Services Program is entirely focused on the spacecraft customer's mission needs. In other words, the work of LSP benefits the customer's goals, which ultimately benefits society through the legacy of scientific discovery! Some of the LSP's customers are listed to the right.

- **Goddard Space Flight Center** in Greenbelt, Maryland
- **Jet Propulsion Laboratory** located at the California Institute of Technology
- **Ames Research Center** at Moffett Field, in California's Silicon Valley
- **Marshall Space Flight Center** at Redstone Arsenal in Huntsville, Alabama
- **Langley Research Center** in Hampton, Virginia
- **Applied Physics Laboratory** in Laurel, Maryland
- Several U.S. universities launching small research satellites (CubeSats)
- International Partners
- Other Government Agencies:
  - National Oceanic and Atmospheric Administration (NOAA)
  - Missile Defense Agency (MDA)
  - National Reconnaissance Organization (NRO)

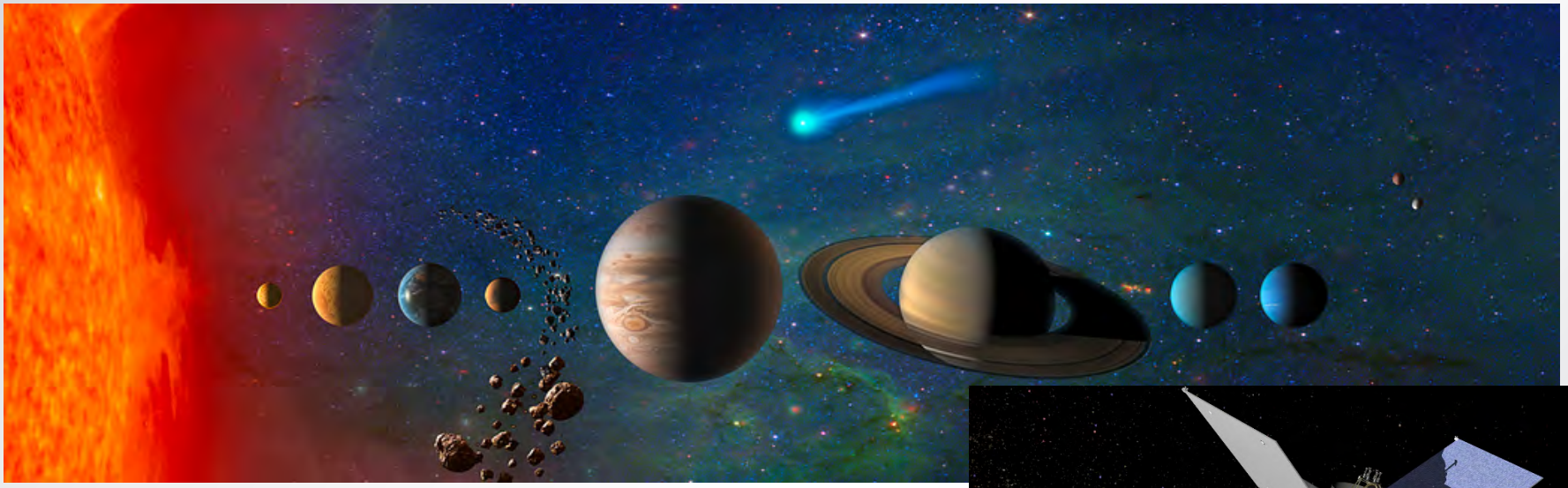
Mission Life Cycle

For traditional primary satellites to be launched, the process from mission selection to launch can take anywhere from 4 to 10 years. The reason for this is primarily due to the vast complexities and risk levels of the specific mission. The below depiction shows the support that LSP provides from years before the spacecraft is even created, all the way through, until well after the spacecraft has launched. This is what comprises end-to-end full service.

The LSP also offers tailored approaches for a wide variety of customers, including one-of-a-kind contracts and advisory services. These types of services vary in length, based on the types of services desired by the spacecraft customer. Generally speaking, mission requirements that are lower in complexity and risk level would warrant a reduction in time and dollars. An example of this tailored approach would be CubeSat missions using the Venture Class Launch Services contract.



Historical Mission Highlights



Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-Rex)

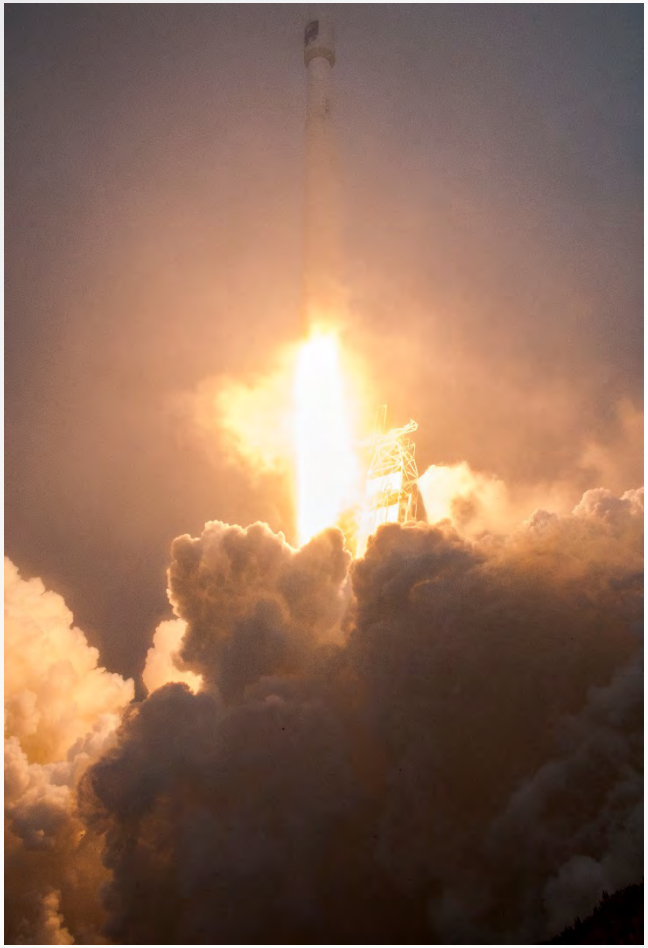
OSIRIS-Rex launched atop a United Launch Alliance Atlas V rocket Sept. 8, 2016, from Cape Canaveral Air Force Station in Florida on a seven-year mission to and from a nearby asteroid. The groundbreaking mission is the first U.S. mission to travel to near-Earth asteroid Bennu, map its surface using 3-D laser imaging, retrieve samples from the surface, and return to Earth. The spacecraft will spend the first two years of the mission cruising to Bennu, arriving in August 2018.

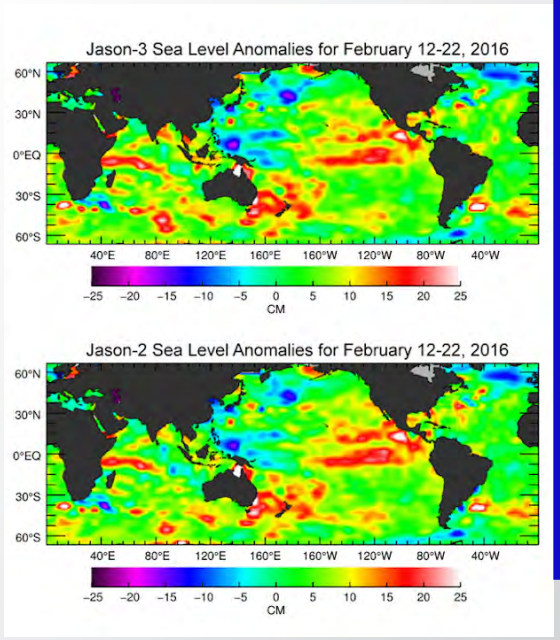
Credit: NASA's Goddard Space Flight Center

Historical Mission Highlights

Joint Altimetry Satellite Oceanography Network-3 (Jason-3)

Jason-3 is the fourth mission in the U.S.-European series of satellite missions that measure the height of the ocean surface. The satellite launched aboard a SpaceX Falcon 9 on Jan. 17, 2016, from Vandenberg Air Force Base in California. The mission extended the time series of ocean surface topography measurements begun by the TOPEX/Poseidon satellite mission in 1992, and continuing through the Jason-1 (launched in 2001), to the currently operating OSTM/Jason-2 (launched in 2008).





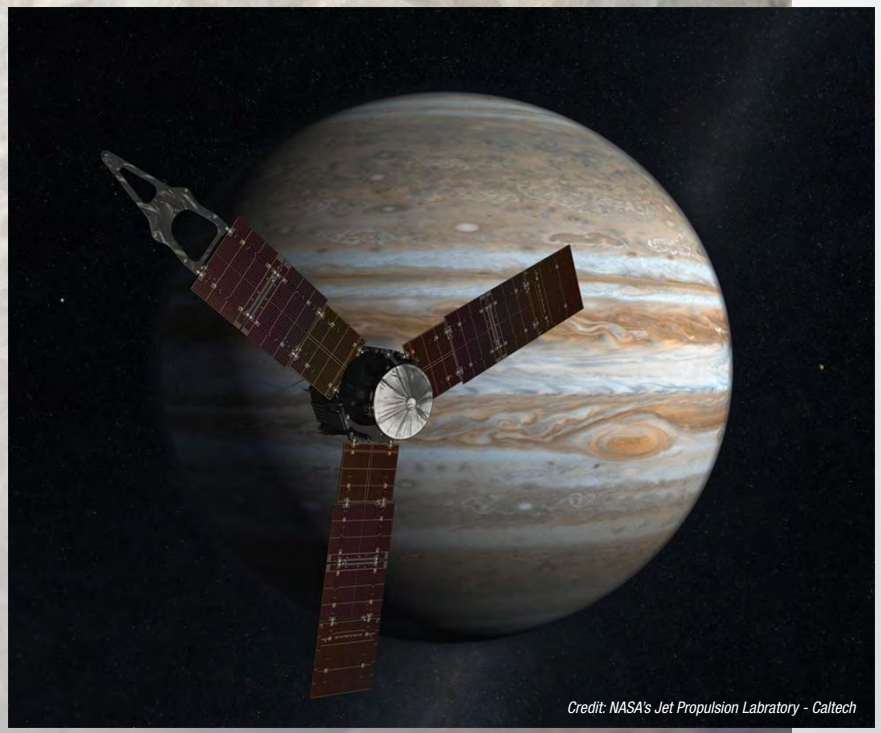
Jason-3 has begun mapping the ocean! This shows surface height, which corresponds well to its predecessor, Jason-2. Data from Jason-3 will be used to monitor climate change and track phenomena like El Niño.

Credit: NASA's Jet Propulsion Labratory - Caltech / Ocean Surface Topography Science team

Historical Mission Highlights

Juno

NASA's solar-powered Juno spacecraft launched aboard an Atlas V rocket Aug. 5, 2011, from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida, to begin a five-year journey to Jupiter. Juno will orbit Jupiter's poles 33 times and use its eight science instruments to find out more about the gas giant's origins, structure, atmosphere and magnetosphere, and investigate the existence of a solid planetary core. Juno recently made its fifth flyby over Jupiter's mysterious cloud tops on March 27, 2017. At the time of closest approach, the spacecraft was about 2,700 miles above the planet's cloud tops, traveling at a speed of about 129,000 miles per hour relative to the gas-giant planet.

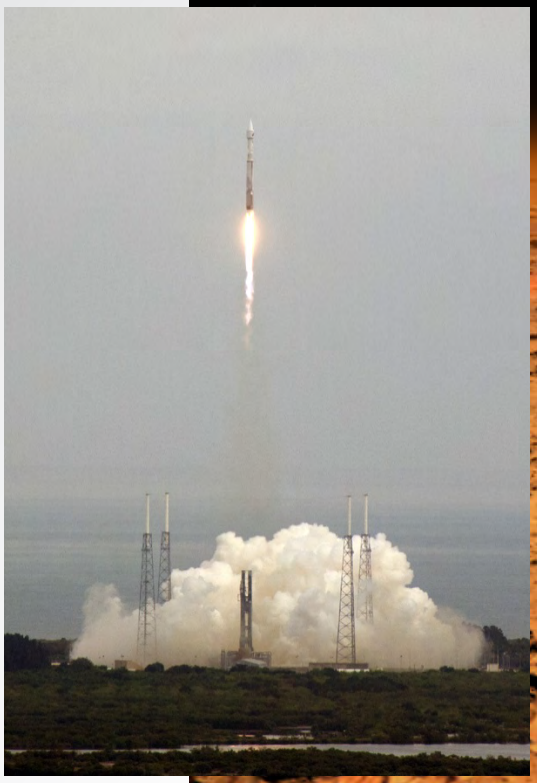


Credit: NASA's Jet Propulsion Labratory - Caltech

Historical Mission Highlights

Mars Atmospheric and Volatile Evolution (MAVEN)

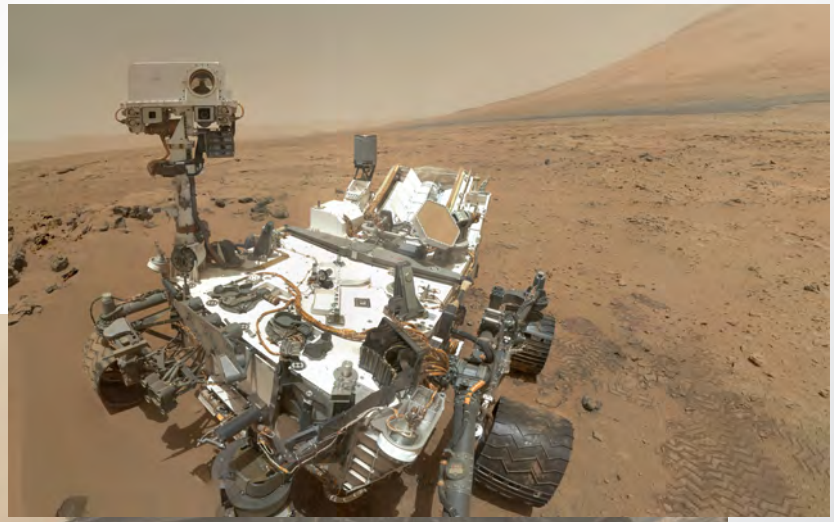
MAVEN launched aboard an Atlas V rocket from Space Launch Complex 41 at Cape Canaveral Air Force Station on Nov. 18, 2013, on its nine-month mission to Mars. MAVEN began orbiting the Red Planet in September 2014, and is orbiting the planet to study its upper atmosphere, ionosphere and interactions with the sun and solar wind. Scientists are using MAVEN's data to determine the role that loss of volatiles from the Mars atmosphere to space has played through time.



Historical Mission Highlights

Mars Science Laboratory (MSL) - Curiosity

NASA's Curiosity rover launched aboard an Atlas V rocket from Space Launch Complex 41 at Cape Canaveral Air Force Station on Nov. 6, 2011. The rover landed on Mars on Aug. 6, 2012. Curiosity was designed to assess whether Mars ever had an environment able to support small life forms, called microbes. Its mission was to determine the planet's habitability. Most recently, Curiosity sent back images of what appear to be dust devils on the Martian surface.

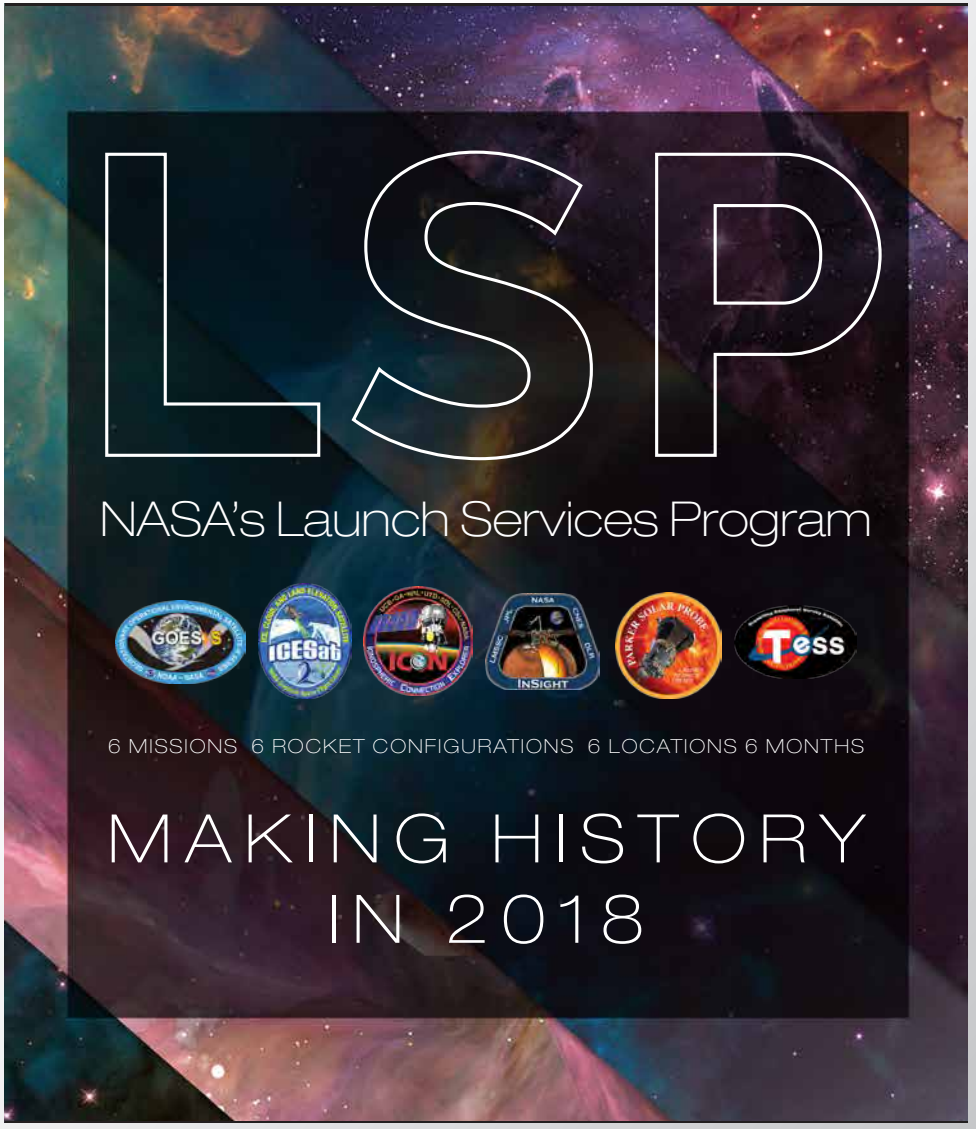


Want more on mars? Video: Mars in a Minute: How Do You Get to Mars? https://mars.jpl.nasa.gov/multimedia/videos/?v=32

Credit: NASA's Jet Propulsion Labratory-Caltech / Malin Space Science Systems

In the Launch Queue for 2018

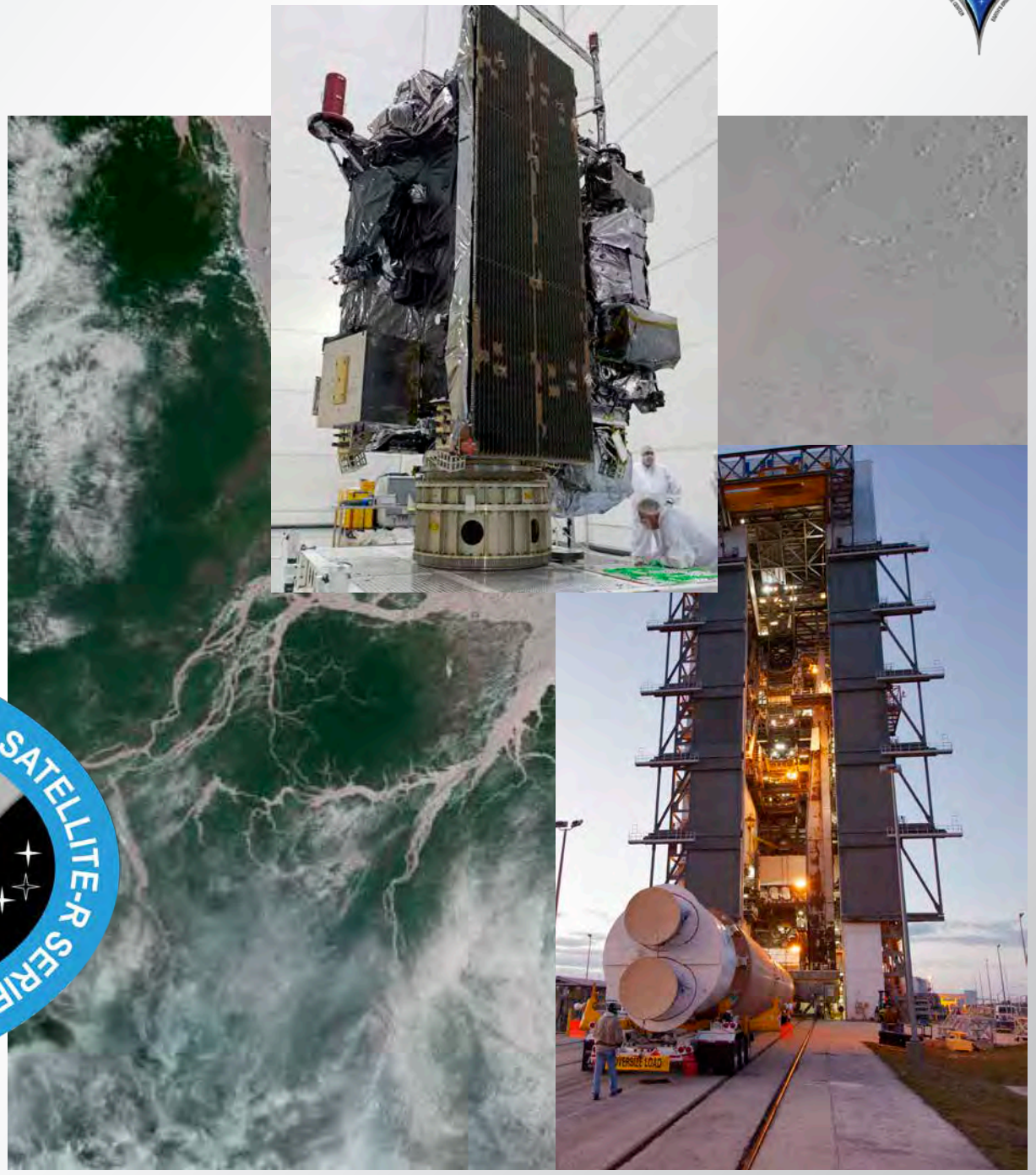
If 2018 has a magic number for NASA's Launch Services Program (LSP), it could be six. That's because there are six primary missions scheduled from two different coasts, within about six months, atop six different rocket configurations (five different rockets.)



In the Launch Queue for 2018 ~ Cont'd.

Geostationary Operational Environmental Satellite-S (GOES-S)

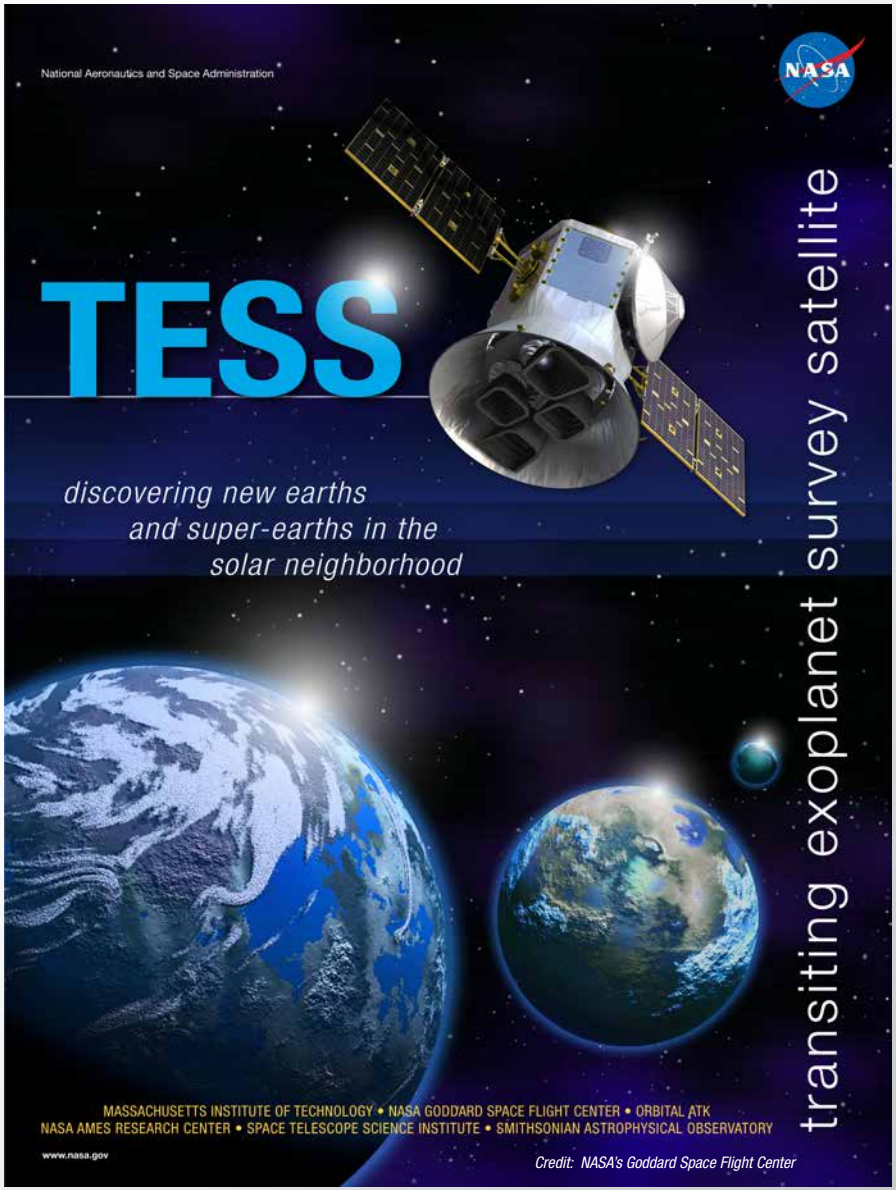
NOAA's GOES-S is scheduled to launch on a United Launch Alliance Atlas V rocket from Cape Canaveral Air Force Station (CCAFS) in Florida. GOES-S is the second in the GOES-R Series of weather satellites that includes GOES-R (now GOES-16), -S, _T and -U. GOES-S will be renamed GOES-17 when it reaches geostationary orbit. Once the satellite is declared operational late 2018, it will occupy NOAA's GOES-West position and provide faster, more accurate data for tracking wildfires, tropical cyclones, fog, and other storm systems and hazards that threaten the western United States, Hawaii, Alaska, Mexico, Central America, and part of South America.



In the Launch Queue for 2018 ~ Cont'd.

Transitioning Exoplanet Survey Satellite (TESS)

TESS is the next step in the search for planets outside our solar system, including those that could support life. The mission will find exoplanets that periodically block part of the light from their host stars, events called transits. TESS will survey 200,000 of the brightest stars near the sun to search for transiting exoplanets. TESS scientists expect the mission will catalog more than 2,000 planet candidates and vastly increase the current number of known exoplanets. Of these, approximately 300 are expected to be Earth-sized and super-Earth-sized exoplanets, which are worlds no larger than twice the size of Earth. TESS will find the most promising exoplanets orbiting our nearest and brightest stars, giving future researchers a rich set of new targets for more comprehensive follow-up studies.

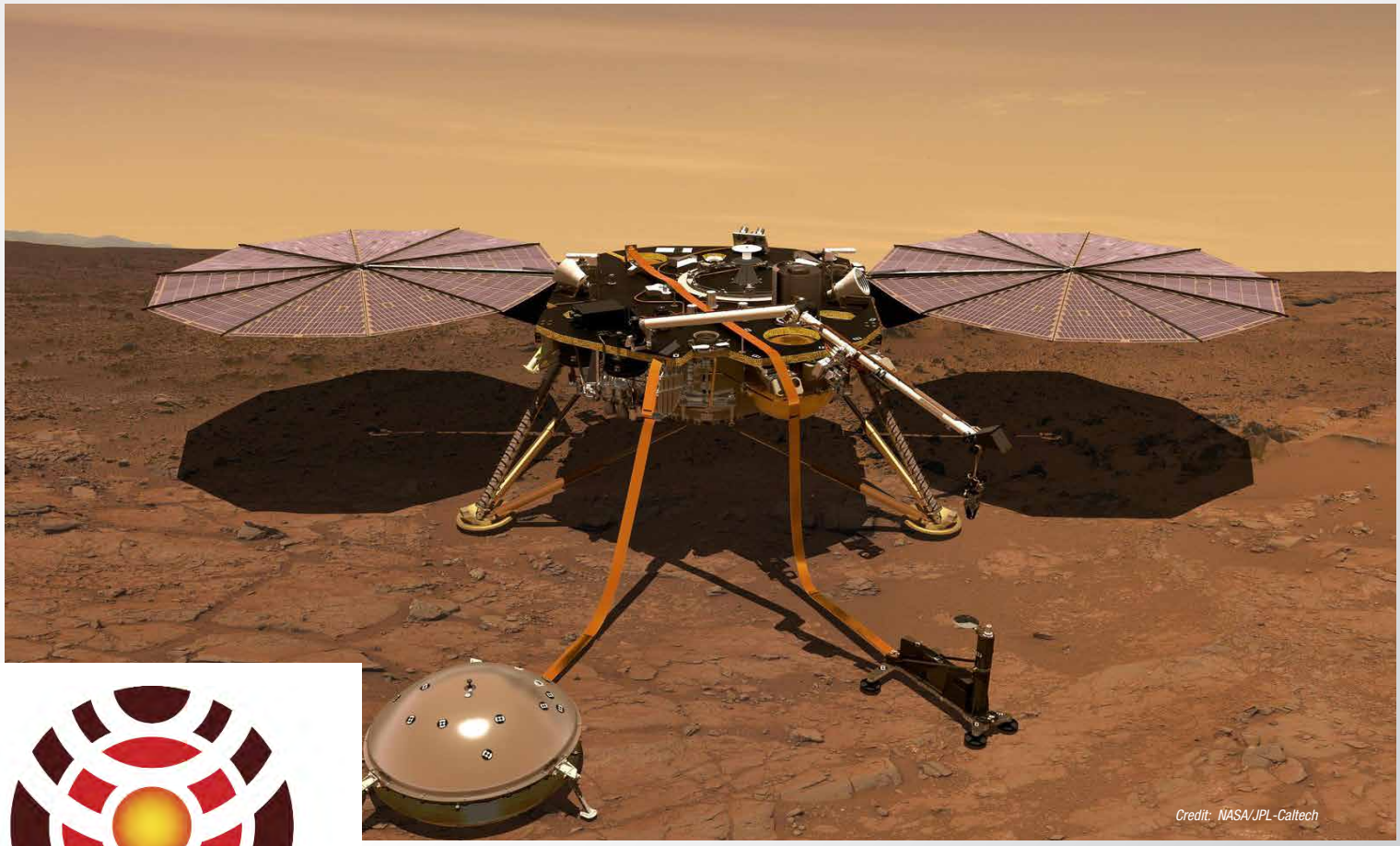


In the Launch Queue for 2018 ~ Cont'd.

Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight)

InSight is the first mission to explore Mars' deep interior, and is scheduled to launch from Vandenberg Air Force Base in California, on a United Launch Alliance Atlas V rocket. It will investigate processes that shaped the rocky planets of the inner solar system (including Earth) more than four billion years ago.

By using sophisticated geophysical instruments, InSight will delve deep beneath the surface of Mars, detecting the fingerprints of the processes of terrestrial planet formation, as well as measuring the planet's "vital signs": Its "pulse" (seismology), "temperature" (heat flow probe), and "reflexes" (precision tracking).



Credit: NASA/JPL-Caltech

InSight

In the Launch Queue for 2018 ~ Cont'd.

Ionospheric Connection Explorer (ICON)

The ICON mission will study the frontier of space: the dynamic zone high in Earth's atmosphere where terrestrial weather from below meets space weather above. In this region, the tenuous gases are anything but quiet, as a mix of neutral and charged particles travel through in giant winds. These winds can change on a wide variety of time scales - due to Earth's seasons, the day's heating and cooling, and incoming bursts of radiation from the sun.

Credit: NASA's Goddard Space Flight Center

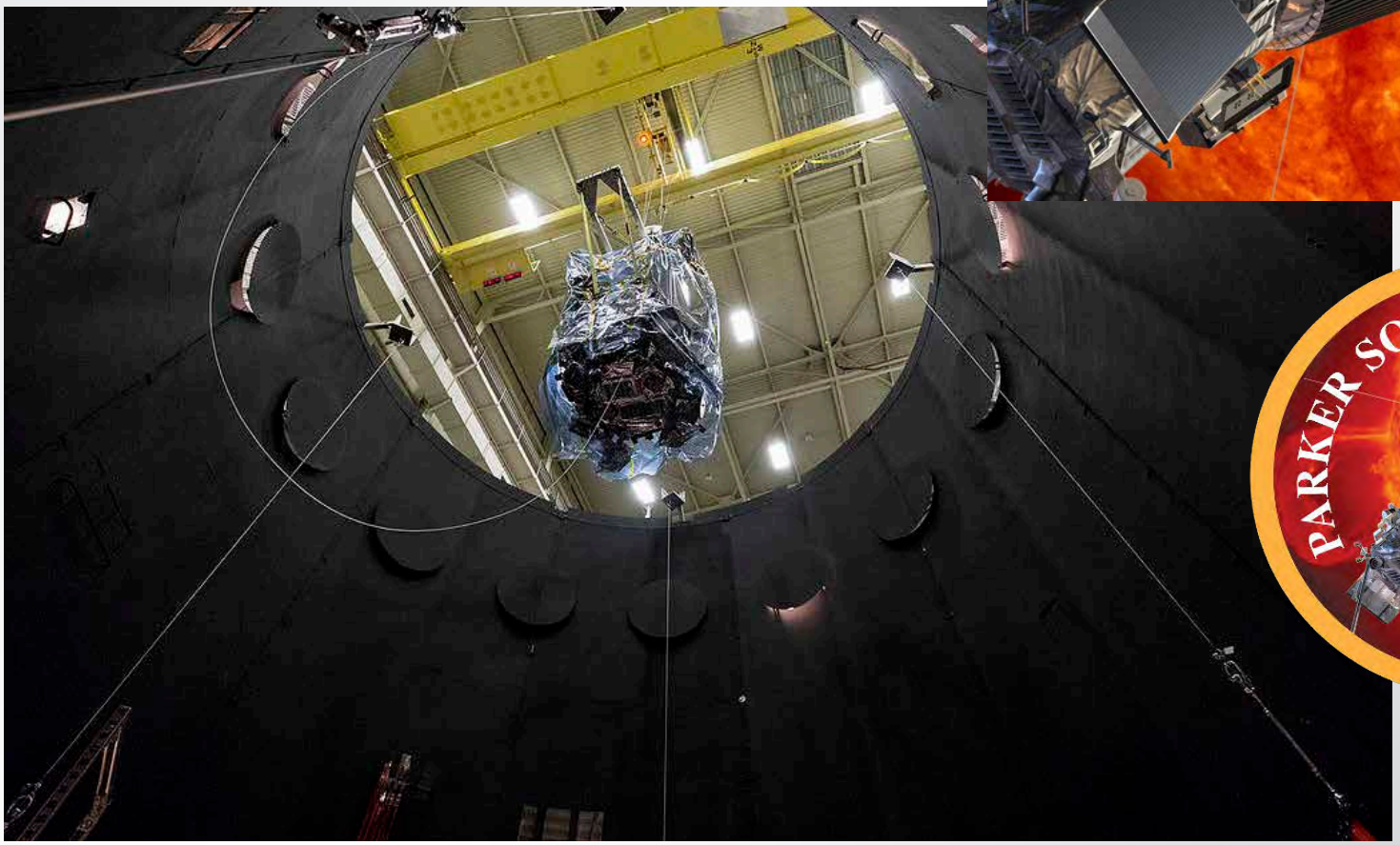
Pictured above is the artist's concept of NASA's ICON mission which will study the ionosphere from a height of about 350 miles to understand how the combined effects of terrestrial weather and space weather influence this ionized layer of particles. Pictured right is the team of engineers at the Naval Research Laboratory in Washington and the instrument they built—the Michelson Interferometer for Global High-resolution Thermospheric Imaging, or MIGHTI, instrument—for NASA's ICON mission.

In the Launch Queue for 2018 ~ Cont'd.

Parker Solar Probe

NASA's Parker Solar Probe will be the first-ever mission to "touch" the sun. The spacecraft, about the size of a small car, will travel directly into the sun's atmosphere about 4 million miles from our star's surface. NASA's historic Parker Solar Probe mission will revolutionize our understanding of the sun, where changing conditions can propagate out into the solar system, affecting Earth and other worlds. Parker Solar Probe will travel through the sun's atmosphere, closer to the surface than any spacecraft before it, facing brutal heat and radiation conditions - and ultimately providing humanity with the closest-ever observations of a star.

Credit: NASA's Goddard Space Flight Center



In the Launch Queue for 2018 ~ Cont'd.

Ice, Cloud and land Elevation Satellite-2 (ICESat-2)

ICESat-2, will measure the height of a changing Earth - one laser pulse at a time, 10,000 laser pulses a second. ICESat-2 will carry a laser altimeter that detects individual photons, allowing scientists to measure the elevation of ice sheets, sea ice, forests and more in unprecedented detail.

Our planet's frozen and icy areas, called the cryosphere, are a key focus of NASA's Earth science research. ICESat-2 will help scientists investigate why, and how much, our cryosphere is changing in a warming climate. The satellite will also measure heights across Earth's temperate and tropical regions, and take stock of the vegetation in forests worldwide.

ICESat-2
ICE, CLOUD, AND LAND ELEVATION SATELLITE-2

Additional Historical LSP Launches

To learn more about LSP's historical launches, visit:
https://lsp.ksc.nasa.gov/launchhistory/f/default.aspx
Once there, you can jump to specific years and missions!

Knowledge Launch

Now that you have broadened your knowledge of 'rocket science' and the work of NASA's Launch Services Program, here are some final questions to see just how much you've launched your learning. Good luck!

1) What year was the LSP established?

a. 2001
b. 1998
c. 1995

2) True or False: LSP's job is to act like a broker, matching spacecraft with launch vehicles.

3) True or False: LSP's two primary launch sites are Cape Canaveral Air Force Station (CCAFS) in Florida and Vandenberg Air Force Base (VAFB) in California. Other launch locations are NASA's Wallops Flight Facility in Virginia, the Kwajalein Atoll in the South Pacific's Republic of the Marshall Islands, and Kodiak Island in Alaska.

4) On average, how long does it take to go from mission selection to launch (end-to-end)?

a. Between 4-10 years
b. Between 1-5 years
c. Between 9-15 years

5) How long did it take from launch for the "Curiosity" rover to land on Mars?

a. 5 hours
b. 9 months
c. 2 years

6) True or False: A satellite must travel fast, at a speed of approximately 17,000 miles per hour, to remain in Low Earth Orbit.

7) How do small satellite missions, CubeSats, compare to traditional/primary satellite missions?

a. CubeSats are the same as primary satellites
b. CubeSats are tiny in size and low in cost, and help engineers, researchers, and students conduct science in a host of fields. CubeSat missions also assume lower risk levels, and have lower insight and approval, and therefore are faster to launch.

8) What primary factors are considered when deciding the proper launch site location?

a. The decision is based on which launch site is available.
b. The decision is based on knowing the type of science needed, and where the orbital destination of the satellite will need to reach in order to accomplish the science.

9) True or False: LSP offers every U.S. commercial launch vehicle built by a U.S. company through a competition that ensures the spacecraft mission requirements will be met.

10) True or False: The Launch Services Program has launched over 80 missions to date.

Answers: 1.B; 2. True; 3. True; 4. a; 5. b; 6. True; 7. b; 8. b.; 9. True; 10. True

To learn more about NASA's amazing spin-offs, and how NASA technologies benefit life on Earth in the form of commercial products, visit: https://spinoff.nasa.gov/

There's more space in your life than you may realize!

Staying Connected to LSP

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For more information about the Launch Services Program, visit: https://www.nasa.gov/centers/kennedy/launchingrockets/index.html, and select:

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For more information about any of the listed missions, visit: http://nasa.gov/missions/index.htm

LSP

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