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SPACE

Satellite collisions are a disaster waiting to happen, experts warn

With satellites old and new orbiting alongside each other, serious crashes are inevitable

In the first half of 2024, satellites belonging to SpaceX's Starlink fleet performed almost 50,000 collision-avoidance manoeuvres. This reflects the number of satellites orbiting Earth and raises fears about satellite collisions if we continue to launch more in an unchecked fashion. Considering how much of our telecommunications and navigation now comes from space, not to mention the observation data that informs us about climate change, fears of a catastrophic crash – triggering a loss of such essential services – are understandable.

But according to Andy Lawrence, Regius Professor of Astronomy at University of Edinburgh, it's more insidious than that. "This idea that eventually there will be some sort of catastrophe is not quite →

DISCOVERIES



With more satellites in orbit, there are more chances of collisions

RIGHT Satellite collisions can produce thousands of pieces of debris that litter orbital space around Earth

→ right. It's more like the infamous 'boiling the frog' problem," he says.

Essentially, the idea is that if a frog were dropped into boiling water, it would instantly leap out. But if it were placed into cold water to which heat was gradually applied, it wouldn't perceive the danger and be boiled alive. "It's exactly like climate change. You know it's getting gradually worse, but where do you say 'stop', and how do you manage to make it stop?" says Lawrence.

To circle the Earth, a satellite has to move at a minimum of 7.8km/s (4.8 miles/s). At this velocity, collisions would release an enormous amount of energy, shattering the spacecraft involved and producing large clouds of debris that could destroy other satellites.

Such crashes have already been happening: in 2009, the functioning US satellite Iridium 33 and the inoperable Russian Cosmos 2251 collided at 11.7km/s (7.3 miles/s), producing more than 2,000 pieces of trackable debris and many smaller pieces.

There are now more than 13,000 satellites in orbit, of which around 10,000 are functioning. In January 2023, the decommissioned US/UK/Netherlands' IRAS (Infrared Astronomical Satellite) space telescope came within 15–30m (49–98ft) of America's Gravity Gradient Stabilization Experiment (GGSE-4) satellite, which has been inoperable since 1972. A month later, NASA's scientific TIMED (Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics) satellite passed just



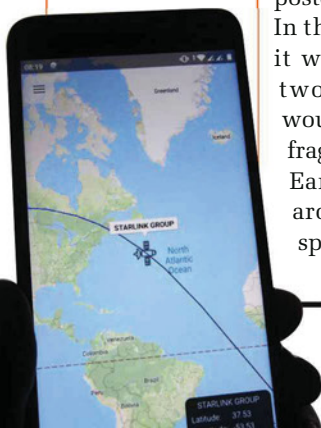
"It's exactly like climate change. You know it's getting gradually worse, but where do you say 'stop'?"

10–20m (33–66ft) from a defunct Russian satellite, Cosmos 2221. Although functioning, TIMED is a non-maneuvrable spacecraft, meaning that operators on Earth could simply watch and hope.

Commenting on the conjunction, as these close passes are called, the space tracking company LeoLabs posted on X: "Too close for comfort." In the subsequent message thread, it was pointed out that if these two satellites had collided, it would have produced 2,000–7,000 fragments big enough to track from Earth. Since there are currently around 12,000 pieces of trackable space debris, such an event would

have significantly added to it. While Lawrence doesn't believe a single catastrophic event is what will happen, he says one day a collision could take out something important to many people. "If suddenly you can't see the Super Bowl game, or an important military asset gets damaged, people will realise something's got to be done."

Satellites have been a feature of our world since 1957 when the Soviet Union launched Sputnik 1 to the astonishment of all. But the huge increase in the number of satellites in orbit in recent years means the risk of these fast-moving objects colliding has never been higher.





The dramatic rise in satellites has been driven by companies seeking to establish space-based internet services. To provide acceptable response times, the satellites have to be in low-Earth orbits, where they speed around the world every 90 minutes. So, to ensure unbreakable coverage and sufficient bandwidth, hundreds, thousands, if not tens of thousands of satellites are needed.

Starlink is the largest of the satellite constellations, having placed more than 7,000 satellites in orbit since 2019. To lower the risk of collisions, its satellites are manoeuvrable: onboard software executes a manoeuvre if it calculates

TOP Thousands of satellites are crowding the night sky

ABOVE Sputnik 1, launched by the Soviet Union in 1957, was the first satellite to orbit Earth

the probability of a collision is higher than 1 in 100,000. This is helpful, but some experts worry that the increasing number of satellites will overwhelm the software's ability to cope. (Starlink did not respond to *BBC Science Focus*'s requests for comment on this.)

In 2023, Dr Jonathan McDowell, an astrophysicist at the Harvard-Smithsonian Center for Astrophysics, expressed this concern to the news website *space.com*, saying "we are operating at the edge of what is safe."

And it's not just orbital space that could be at risk from the increasing number of satellites. In an early effort to combat space junk, a decade or two ago NASA and ESA issued guidelines saying that at the end of a satellite's working life or after 25 years (whichever comes sooner) an operator must remove it. Mostly this means burning it up in Earth's atmosphere, but this could just be shifting the problem.

"You're filling the atmosphere with aluminium and nitrous oxide, so it's about atmospheric pollution as well," says Lawrence.

In April, NASA confirmed that a piece of discarded cargo from the International Space Station had survived re-entry and fallen to Earth, leaving a large hole in the ceiling and floor of a Florida house. Thankfully no one was hurt.

Obscuring our view of the Universe

As the number of satellites around Earth grows, so does the interference that astronomers experience when studying the sky. At visual wavelengths, satellites can leave streaks across images.

At radio wavelengths, satellites can emit signals that drown out the precious whispers from the distant Universe.

"As we industrialise space, which is a good thing, there will be challenges to astronomy," Prof Brian Cox recently told *BBC Science Focus*. "How you balance those things is the challenge in the next decades." (Read more from Prof Cox on p66).

A study with the LOFAR (Low Frequency Array) radio telescope, below, in the Netherlands showed that the most recent V2-mini Starlink satellites emit unintended radio waves that are up to 32 times brighter than the previous generation. That's 10 million times brighter than the faintest objects that LOFAR is capable of detecting.

