

# The Aerospace Update



Antares Seen from Washington D.C. Tidal Basin

Nov. 22, 2018

Photo Credit: NASA/Aubrey Gemignani

# Progress Resupply Craft Lifts Off From Kazakhstan



*Video Credit: ROSCOSMOS*

A Russian Progress freighter loaded with nearly three tons of supplies, water and fuel lifted off on top of a Soyuz rocket Friday, Nov. 16<sup>th</sup> from the Baikonur Cosmodrome in Kazakhstan on a two-day trek to the ISS, clearing the way for the next Soyuz launch Dec. 3<sup>rd</sup> with the next station-bound crew. The Soyuz launcher that lifted off Friday flew in the Soyuz-FG configuration, the same variant of Russian's most famous rocket used for liftoffs with crews heading for the space station. This launch was the fourth Soyuz launch since a booster separation failure forced a Russian cosmonaut and a NASA astronaut to abort their launch to the space station Oct. 11<sup>th</sup>, but the first flight since then to use the human-rated Soyuz-FG version.

*Source: Stephen Clark @ SpaceFlightNow.com*

# Antares Launches Cygnus Cargo Spacecraft to ISS

CAM 12



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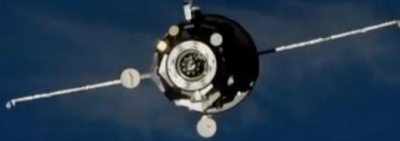
Video Credit: NASA



Northrop Grumman successfully launched a Cygnus cargo spacecraft to the International Space Station Nov. 17<sup>th</sup> after two days of weather delays. The Cygnus spacecraft, called S.S. John Young by the company after the late astronaut, is carrying 3,350 kilograms of cargo for the station. That includes approximately 1,140 kilograms of crew supplies, 1,040 kilograms of science payloads, 940 kilograms of vehicle hardware, 115 kilograms of computer resources and 31 kilograms of spacewalk equipment. The spacecraft is also carrying 77 kilograms of unpressured cargo in the form of a cubesat deployer from NanoRacks that will be used after the Cygnus departs the station.

Source: Jeff Foust @ SpaceNews.com

## Progress Arrives at ISS



Two days after launching from the steppe of Kazakhstan, a Russian Progress resupply and refueling freighter docked with the International Space Station Sunday, Nov 18<sup>th</sup>. The supply ship's radar-guided rendezvous culminated in an automated docking with the aft port on the space station's Zvezda service module delivering around 5,500 pounds (2,495 kilograms) of supplies, experiments and commodities for the orbiting outpost and its crew.

*Source: Stephen Clark @ SpaceFlightNow.com*

*Image Credit: NASA*

## Cygnus Arrives at ISS 15 Hours after Progress



*Photo Credit: NASA/Serena Auñón-Chancellor*

Wrapping up a two-day chase since launching from Virginia's Eastern Shore, a commercial Cygnus cargo craft arrived at the ISS Monday, Nov 19<sup>th</sup> with more than 7,200 pounds of supplies and experiments, the second freighter to reach the orbiting complex in 15 hours. The Cygnus spacecraft, named the S.S. John Young in honor of the former Gemini, Apollo and space shuttle astronaut who died in January, is scheduled to stay at the station until mid-February. During the nearly three-month stay, astronauts will unpack 7,215 pounds (3,273 kilograms) of supplies and experiments stowed inside the ship's pressurized compartment, built by Thales Alenia Space in Italy, then replace the items with trash for disposal.

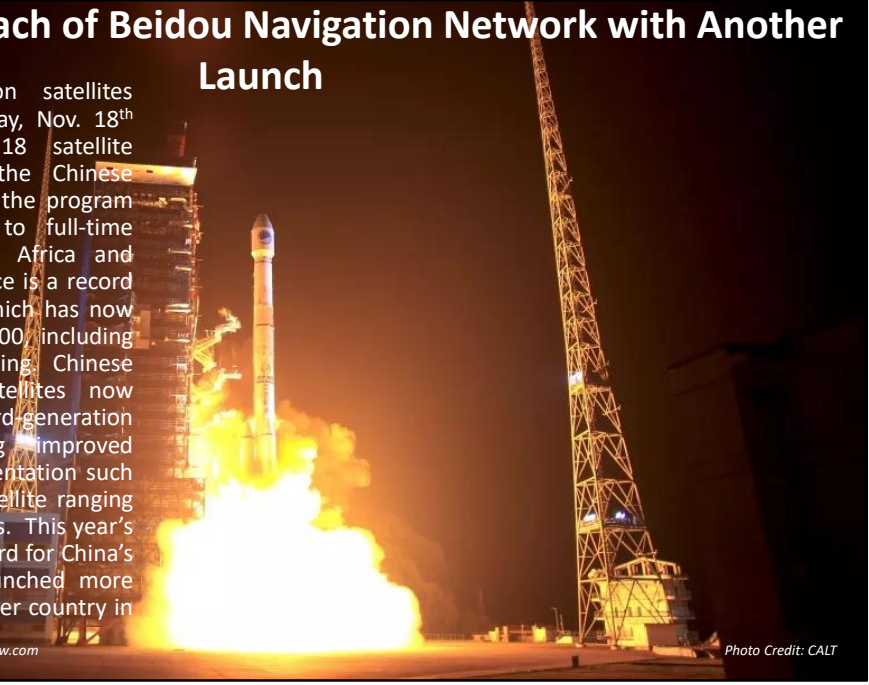
*Source: Stephen Clark @ SpaceFlightNow.com*

## China Expands Reach of Beidou Navigation Network with Another Launch

Two more Beidou navigation satellites launched from China on Sunday, Nov. 18<sup>th</sup> ending a record run of 18 satellite deployments this year for the Chinese alternative to GPS and placing the program on the cusp of expanding to full-time coverage over most of Asia, Africa and Europe. The feverish launch pace is a record for China's Beidou program, which has now launched 43 satellites since 2000, including test models no longer operating. Chinese officials say the Beidou satellites now launching are upgraded, third-generation Beidou spacecraft, featuring improved positioning and timing instrumentation such as new atomic clocks, inter-satellite ranging links, and longer design lifetimes. This year's overall launch rate is also a record for China's space program, which has launched more missions into orbit than any other country in 2018.

*Source: Stephen Clark @ SpaceFlightNow.com*

*Photo Credit: CALT*



## Moroccan Spy Satellite Launched Aboard Vega Rocket



A Vega launcher lifted off Tuesday night from a spaceport at the edge of South America's Amazon rainforest, climbed into orbit on the power of four Italian- and Ukrainian-built rocket stages, and successfully deployed a French-built, Moroccan-owned military surveillance satellite nearly 400 miles above Earth. Morocco's second spy satellite, named Mohammed VI-B for the nation's king, rode the Vega launcher to orbit a little more than a year after an identical reconnaissance craft lifted off on a prior Vega flight. The Mohammed VI-B satellite's imaging capabilities are secret, but it carries an optical camera and image transmission system provided by Thales Alenia Space, which served as prime contractor for the mission under an agreement with the Moroccan government. Airbus Defense and Space provided the satellite bus, which was assembled in Toulouse, France.

Source: Stephen Clark @ SpaceFlightNow.com

Video Credit: Arianespace

## Long March 2D Sends 5 Satellites into Orbit

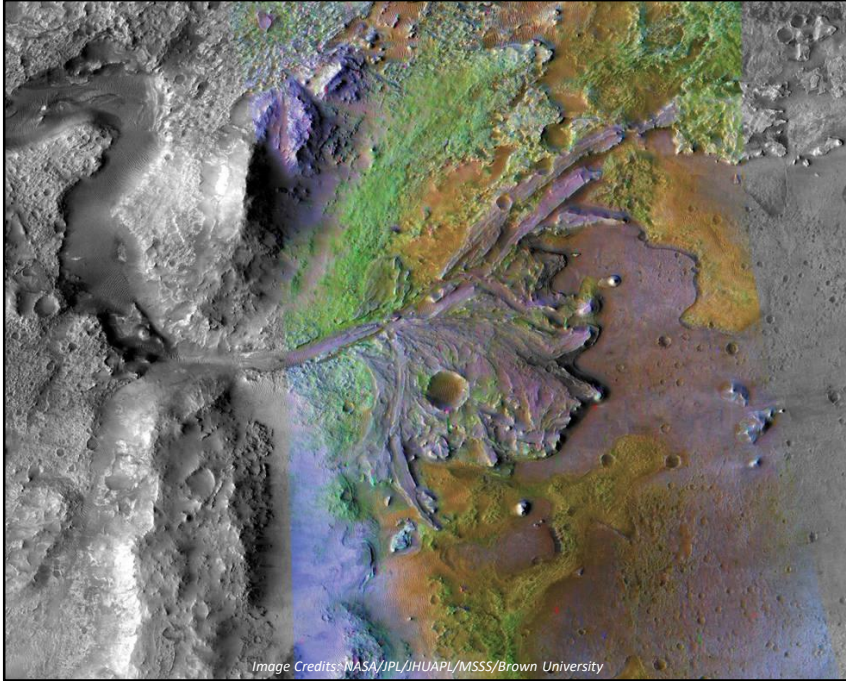


A Long March 2D rocket took to the skies early Tuesday, May 20<sup>th</sup> to orbit the Shiyang-6 Earth-observing spacecraft and four smaller satellites for China. The mission's goal was to deliver its satellite passengers into a low-Earth orbit (LEO). The identity of four other satellites that piggybacked on the mission has not yet been officially confirmed. Xinhua only reported that they are nanosatellites, not disclosing any details about them. Shiyang-6, however, is a space environment research satellite, which according to Xinhua will be employed for conducting space environment exploration experiments. The first satellite in the series, Shiyang-1, was launched in April 2004.

*Source: Tomasz Nowakowski @SpaceFlightInsider.com*

*Photo Credit: Xinhua*





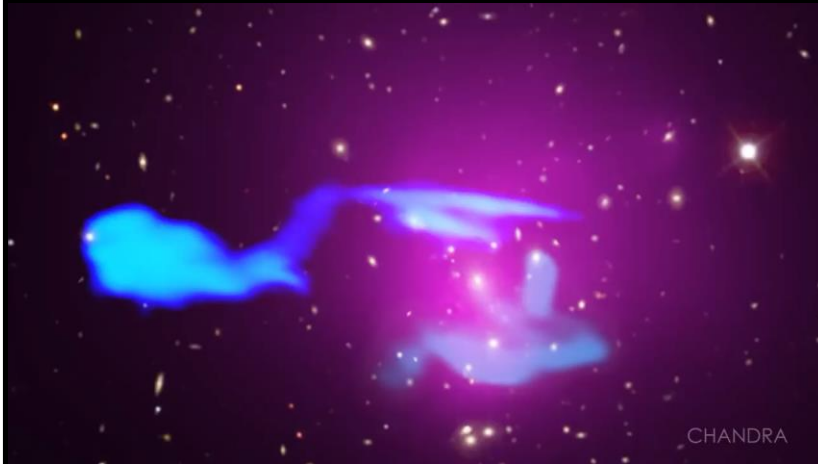
*Image Credits: NASA/JPL/JHUAPL/MSSS/Brown University*

## Landing Site for Mars 2020 Rover

NASA has chosen Jezero Crater as the landing site for its upcoming Mars 2020 rover mission after a five year search, during which every available detail of more than 60 candidate locations on the Red Planet was scrutinized and debated by the mission team and the planetary science community. The landing site in Jezero Crater offers geologically rich terrain, with landforms reaching as far back as 3.6 billion years old, that could potentially answer important questions in planetary evolution and astrobiology," said Thomas Zurbuchen, associate administrator for NASA's Science Mission Directorate. "Getting samples from this unique area will revolutionize how we think about Mars and its ability to harbor life."

*Source: NASA.gov*

## Abell 1033: To Boldly Go into Colliding Galaxy Clusters



A new image with data from NASA's Chandra X-ray Observatory may have science fiction fans doing a double take. This view of the galaxy cluster Abell 1033 combines X-rays from Chandra with radio emission from a network of telescopes in the Netherlands called LOFAR. The result is an image that bears an uncanny resemblance to the Starship Enterprise of the Star Trek franchise. In fact, Abell 1033 is the site of two merging clusters of galaxies, which are the largest structures in the Universe held together by gravity. Studies of Abell 1033 and other merging galaxy clusters help scientists better understand the physics that occurs when these cosmic giants collide.

*Video Credit: NASA/CXC*

*Source: NASA/CXC*

## Virgin Orbit 747 Makes First Captive-Carry Test Flight



*Video Credit: Virgin Orbit/FlightGlobal*

Virgin Orbit's modified Boeing 747-400 completed its first test flight on 19 November carrying the 21.4m (70ft) -long "LauncherOne" rocket attached to its port wing. The test by Richard Branson's small-satellite launch company was designed to prove the feasibility of using the ex-Virgin Atlantic 747 N744VG (ex- G-VWOW) to launch the two-stage rocket. The system uses the existing "fifth-pod" engine-pylon attachment points on the underside of the wing. This marks the start of a new phase in Virgin Orbit's 747 flight-test campaign, which will involve several more sorties - some with and some without a LauncherOne rocket attached. Further trials will conclude with a drop-test, during which a rocket will be released without igniting. Virgin Orbit expects its first space shot will be undertaken early next year.

*Source: FlightGlobal.com*

## First Ever Plane With No Moving Parts Takes Flight

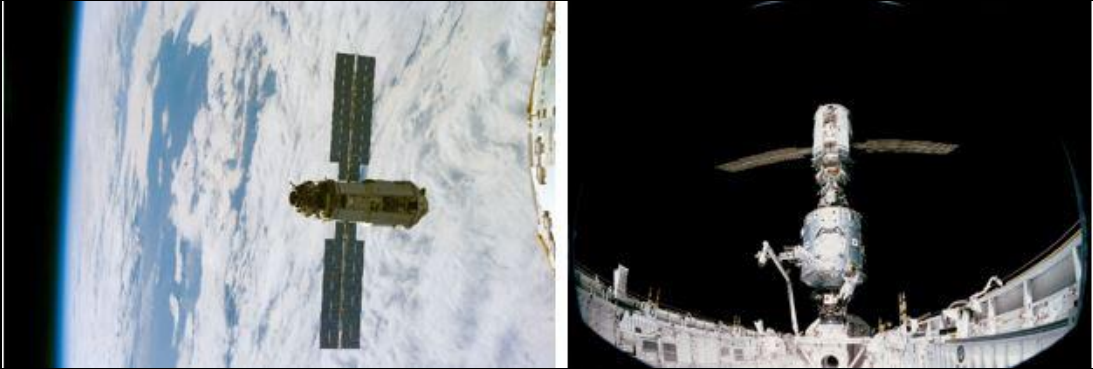


The first ever “solid state” plane, with no moving parts in its propulsion system, has successfully flown for a distance of 60 meters, proving that heavier-than-air flight is possible without jets or propellers. This is enough to induce “electron cascades”, ultimately charging air molecules near the wire. Those charged molecules then flow along the electrical field towards a second wire at the back of the wing, bumping into neutral air molecules on the way, and imparting energy to them. Those neutral air molecules then stream out of the back of the plane, providing thrust. The end result is a propulsion system that is entirely electrically powered, almost silent, and with a thrust-to-power ratio comparable to that achieved by conventional systems such as jet engines.

Source: Alex Hern @ theGuardian.com

Image Credit: MIT

## 20 Years Ago, Space Station Construction Begins



The largest and most complex international construction project in space began on the steppes of Kazakhstan 20 years ago today. Atop its Proton rocket, on Nov. 20, 1998, the Zarya Functional Cargo Block (FGB) thundered off its launch pad at the Baikonur Cosmodrome into cold wintry skies. On Dec. 4, Space Shuttle Endeavour on the STS-88 mission roared off Launch Complex 39A at Kennedy Space Center in Florida, carrying the Unity Node 1 module in its cargo bay. The STS-88 crew spent the several days making connections between the two modules before releasing the newly formed but still embryonic ISS. This marked the first step in the assembly of the ISS, which continued for 13 years. Zarya as seen from the approaching Space Shuttle Atlantis during the STS-88 mission is on the left. On the right, Zarya has been mated with Unity in the Shuttle's cargo bay and astronauts are outside making connections between the two modules.

*Source & Photo Credits: NASA*

## Boeing Completes Final Body Join For First 777-9



The airframe of the first Boeing 777-9 flight test aircraft has been completed in the company's Everett, Washington, facility marking a key milestone towards rollout and first flight of the initial 777X family variant in early 2019. At a length of 77m (252ft) from nose to tail, it is the longest passenger aircraft ever manufactured by Boeing. Five 777-9 airframes, four for flight testing and one for fatigue tests, are currently in various stages of assembly. All four 777-9 test aircraft are scheduled to be in the flight program by late 2019 with first deliveries due to begin around May 2020.

*Source: Guy Norris @ Aviation Daily*

*Photo Credit: Boeing*

## In The News



**First Airbus ACJ320neo Takes Flight.** The first Airbus ACJ320neo successfully completed a two-hour, 40-minute first flight from Hamburg, Germany, on Friday, beginning what is anticipated to be a short flight-test program. Derived from the certified A320neo airliner, the bizliner version differs with the inclusion of up to four extra center fuel tanks in the cargo hold for more range, as well as greater cabin pressure for better passenger comfort and built-in airstairs. (*Chad Trautvetter @AINonline.com*)



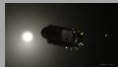
**Russia Working On 378-knot Compound Helicopter.** Russia's Kamov Design Bureau is working on a two-seat, 378-knot compound helicopter that features an integral delta wing and forward canards, coaxial rigid main rotors, stealth features, and an internal weapons bay. Forward high-speed thrust will be provided by a pair of aft-mounted fanjets that will also drive the main rotors via connected gearboxes. The design, if successful, would provide a substantial speed advantage—nearly 100 knots in some cases—over U.S. Army technology demonstration aircraft currently under development (*Mark Huber @AINonline.com*)



**First SpaceX Crew Dragon Test Flight Set For January.** NASA has set Jan. 7 as the date for the launch of the first commercial crew test flight, an uncrewed SpaceX Dragon spacecraft that will start a series of high-stakes missions over the next year. On that mission, the Crew Dragon spacecraft, also known as Dragon 2, will fly a mission to the International Space Station to test the vehicle's systems. It will be the first orbital flight for the vehicle, and will not carry astronauts. (*Jeff Foust @SpaceNews.com*)

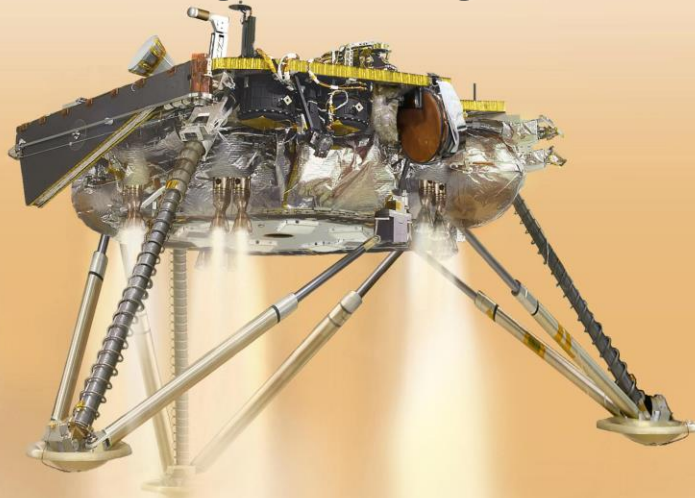


**NASA to Review Safety Cultures at Boeing & SpaceX.** NASA plans to carry out a review in the coming months of the safety practices at Boeing and SpaceX, an examination reportedly prompted by the actions of SpaceX founder Elon Musk. NASA did not explain why it decided to undertake the review at this advanced stage of development of Boeing's CST-100 Starliner or SpaceX's Crew Dragon. However, according to a report, the review was prompted by an interview Musk did earlier this year during which he briefly smoked marijuana (*Jeff Foust @SpaceNews.com*)



**Kepler Telescope Bids 'Goodnight' with Final Commands.** On the evening of Thursday, Nov. 15, NASA's Kepler space telescope received its final set of commands to disconnect communications with Earth. The "goodnight" commands finalize the spacecraft's transition into retirement, Kepler's "goodnight" falls on the same date as the 388-year anniversary of the death of its namesake, German astronomer Johannes Kepler, who discovered the laws of planetary motion and passed away on Nov. 15, 1630. (*NASA.gov*)

## NASA Mars InSight Landing Livestream



Monday, Nov. 26 from 11:00 AM to 12:30 PM  
Charles Simonyi Space Gallery

Commentary will be provided by Geoff Nunn, Adjunct Curator for Space History at The Museum of Flight

Image Credit: NASA/JPL-CalTech

It has been 6 years since the last successful Mar's landing when the Curiosity rover landed in 2012. If successful, InSight will be the 8<sup>th</sup> successful landing on Mars.

NASA's Livestream of the landing will be shown in the Charles Simonyi on Monday, Nov. 26 which will be narrated by the Museum of Flight's adjunct curator for space history, Geoff Nunn.

The objective of the InSight mission is to understand the evolutionary formation of rocky planets, including Earth, by investigating the interior structure and processes of Mars. InSight will also investigate the dynamics of Martian tectonic activity and meteorite impacts, which could offer clues about such phenomena on Earth.





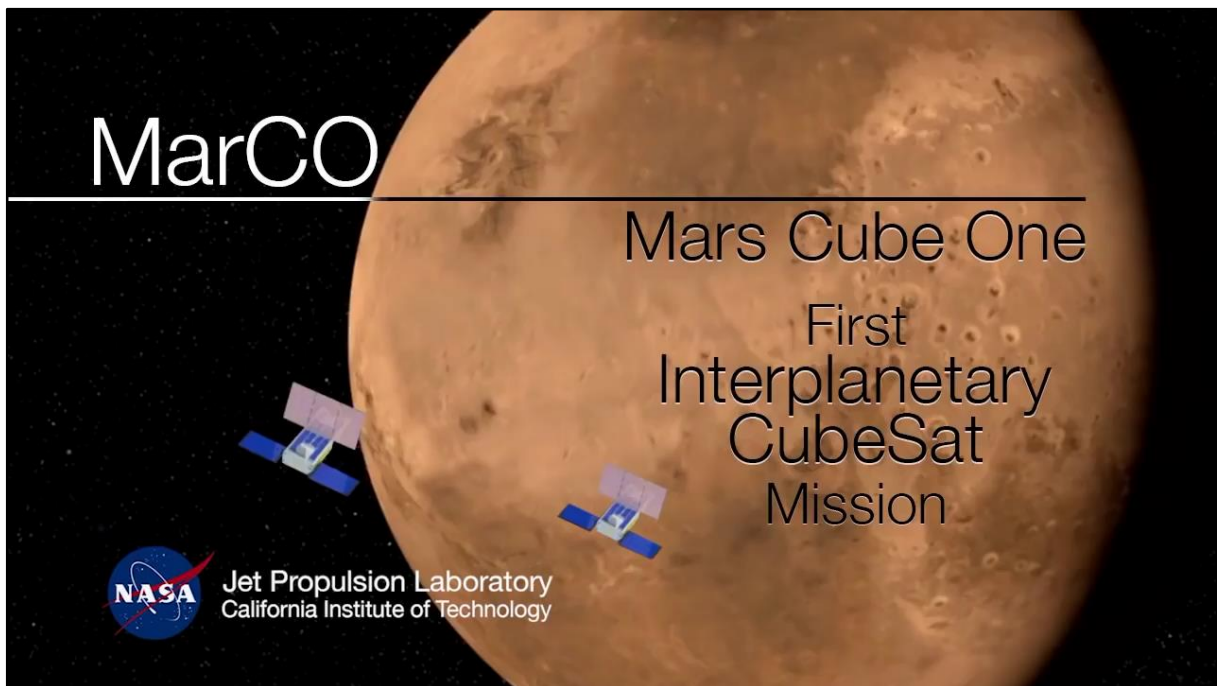
(<https://mars.nasa.gov/insight/timeline/launch/>)

Video Showing the launch of InSight atop an Atlas 5 Rocket from Vandenberg Air Force Base on the central coast of California on May 5, 2018

InSight is the first mission to another planet to leave Earth from Vandenberg Air Force Base. Missions to other planets normally launch from NASA's Kennedy Space Center and fly east, over water. That's because launching towards the east adds the momentum of Earth's eastward rotation to the launch vehicle's own thrust. But the Atlas V-401 is powerful enough to fly south towards the sea from Vandenberg Air Force Base. Besides, Vandenberg Air Force Base was more available at this time to accommodate InSight's five-week launch period.

The launch is only the beginning; the trip to Mars takes about six months.

The journey is about 301 million miles (485 million kilometers).



Launched along with INSIGHT were two cubesats, MarCO-A and MarCO-B.

1. MarCO is a pathfinder mission for small spacecraft technology

Two mini-spacecraft called Mars Cube One, or MarCO, have been flying on their own path to Mars behind InSight as a separate NASA technology experiment. MarCO is the first deep space mission for CubeSats, a class of briefcase-sized spacecraft that rely on miniaturized technology.

If the MarCOs make it to Mars, they will attempt to relay data from InSight as it enters the Martian atmosphere and lands. If successful, this could represent a new kind of communication capability to Earth.

2. The MarCOs already have made several big achievements.

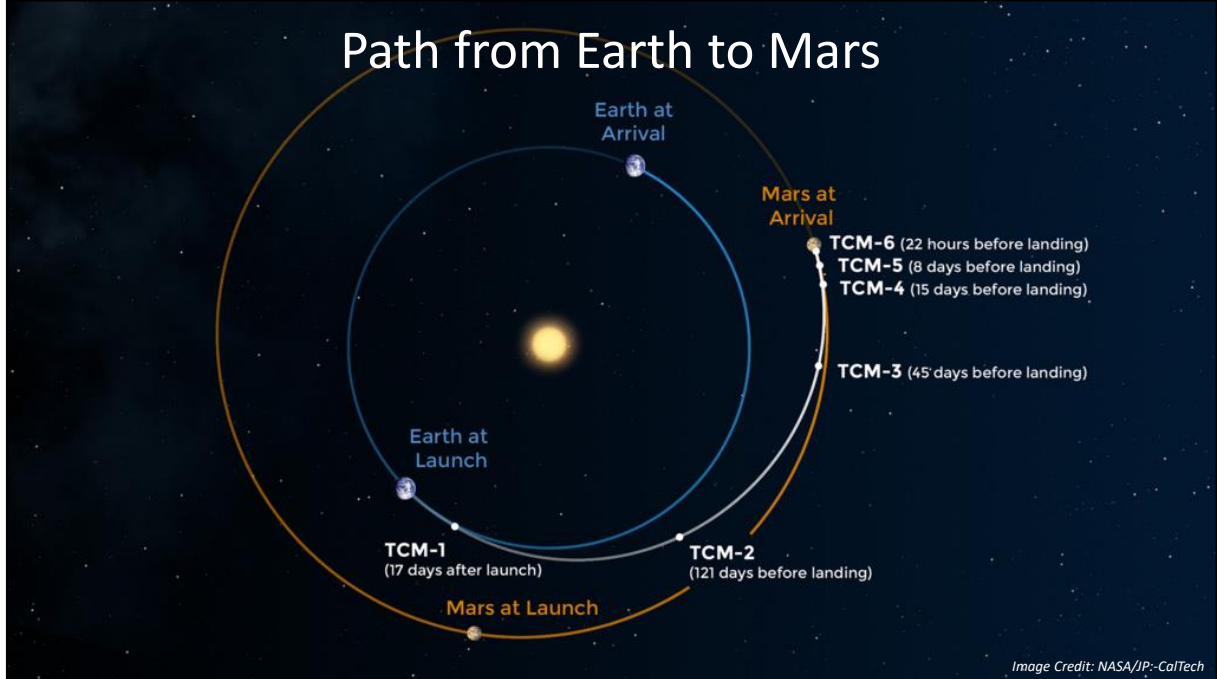
They have proved the feasibility of operating tiny spacecraft in deep space for the first time. The MarCOs have proved this class of spacecraft can survive

the deep-space environment, becoming the first CubeSats to provide images of Earth, its moon and Mars along the way. They've successfully tested

several experimental technologies, including their radios, high-gain antennas and propulsion systems. They became the first CubeSats to fly to deep space, performing the first trajectory correction maneuvers by CubeSats (each steering towards Mars).

3. InSight's success is independent of its CubeSat tag-alongs.

InSight and MarCO are separate missions. The MarCOs were never intended as the primary telecommunications relay for InSight during landing. NASA's Mars Reconnaissance Orbiter and 2001 Mars Odyssey orbiter have that primary responsibility.



(From <https://mars.nasa.gov/insight/timeline/cruise/>)

While InSight was on its way to Mars, it moved away from Earth at a speed of 6,200 miles per hour (10,000 kilometers per hour). Mission navigators tracked the spacecraft almost continuously since launch. The team adjusted InSight's flight path several times during cruise to make sure that it is flying at the right speed and direction. Six such adjustments were planned during the almost seven-month trip to Mars, as were two back-ups. The first adjustment to InSight's flight path was completed on May 22, 2018, just 17 days after launch.

InSight's flight path was planned to minimize its travel time. After its launch in May 2018, InSight traveled less than halfway around the sun before it reached Mars. In late July 2018, while InSight was on its way, Mars was at the point in its orbit where it was closest to Earth. This happens roughly every 26 months and is also known as [Mars Close Approach](#). This can sometimes be beneficial for Mars launches, and is one of the reasons why they are scheduled only every other year.



NASA video explaining the landing sequence

InSight spacecraft will enter the Martian atmosphere at supersonic speed, then hit the brakes to get to a soft, safe landing on the alien red plains.

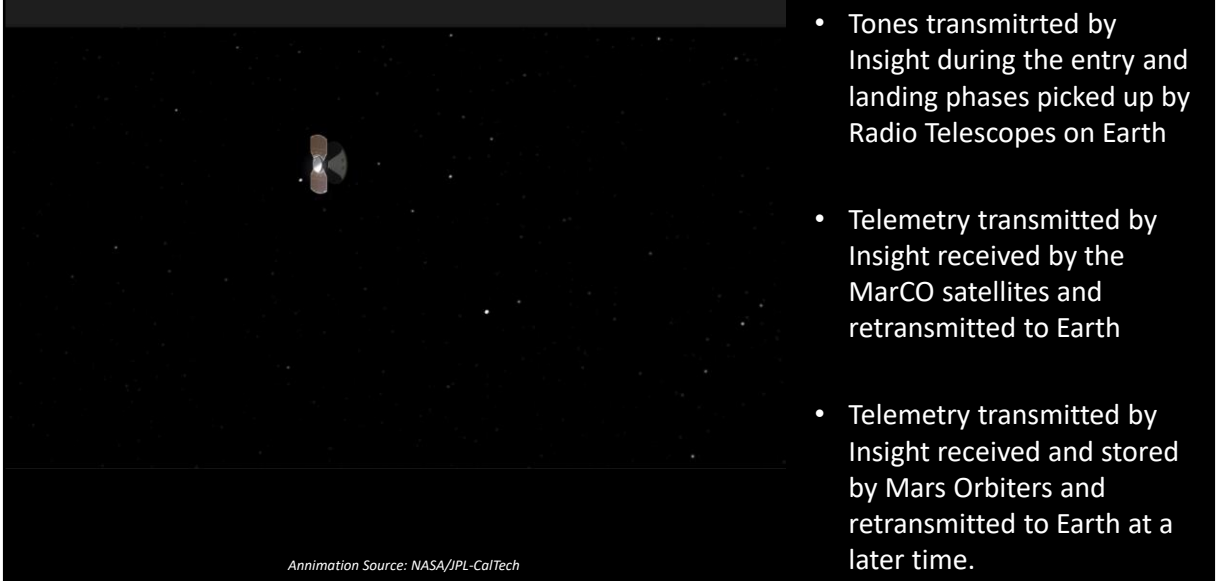
After micromanaging every step of the way, flight controllers will be powerless over what happens at the end of the road Monday, nearly 100 million miles (160 million kilometers) away. The communication lag between Mars and Earth is eight minutes.

"By the time we hear anything, the whole thing is already done," said project manager Tom Hoffman of NASA's Jet Propulsion Laboratory. "Either it happened or it hasn't happened."

Any small last-minute adjustments must be completed 1 ½ hours before touchdown, said Rob Grover, lead engineer for the landing team.

<https://phys.org/news/2018-11-mars-minutes-month.html#jCp>

# How NASA Will Know When InSight Touches Down



Animation Source: NASA/JPL-CalTech

- Tones transmitted by InSight during the entry and landing phases picked up by Radio Telescopes on Earth
- Telemetry transmitted by InSight received by the MarCO satellites and retransmitted to Earth
- Telemetry transmitted by InSight received and stored by Mars Orbiters and retransmitted to Earth at a later time.

## Radio Telescopes

As the InSight lander descends into Mars' atmosphere, it will broadcast simple radio signals called "tones" back to Earth. Engineers will be tuning in from two locations: the National Science Foundation's Green Bank Observatory in Green Bank, West Virginia and the Max Planck Institute for Radio Astronomy's facility at Effelsberg, Germany. Their results will be relayed to Mission Control at JPL and engineers at Lockheed Martin Space in Denver.

These tones don't reveal much information, but radio engineers can interpret them to track key events during InSight's entry, descent and landing (EDL). For example, when InSight deploys its parachute, a shift in velocity changes the frequency of the signal. This is caused by what's called the Doppler effect, which is the same thing that occurs when you hear a siren change in pitch as an ambulance goes by. Looking for signals like these will allow the team to know how InSight's EDL is progressing.

## Mars Cube One (MarCO)

Two briefcase-sized spacecraft are flying behind InSight and will attempt to relay its signals to Earth. Belonging to a class of spacecraft called CubeSats, the MarCOs are

being tested as a way for future missions to send home data during EDL.

The MarCOs are experimental technology. But if they work as they should, the pair will transmit the whole story of EDL as it's unfolding. That might include an image from InSight of the Martian surface right after the lander touches down.

### **InSight**

After it touches down, InSight will essentially yell, "I made it!" Seven minutes later, the spacecraft says it again - but a little louder and clearer.

The first time, it will communicate with a tone beacon that the radio telescopes will try to detect. The second time, it will send a "beep" from its more powerful X-band antenna, which should now be pointed at Earth. This beep includes slightly more information and is only heard if the spacecraft is in a healthy, functioning state. If NASA's Deep Space Network picks up this beep, it's a good sign that InSight survived landing. Engineers will need to wait until early evening to find out if the lander successfully deployed its solar arrays.

### **Mars Reconnaissance Orbiter (MRO)**

Besides the MarCO CubeSats, NASA's MRO will be soaring over Mars, recording InSight's data during descent.

MRO will hold on to the data it records during EDL as it disappears over the Martian horizon. When it comes back around from the other side, it will play back that data for engineers to study. By 3 p.m. PST (6 p.m. EST), they should be able to piece together MRO's recording of the landing.

MRO's recording is similar to an airplane's black box, which means that it could also prove important if InSight doesn't successfully touch down.

### **2001 Mars Odyssey**

NASA's longest-lived spacecraft at Mars will also relay data after InSight has touched down. Odyssey will relay the entire history of InSight's descent to Mars, as well as a couple images. It will also relay confirmation that InSight's solar arrays, which are vital to the spacecraft's survival, fully deployed. Engineers will have this data just before 5:30 p.m. PST (8:30 p.m. EST).

Odyssey will also serve as a data relay for InSight during surface operations, along with MRO, NASA's Mars Atmosphere and Volatile Evolution mission (MAVEN) and the European Space Agency's Trace Gas Orbiter.

## Elysium Planitia, The Landing Site

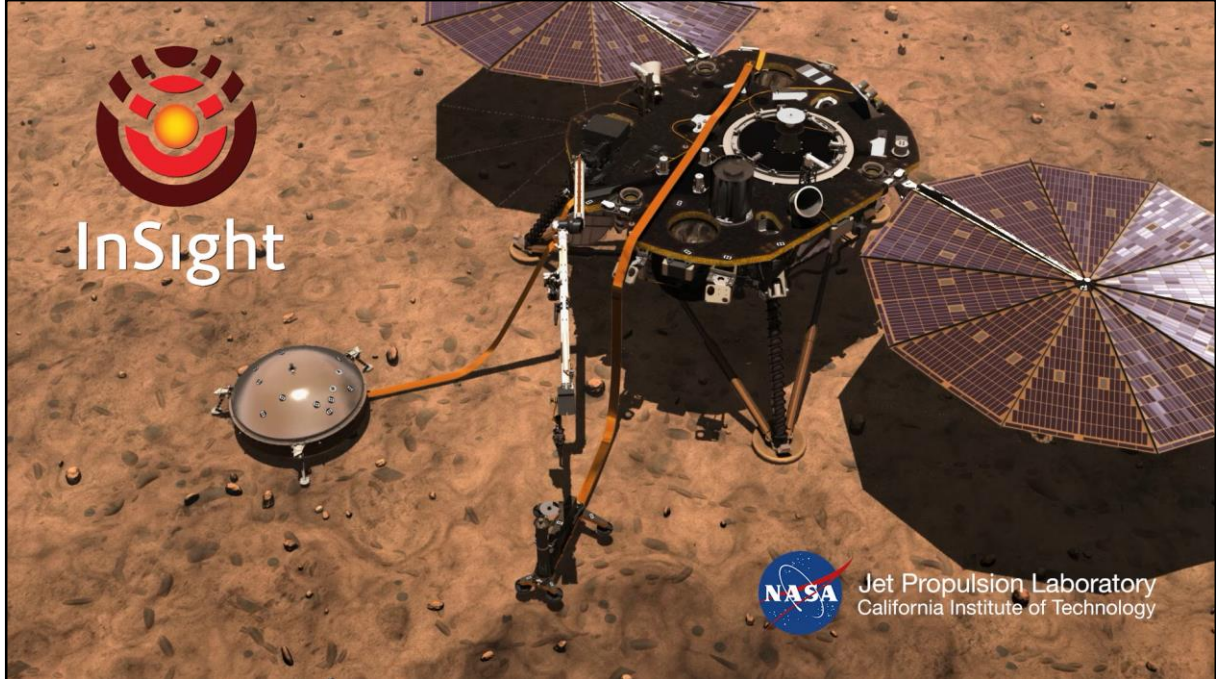


Artist's concept depicts the smooth, flat ground that dominates InSight's landing ellipse in the Elysium Planitia region of Mars.

Credits: NASA/JPL-Cd

Elysium Planitia is a 81-mile long, 17-mile-wide (130-kilometer-long, 27-kilometer-wide) landing ellipse on the western edge of a flat, smooth expanse of lava plain, a flat, non rocky parking lot which increases the odds of a successful landing. It is also near Mars's equator where the lander's solar array would have adequate sunlight to power its systems year-round. The ground at the landing site also needed to be penetrable by the 16-foot-long (5-meter) heat-flow probe. Of three potential landing sites, Elysium Planitia met all the requirements





NASA Video which explains how InSight will perform its science once on Mar's surface

After touching down in November, NASA's InSight spacecraft will spread its solar panels, unfold a robotic arm ... and stay put. Unlike the space agency's rovers, InSight is a lander designed to study an entire planet from just one spot.

This sedentary science allows InSight to detect geophysical signals deep below the Martian surface, including marsquakes and heat. Scientists will also be able to track radio signals from the stationary spacecraft, which vary based on the wobble in Mars' rotation. Understanding this wobble could help solve the mystery of whether the planet's core is solid.

The instruments aboard InSight which will allow this science are:

**SEIS (Seismic Experiment for Interior Structure)**

SEIS will measure seismic waves from marsquakes and meteorite strikes as they move through Mars. The speed of those waves changes depending on

the material they're traveling through, helping scientists deduce what the planet's interior is made of.

### **HP3 (Heat Flow and Physical Properties Package)**

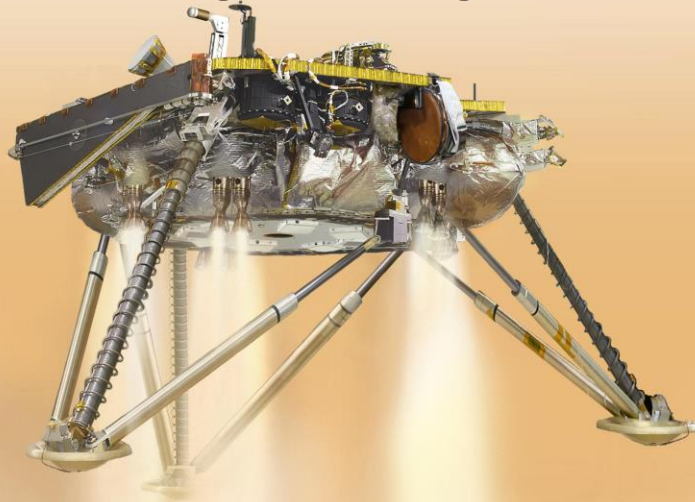
This unique instrument holds a spike attached to a long tether. A mechanism inside the spike will hammer it up to 16 feet (5 meters) underground, dragging out the tether, which is embedded with heat sensors.

At that depth, it can detect heat trapped inside Mars since the planet first formed. That heat shaped the surface with volcanoes, mountain ranges and valleys. It may even have determined where rivers ran early in Mars' history.

### **RISE (Rotation and Interior Structure Experiment)**

Two X-band antennas on InSight's deck whose radio signals will be measured over months, maybe even years, to study the tiny "wobble" in the rotation of the planet. That wobble is a sign of whether Mars' core is liquid or solid – a trait that could also shed light on the planet's thin magnetic field.

# NASA Mars Insight Landing Livestream



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*Image Credit: NASA/JPL-CalTech*