A million-mile service

NASA wants many of its space telescopes to orbit far from Earth. So how will they be repaired if they go wrong? Tony Reichhardt investigates.

If you keep the Sun at your back and head one-and-a-half-million kilometres away from Earth, you'll hit astronomy's most sought-after location. This unassuming spot, known as L2, is set to become home to eight new space telescopes over the next 15 years, and many more could follow.

L2 has obvious attractions. It is a lagrangian (or libration) point, which means that objects stationed there are held in a fixed position relative to Earth, as a result of the combined gravitational pull of the Sun and Earth. Ground-based antennas are always in sight, and the detectors, some of which require cooling, can more easily be protected from heat given off by Earth.

Placing telescopes at L2 could also boost NASA's plans for human space flights. Astronauts have repaired and upgraded the Hubble Space Telescope four times in the past decade. If NASA decides that astronauts should service the L2 telescopes, it will have to reinvent its human spaceflight programme, which hasn't ventured beyond Earth's orbit since the final Apollo lunar mission in 1972.

Some of the possibilities were discussed this week at the World Space Congress, held in Houston, Texas. One suggestion, developed over the past two years by a group of about 100 NASA scientists and engineers known as the NASA Exploration Team (NEXT), is to build an intermittently occupied astronaut outpost at a lagrangian point in the Earth–Moon system.

A station at this point, about three-quarters of the way to the Moon, would orbit Earth in sync with the Moon (see diagram, below). More importantly, moving the telescopes from L2 to this point and back again would require relatively little energy. Gary Martin, director of the Advanced Systems Office at NASA's Office of Space Flight in Washington, likens it to a ridge trail in the mountains. Stay on the trail, and you'll use far less energy than if you hike up and down.

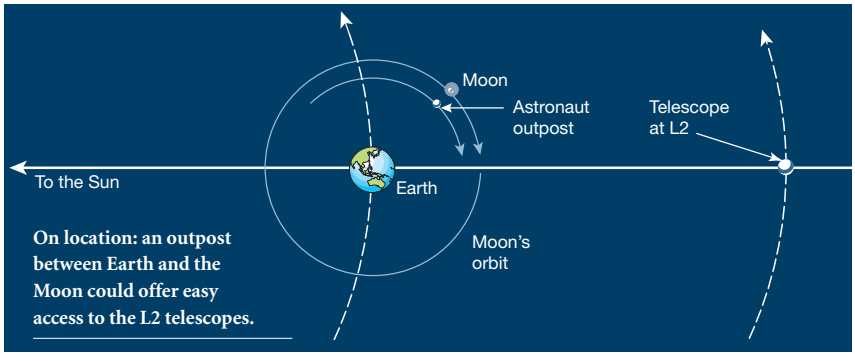
The plan has yet to be fully evaluated, but it would require expensive new technologies, including vehicles to ferry astronauts to and from the outpost, and a low-thrust propulsion system to move the telescopes. The outpost would, however, have other uses. Astronauts could be dispatched to the Moon from it, and it could also be a base from which to assemble and launch an expedition to Mars.

But if telescope servicing is the main aim, NASA could avoid building an outpost, says Robert Farquhar, a veteran space-mission designer at the Applied Physics Laboratory in Laurel, Maryland. Farquhar, who also presented his ideas in Houston, believes that the telescopes could be moved from L2 into a very high Earth orbit and serviced there.

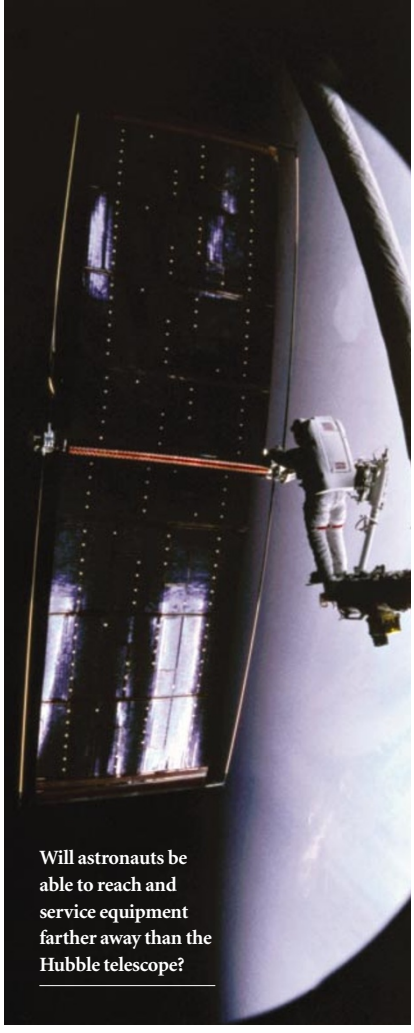
Safety catch

He and others say that direct missions to the L2 telescopes may also be possible. At distances greater than about 40,000 kilometres from Earth, the planet's magnetic field no longer protects astronauts from the dangerous charged particles emitted by the Sun and other sources. To play it safe, NASA would keep long-distance human missions as short as possible, although it has made radiation-protection research a priority on the International Space Station. Round trips to L2, which would take at least a month, could be possible if the agency solves this problem.

So will any of the first generation of L2 telescopes require human involvement? One, the Microwave Anisotropy Probe, designed to measure background levels of microwave radiation, is already in place. But like the others now on the drawing board, such as NASA's James Webb Space Telescope, the successor to Hubble (see *Nature* **419,** 235–236; 2002), it was not built to be serviced by astronauts.



On location: an outpost between Earth and the Moon could offer easy access to the L2 telescopes.



NASA

Will astronauts be able to reach and service equipment farther away than the Hubble telescope?

"There's nothing better than an astronaut in the loop," says Charles Beichman of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, chief scientist for the Terrestrial Planet Finder (TPF), an L2 telescope that should start hunting for Earth-size planets in the middle of the next decade. "But it will be a significant investment. We don't want to stop what we're doing while waiting for them."

The situation may have changed, however, by the time larger, more complex telescopes are ready to follow the TPF. The NEXT team, for example, is honing its plans by assessing the needs of the Dual Anamorphic Reflector Telescope, currently under study at JPL.

This large but lightweight infrared telescope is unlikely to be launched within the next 15 years. But if NASA does decide to use astronauts to service such telescopes, it would present a historic opportunity to align the agency's science and human spaceflight programmes, says Wesley Huntress, NASA's former associate administrator for space science who now directs the Carnegie Institution of Washington's Geophysical Laboratory. From Apollo onwards, astronaut missions have been dictated by space engineering capabilities and politics. If human telescope servicing is needed, says Huntress, scientists could find themselves setting the agenda. ■

Tony Reichhardt writes for *Nature* from Washington.