National Aeronautics and Space Administration
www.nasa.gov

Deep Space Network — Communications

The Deep Space Network (DSN) is a worldwide network of antennas developed by the National Aeronautics and Space Administration (NASA) to communicate with robotic spacecraft exploring the solar system and beyond. These spacecraft gather information about distant planets, moons, asteroids, comets, stars, and galaxies, sending extraordinary images to Earth during their long journeys into space. We are the first humans in history to experience and see, through robotic eyes and ears, these alien realms. Yet none of these adventures would be possible without the communications links provided by the DSN.

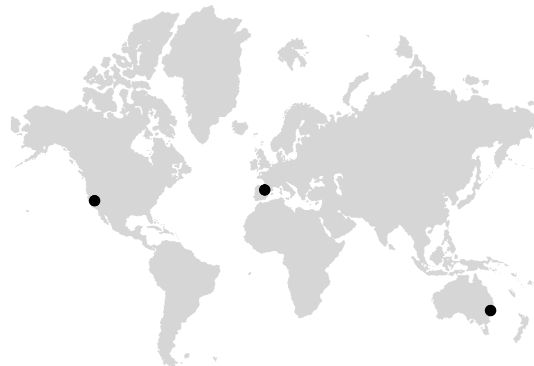
Capturing a Whisper from a Billion Kilometers

Deep space communications are very challenging because of the extreme distances between the spacecraft and Earth. Signals must travel millions or even billions of kilometers between Earth and a spacecraft in deep space. The spacecraft's communications equipment — designed to be small and lightweight — transmits at very low power, typically limited to 20 watts, about the same as a refrigerator light bulb. Signal power arriving at the antenna can be as weak as a billionth of a billionth of a watt — 20 billion times less than the power required for a digital wristwatch.

To "hear" the whisper of a signal from a spacecraft at planetary distances (known as downlink), receiving antennas on Earth must be very large and equipped with highly sensitive receivers. Large collectors (antenna dishes) with precisely shaped surfaces are crucial, and they must accurately point towards the spacecraft. The extremely sensitive receivers use amplifiers that are cooled to within a few degrees above absolute zero (minus 273 degrees C; minus 460 degrees F) to reduce the background noise generated by the electronic equipment.

During its mission, the spacecraft sends many kinds of data to Earth. One type reports on spacecraft health, advising mission operators about power levels and instrument functioning. The spacecraft also sends data gathered by its instruments, which measure atmospheric chemical composition, surface temperature, humidity, windspeed, and other characteristics. Images are taken by a special onboard camera, transformed into electrical signals by an encoder, then transmitted to Earth in the form of zeroes and ones, known as bits. When these signals are received on Earth, computers reconstruct them into the images originally "seen" by the spacecraft camera.

Photographs show two antenna sites at the Goldstone complex in the Mojave Desert in California. One site includes two 34-meter-diameter beam waveguide antennas, and the second site features a 70-meter-diameter antenna.

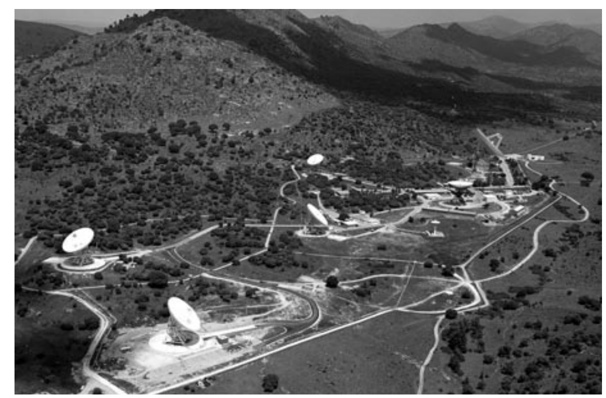


A map shows DSN Communications Complexes around the world.

Talking to the Spacecraft High-power transmitters send commands to the spacecraft to turn on computers, activate instruments, and make course corrections. By using information derived from the spacecraft's signal, we are able to determine the precise location and velocity of the spacecraft — this is vital data needed for navigation. Commands are sent, or uplinked, to correct the spacecraft's course or place it in orbit around a planet at the precise time for orbit insertion.

The Global Network To compensate for Earth's rotation, the DSN operates clusters of antennas at three locations around the globe — in California; near Canberra, Australia; and near Madrid, Spain. The spacecraft signals are received at one site; as Earth turns, the spacecraft "sets" at that site — like the Sun setting each evening — and the next site picks up the signal, then the third site, and on to the first again. With this configuration, a distant spacecraft is in view of one of the DSN Communications Complexes 24 hours a day, every day.

There are several different types of antennas at each DSN complex, ranging from 26 meters (85 feet) in diameter, used for tracking near-Earth spacecraft, to the largest — a 70-meter (230-foot) antenna used for tracking spacecraft at great distances and supporting critical events. The antennas most used for routine communications are the 34-meter (111-foot) beam waveguide antennas. The antennas typically offer different frequency and bandwidth options depending on the antenna diameter.



An aerial photograph shows the DSN Communications Complex near Madrid, Spain.

As NASA continues to explore the solar system, the need for expanded deep space communications increases. The DSN incorporates the most advanced telecommunications technology, while research into new methods continually improves the capability of receiving data and transmitting commands.

How to Get More Information The Jet Propulsion Laboratory, a division of the California Institute of Technology, manages the DSN for NASA. To learn more, visit our website at *deepspace.jpl.nasa.gov/dsn*

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