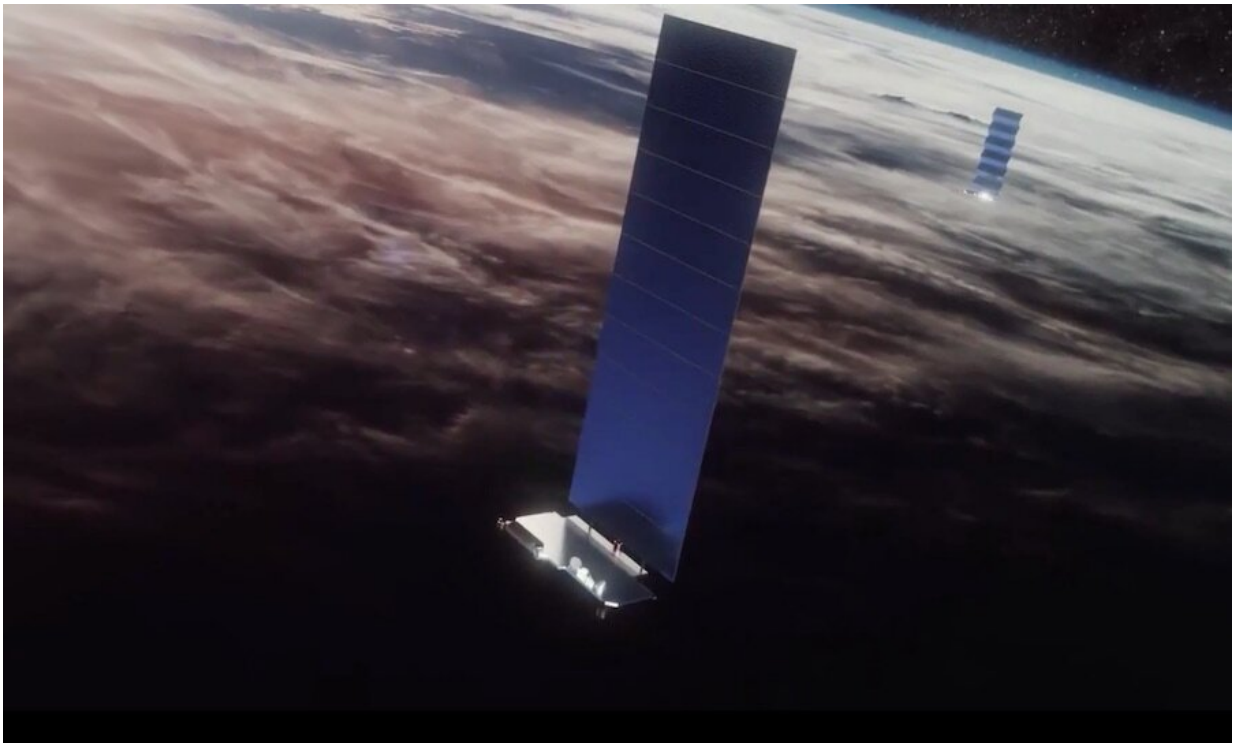
About 3% of Starlink satellites have failed so far

October 26 2020, by Matt Williams



Credit: SpaceX

SpaceX has drawn plenty of praise and criticism with the creation of Starlink, a constellation that will one day provide broadband internet access to the entire world. To date, the company has launched over 800 satellites and (as of this summer) is producing them at a rate of about 120 a month. There are even plans to have a constellation of 42,000

satellites in orbit before the decade is out.

However, there have been some problems along the way, as well. Aside from the usual concerns about light pollution and radio frequency interference (RFI), there is also the rate of failure these satellites have experienced. Specifically, about 3% of its satellites have proven to be unresponsive and are no longer maneuvering in orbit, which could prove hazardous to other satellites and spacecraft in orbit.

In order to prevent collisions in orbit, SpaceX equips its satellites with krypton Hall-effect thrusters (ion engines) to raise their orbit, maneuver in space and deorbit at the end of their lives. However, according to two recent notices SpaceX issued to the Federal Communications Commission (FCC) over the summer (mid-May and late June), several of their satellites have lost maneuvering capability since they were deployed.

Unfortunately, the company did not provide enough information to indicate which of their satellites were affected. For this reason, astrophysicist Jonathan McDowell of the Harvard-Smithsonian Center for Astrophysics (CfA) and the Chandra X-ray Center presented his own analysis of the satellites' orbital behavior to suggest which satellites have failed.

The analysis was posted on McDowell's website (Jonathan's Space Report), where he combined SpaceX's own data with U.S. government sources. From this, he determined that about 3% of satellites in the constellation have failed because they are no longer responding to commands. Naturally, some level of attrition is inevitable, and 3% is relatively low as failure rates go.

But every satellite that is incapable of maneuvering due to problems with its communications or its propulsion system creates a collision hazard

for other satellites and spacecraft. As McDowell told *Business Insider*:

Artist's impression of the orbital debris problem. Credit: UC3M

"I would say their failure rate is not egregious. It's not worse than anybody else's failure rates. The concern is that even a normal failure rate in such a huge constellation is going to end up with a lot of bad space junk."

Kessler syndrome

Named after NASA scientists Donald J. Kessler, who first proposed it in 1978, Kessler syndrome refers to the threat posed by collisions in orbit. These lead to catastrophic breakups that create more debris that will lead

to further collisions and breakups, and so on. When one takes into account rates of failure and SpaceX's long-term plans for a "megaconstellation," this syndrome naturally rears its ugly head.

Not long ago, SpaceX secured permission from the Federal Communications Commission (FCC) to deploy about 12,000 Starlink satellites to orbits ranging from 328 km to 580 km (200 to 360 mi). However, more recent filings with the International Telecommunications Union (ITU) show that the company hopes to create a megaconstellation of as many as 42,000 satellites.

In this case, a 3% failure rate works out to 360 and 1,260 (respectively) 250 kg (550 lbs) satellites becoming defunct over time. As of February of 2020, according to the ESA's Space Debris Office (SDO), there are currently 5,500 satellites in orbit of Earth—around 2,300 of which are still operational. That means (employing naked math) that a full Starlink megaconstellation would increase the number of non-functioning satellites in orbit by 11% to 40%.

The problem of debris and collisions looks even more threatening when you consider the amount of debris in orbit. Beyond non-functioning satellites, the SDO also estimates that there are currently 34,000 objects in orbit measuring more than 10 cm (~4 inches) in diameter, 900,000 objects between 1 cm to 10 cm (0.4 to 4 in), and 128 million objects between 1 mm to 1 cm.

Mitigation Strategies

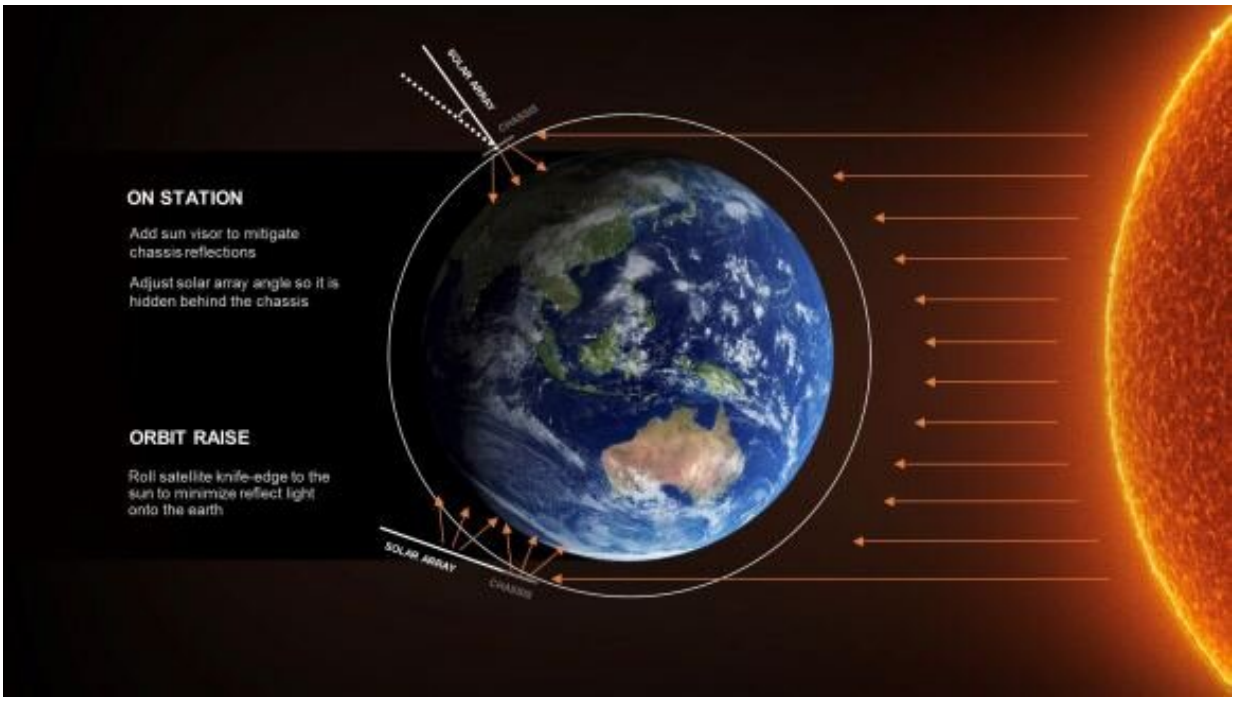


Illustration of Starlink orbits and their reflective qualities. Credit: SpaceX

Naturally, SpaceX has emphasized that the risk of collision is very small. In their filings with the FCC in April of 2017, SpaceX addressed the possibility of collision risks assuming rates of "satellite failure resulting in the inability to perform collision avoidance procedures of 10, 5 and 1 percent." In response, the company indicated that even a 1% risk was unlikely, given the following specifications and guidelines:

- Designing the Starlink constellation to exceed NASA's debris mitigation guidelines and an "aggressive monitoring program" to detect potential problems and deorbit affected satellites.
- An incremental deployment schedule over a long period of time (which they are performing by deploying one batch of 60 satellites per launch).
- An iterative design process that leverages new technologies and

> upgrades, avoiding launching any more satellites identified as problematic, and deorbiting those identified as a risk.

Last, but not least, SpaceX emphasized that it conducts simulations, which it corroborates with information from the USAF's Joint Space Operations Center (JSpOC) and the NASA Orbital Debris Engineering Model. From this, they claimed that based on a satellite failure rate of 1% and no corrective maneuvers, there was "approximately a 1% chance per decade that any failed SpaceX satellite would collide with a piece of tracked debris."

> Deployment of 60 Starlink satellites confirmed
> pic.twitter.com/x83OvjB4Pa
>
> — SpaceX (@SpaceX) October 6, 2020

There's also the likely scenario in which Starlink satellites naturally deorbit if their propulsion systems fail and they are unable to raise their orbit or apply corrective thrust. But even with their lower orbits, compared to other telecommunications satellites, this process will still take one to five years. At the end of the day, there are no guarantees, just vigilance and preparedness.

In the meantime, Musk announced earlier this month that with the latest batch of their satellites released in orbit, Starlink is planning on launching a beta test of its internet service. "Once these satellites reach their target position, we will be able to roll out a fairly wide public beta in northern U.S. & hopefully southern Canada. Other countries to follow as soon as we receive regulatory approval," he tweeted.

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