

NASA's Voyager team focuses on software patch, thrusters

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NASA's Voyager 1 spacecraft is depicted in this artist's concept traveling through interstellar space, or the space between stars, which it entered in 2012. Traveling on a different trajectory, its twin, Voyager 2, entered interstellar space in 2018. Credit: NASA/JPL-Caltech

Engineers for NASA's Voyager mission are taking steps to help make sure both spacecraft, launched in 1977, continue to explore interstellar space for years to come.

One effort addresses fuel residue that seems to be accumulating inside narrow tubes in some of the [thrusters](#) on the spacecraft. The thrusters are used to keep each spacecraft's antenna pointed at Earth. This type of buildup has been observed in a handful of other spacecraft.

The team is also uploading a [software patch](#) to prevent the recurrence of a glitch that arose on Voyager 1 last year. Engineers resolved the glitch, and the patch is intended to prevent the issue from occurring again in Voyager 1 or arising in its twin, Voyager 2.

Thruster buildup

The thrusters on Voyager 1 and Voyager 2 are primarily used to keep the spacecraft antennas pointed at Earth in order to communicate.

Spacecraft can rotate in three directions—up and down, to the left and right, and around the central axis, like a wheel. As they do this, the thrusters automatically fire and reorient the spacecraft to keep their antennas pointed at Earth.

Propellant flows to the thrusters via fuel lines and then passes through smaller lines inside the thrusters called propellant inlet tubes that are 25 times narrower than the external fuel lines. Each thruster firing adds tiny amounts of propellant residue, leading to gradual buildup of material over decades. In some of the propellant inlet tubes, the buildup is becoming significant. To slow that buildup, the mission has begun letting the two spacecraft rotate slightly farther in each direction before firing the thrusters. This will reduce the frequency of thruster firings.

The adjustments to the thruster rotation range were made by commands sent in September and October, and they allow the spacecraft to move almost 1 degree farther in each direction than in the past. The mission is also performing fewer, longer firings, which will further reduce the total number of firings done on each spacecraft.

The adjustments have been carefully devised to ensure minimal impact on the mission. While more rotating by the spacecraft could mean bits of science data are occasionally lost—akin to being on a [phone call](#) where the person on the other end cuts out occasionally—the team concluded the plan will enable the Voyagers to return more data over time.

Engineers can't know for sure when the thruster propellant inlet tubes will become completely clogged, but they expect that with these precautions, that won't happen for at least five more years, possibly much longer. The team can take additional steps in the coming years to extend the lifetime of the thrusters even more.

"This far into the mission, the engineering team is being faced with a lot of challenges for which we just don't have a playbook," said Linda Spilker, project scientist for the mission at NASA's Jet Propulsion Laboratory in Southern California. "But they continue to come up with creative solutions."

Patching things up

In 2022, the onboard computer that orients the Voyager 1 spacecraft with Earth began to send back garbled status reports, despite otherwise continuing to operate normally. It took [mission](#) engineers months to pinpoint the issue. The attitude articulation and control system (AACS) was misdirecting commands, writing them into the computer memory instead of carrying them out. One of those missed commands wound up garbling the AACS status report before it could reach engineers on the ground.

The team determined the AACS had entered into an incorrect mode; however, they couldn't determine the cause and thus aren't sure if the issue could arise again. The software patch should prevent that.

"This patch is like an [insurance policy](#) that will protect us in the future and help us keep these probes going as long as possible," said JPL's Suzanne Dodd, Voyager project manager. "These are the only spacecraft to ever operate in interstellar space, so the data they're sending back is uniquely valuable to our understanding of our local universe."

Voyager 1 and Voyager 2 have traveled more than 15 billion and 12 billion miles from Earth, respectively. At those distances, the patch instructions will take over 18 hours to travel to the spacecraft. Because of the spacecraft's age and the communication lag time, there's some risk the patch could overwrite essential code or have other unintended effects on the spacecraft.

To reduce those risks, the team has spent months writing, reviewing, and checking the code. As an added safety precaution, Voyager 2 will receive the patch first and serve as a testbed for its twin. Voyager 1 is farther from Earth than any other [spacecraft](#), making its data more valuable.

The team will upload the patch and do a readout of the AACS memory to make sure it's in the right place on Friday, Oct. 20. If no immediate issues arise, the team will issue a command on Saturday, Oct. 28, to see if the patch is operating as it should.

Provided by NASA

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