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Space

Starlink's year of near misses

SpaceX's mega-constellation is having to perform a huge number of manoeuvres to prevent a collision in Earth orbit, discovers **Jonathan O'Callaghan**

A REPORT filed by SpaceX with the US Federal Communications Commission (FCC) in late December reveals some startling information – including that the firm's Starlink satellites had to perform about 300,000 collision-avoidance manoeuvres in 2025.

Starlink is a mega-constellation of satellites that beams the internet to the ground. The first Starlink satellites were launched in 2019; they now number about 9400, accounting for 65 per cent of all active satellites in orbit.

The FCC requires SpaceX to publish an update every six months on Starlink's approach to safety, given that two satellites could produce thousands of pieces of debris if they were to collide, potentially rendering parts of Earth's orbit unusable.

In its latest report, filed on 31 December, SpaceX said that its Starlink satellites performed about 149,000 collision-avoidance manoeuvres from June to November 2025. Such manoeuvres are performed when two satellites are deemed to be passing too close to each other and have a reasonable risk of collision.

DON PETTIT/NASA

Starlink satellite trails (small, horizontal flashes in the middle), seen from the ISS

300,000

How many collision-avoidance manoeuvres Starlink satellites performed in 2025

The industry standard is to manoeuvre when there is a 1 in 10,000 risk of collision, but SpaceX is more conservative and manoeuvres at a risk of 3 in 10 million.

In addition to the 144,000 manoeuvres previously reported by SpaceX from December 2024 to May 2025, this amounts to about 300,000 in 2025, an increase of about 50 per cent from 200,000 manoeuvres in 2024. "That's a huge amount of manoeuvres," says Hugh Lewis at the University of Birmingham, UK.

Most other satellite operators in the US and abroad don't publish their manoeuvre figures, but a typical satellite pre-Starlink might have performed a handful of manoeuvres a year. Per SpaceX's figures, it is performing up to 40 manoeuvres per year, per satellite.

Lewis says the company is on track to perform 1 million manoeuvres every year by 2027, with several other mega-constellations in the US and China also being deployed – meaning the number of potential collisions is going to grow. "We are moving ourselves towards a pretty bad scenario in orbit. It is not sustainable," says Lewis.

In its latest report, SpaceX also revealed, for the first time, repeated encounters with other satellites. It singled out a Chinese satellite called Honghu-2 as having more than 1000 close approaches with its Starlink satellites, probably because they operate in similar orbits.

"It highlights how SpaceX really owns that orbit," says Samantha Lawler at the University of Regina in Canada, with most of its Starlink satellites operating at an altitude of between 340 and 570 kilometres.

Starlink uses an autonomous system to dodge collisions and cope with the huge number of manoeuvres required. However, SpaceX said it had one incident in which a spacecraft operated by Japanese company Astroscale "performed an unannounced manoeuvre", which could have raised the risk of collision with a Starlink satellite.

A spokesperson for Astroscale said the company publicly shared the planned manoeuvre ahead of time and it was "conducted in compliance with Japanese on-orbit servicing guidelines". SpaceX didn't respond to a request for comment.

However, it is the overall number of manoeuvres that is the most eye-catching statistic. "They're doing all these manoeuvres and they're doing them perfectly," says Lawler. "But if they make a mistake, we're in really big trouble." ▮

Satellites could use magnetic fields to avoid collisions

One way to avoid satellite collisions (see main story) could be by harnessing magnetic fields.

Electromagnetic formation flying (EMFF) is an approach that relies on renewable power sources, such as solar panels, to power electromagnetic coils on board satellites. These generate a magnetic field that, through interaction with similar magnetic fields generated on any nearby satellite, can theoretically be used to manoeuvre the spacecraft.

But the magnetic field generated by a satellite doesn't interfere with just one nearby satellite but all the satellites around it, making it tricky to move more than two nearby satellites in a controlled way.

A team of researchers at the University of Kentucky has tried a different approach, called alternating magnetic field forces (AMFF), which uses unique interaction frequencies so that two satellites can communicate and coordinate their movement on one frequency while simultaneously communicating with other nearby satellites on different frequencies (arxiv, doi.org/qn22).

The AMFF concept was successfully tested on three satellites on Earth, but scaling it up might be tricky. "It's not something that applies at a constellation level," says Ray Sedwick at the University of Maryland. Chris Stokel-Walker