Robot garbage hunters are coming to clean up space

Tim Fernholz

https://qz.com/1984867/astroscales-robot-garbage-hunter-is-coming-for-space-junk/?utm_source=email&utm_medium=daily-brief&utm_content=74249b3f-8e78-11eb-9a0c-36b2db12825d

Picture it: The vacuum of space around the earth, the curve of the planet silhouetted against the inky blankness of the universe. Perhaps there's some Strauss playing. An orbiting satellite comes into view, its boxy body framed by solar panel wings stretching out on either side. Unfortunately, that satellite isn't alone. Years before, an abandoned Russian rocket body in orbit exploded after leaking propellants mixed together. Or an anti-satellite missile was tested, blowing up a spacecraft and scattering its parts around the planet. Or a satellite was cut free from its rocket with an explosive charge, tossing a single bolt into orbit. And as our satellite comes along, that bolt, or paint chip, or broken strut, is approaching at a spicy pace. Objects circling the earth move impossibly quickly—17,500 miles per hour (28,163 kph) is the headline number, but 5 miles per second might be easier to conceptualize.

More often than not, the junk and the spacecraft pass each other by. If they don't—if the satellite collides with that debris—the resulting damage could destroy hardware worth tens of millions of dollars. The odds are starting to shift. More satellites are being launched, with the number of active spacecraft expected to increase tenfold or more in coming years. More junk has been scattered by recent anti-satellite weapons tests, and, in 2009, by the first collision between an operational spacecraft and a defunct one. And each new collision increases the amount of debris in orbit, which NASA currently estimates to weigh more than 8,000 metric tons, and consist of more than 500,000 pieces larger than a centimeter in diameter. This proliferation is, in part, caused by businesses champing at the bit to earn more money in orbit by launching ever more satellites. And now, an industry is emerging to stop space junk by fixing or removing dying satellites before they become part of the problem.

Astroscale's plan to help satellites end their lives

One of those companies is Astroscale, a firm founded in Japan in 2013 by CEO Nobu Okada, with offices in the US and the UK. It is about to perform its first major test to show this is possible. On March 22, the company launched a 200 kg spacecraft on a Russian Soyuz rocket. It is called ELSA-d, for End of Life Services by Astroscale-demonstration. All satellites eventually stop working. Their batteries lose the ability to recharge, propellants run out, they are struck by orbital debris, or like any machine, they just break.Satellites flying in low-earth orbit within 2,000 miles of earth, the busiest area around the planet, will eventually be pulled into the atmosphere by gravity. Current international standards require these satellites be designed to burn up in 25 years—but it's increasingly clear that isn't fast enough to lower the risk of collision. Even five years, the voluntary standard adopted by many satellite operators, might

prove too long to prevent risky congestion. Enter Astroscale: When a satellite's life is over, Astroscale would like satellite operators to pay it to send a spacecraft to zip up, snag the defunct satellite, and tow it down to a lower orbit where it will burn up even more quickly. To prove it can be done, Elsa-D is two spacecraft in one. In space, it will release a target satellite with a special magnetic plate attached, and maneuver to snag it. Then, it will release the target again, but this time in a spin, since damaged satellites can wind up tumbling through space. If it can snatch the tumbling satellite, the final demonstration will involve maneuvering around the target and inspecting it with sensors.

https://youtu.be/HCWxdK7l0hI

None of this is simple—it requires sophisticated sensors, software that can react in real time, and finely tuned robotics and propulsion systems.

A brief history of in-space servicing

ELSA-d is among the first private spacecraft to assist another in orbit, in large part because most satellites aren't designed for it. Getting up to space is so expensive and risky that engineers don't count on the ability to re-fuel or perform repairs—everything is built to last. "The International Space Station and Hubble are really two notable exceptions to the general rule that the vast majority of spacecraft are optimized for assembly, integration, testing on the ground—never to be accessed or visited or modified in space," Ben Reed, the former lead of in-space servicing research at NASA's Goddard Space Center, told Quartz last year. That presents a big problem: The astronauts who repair the ISS or the Hubble space telescope are able to improvise in ways that robots can't—on the final mission to repair Hubble's spectrograph in 2009, an astronaut had to use brute force to remove a handle after one of the bolts holding it in place was stripped.

Still, robots can work with uncooperative targets. Last year, Northrop Grumman demonstrated a spacecraft it calls the Mission Extension Vehicle, or MEV. Its target was a 19-year-old Intelsat communications satellite, running out of fuel and expected to lose the ability to keep itself in the right place. The MEV was able to fly to the satellite and insert a docking probe into an unused engine port, snagging it. Now, the MEV can use its own engines to keep the satellite in the right place for another five years—a significant financial benefit for Intelsat, which paid more than $120 million to build that satellite in 1999, and now will be able to delay replacing it. Intelsat has hired Northrop to use a second MEV to extend the life of another satellite, with docking expected in the weeks ahead.

The future of satellites is repair-ready

Wrangling uncooperative satellites into position using the MEV model, for all its benefits, it still very expensive: It requires a dedicated spacecraft, rather than a more cost-effective vehicle that could service one spacecraft before moving on to the next. NASA is developing a mission called OSAM-1 with that idea in mind. It expects to demonstrate a number of space servicing

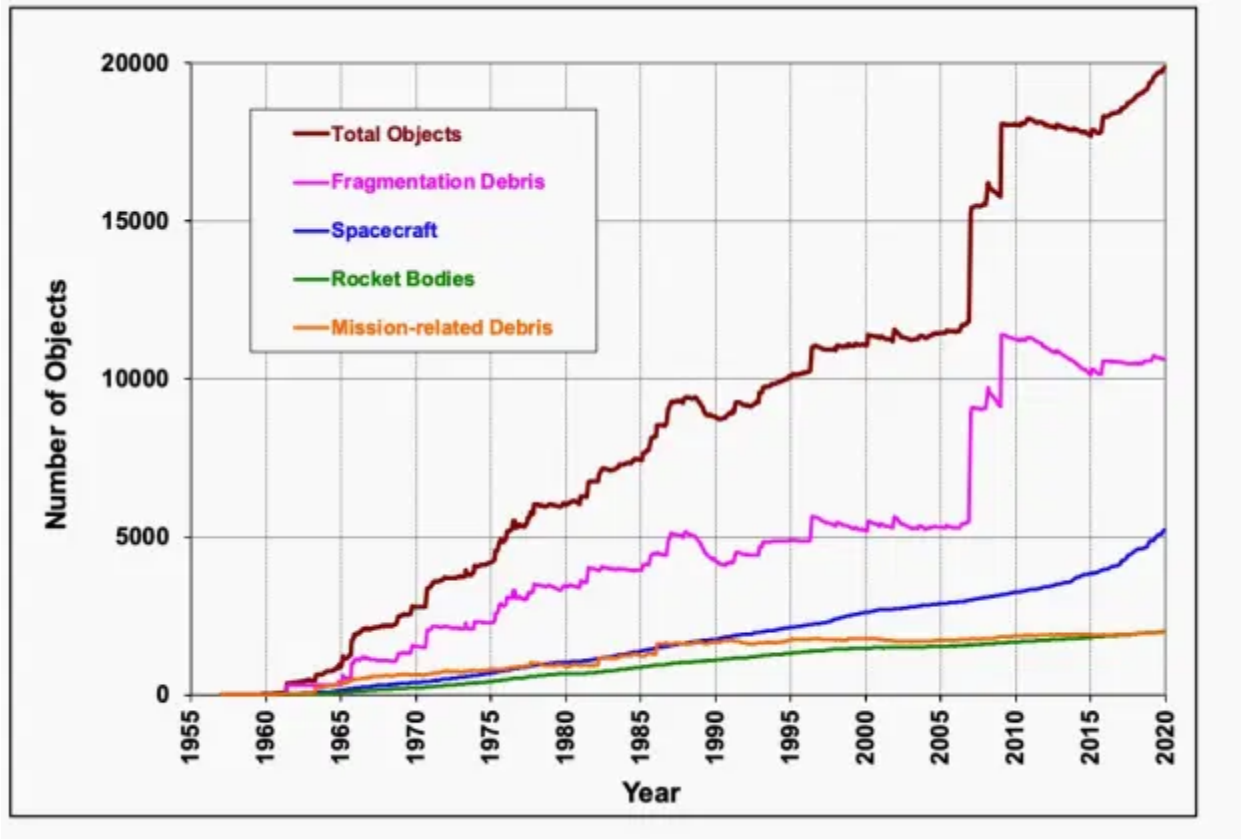
technologies in a mission after 2024, including refueling Landsat-7, a US earth-imaging satellite launched in 1999. Landsat-7 wasn't designed for an orbital top-off. The NASA spacecraft will need to use robotic tools to cut away thermal shielding and remove metal wires that secure a cap on the fuel valve, deploy a refueling tool to pump in new propellant, then attempt to close everything back up again so the satellite can continue on its way.

This kind of technology will be necessary for cleaning up older junk in orbit, from dead satellites to discarded rockets. Making things easier in the future requires satellite designers to design their vehicles with features like accessible compartments and refueling ports. Lockheed Martin said in February that it would design its next generation of GPS satellites to be serviced, but that choice is an outlier. "It's kind of chicken and egg," NASA's Reed says. "There is no servicer for the masses. Why would anyone design their satellite to be serviceable if there is no servicer?"

Space safety advocates want to start with something as simple as a sticker—a standardized decal with symbols that can become an optical target for an approaching satellite, without adding much mass."The hardest part of the mission is autonomous rendezvous and grapple—the phase in time where we are a couple of meters away from another free floating object, and by the way, it doesn't have a grapple fixture, we need to grab it somewhere that doesn't break it, there are no beacons or LEDs or retroreflectors," Reed says. In contrast, Spacecraft arriving at the ISS find pre-placed reflecting targets on the space station to accurately determine how far away they are and how fast they are approaching. Astroscale's pitch is one step further: It hopes that satellite operators will use similar symbols, but on a magnetized metal plate that makes grappling simpler. OneWeb, a company that is building a massive satellite constellation in low-earth orbit, has said it will attach similar fixtures to all its spacecraft.

A government mandate for sustainability?

"I'll pay by the ton if they can remove debris," general David Thompson, a top commander in the US Space Force, told reporters last week when asked if the government should pay companies to remove debris from orbit. That may be the path for space servicing to become a real business, and avoid the chicken-and-egg problem of who will invest first in expensive technology whose very real benefits can be seen as diffuse. Astroscale and other companies making that investment hope that governments will push satellite operators to develop higher standards, but also become path-finding customers, as they have in satellite launch, human spaceflight, and now lunar exploration. "We know that sustainability in orbit is big business," Charity Weeden, Astroscale's head of public policy, told Quartz. "It opens up the door to accessing on-orbit services—tow-trucks, fuel stations, machine shops, and more. It allows operators choice and flexibility, continuity of service, and certainty against incoming regulatory requirements. It helps protect your investment and in doing so, protect the orbital environment."



White House Office of Science and Technology Policy
Growth in orbital objects over time by object type.

Getting there, however, won't be easy, with turf wars over who will make these decisions and how ongoing within national governments and global institutions alike. "I don't see it as a linear path, unfortunately," Weeden warns, but takes heart that never before have so many different NGOs, trade groups, and governments been engaged in debating the right way to deal with space debris. That conversation, however, will be driven by what technologists can prove is possible—which is why Elsa-D and similar public and private sector missions are so important "We're in the space of all these dialogues, because we are both a proponent for policies and advancing regulatory structure, but also doing something about it," Weeden says. "There's a lot of talk, but there's not a lot of action. We are opening up the action case."