

Too congested before we're connected? Broadband satellites will need to navigate a crowded sky

LEO satellites could bring high-speed internet to every corner of the world—if they can stay out of each other's way. Fortunately, adjacent industries are gearing up to help.

David Jarvis, Duncan Stewart, Kevin Westcott, and Ariane Bucaille

IN *TMT PREDICTIONS 2020*, we said that low Earth orbit (LEO) satellite broadband constellations would be either a revolution or just a bunch of space junk.¹ Three years later, it still isn't entirely clear which it is—but a lot of companies are betting on the former. Deloitte Global predicts that more than 5,000 broadband satellites will be in LEO by the end of 2023, making up two working constellations providing high-speed internet to nearly a million subscribers on all parts of the planet, no matter how remote. Looking further out, if every organization currently planning to build a LEO constellation succeeds, seven to 10 competing networks could be operational by 2030, with a total

of 40,000 to 50,000 satellites serving more than 10 million end users.

Doing choreography ... in space

The anticipated surge in satellite broadband deployments spells good news for users. It is likely that new applications will emerge, prices will decline, coverage and reliability will improve, and latency will fall. But several complications could slow the industry down. A much more crowded orbital environment significantly raises the risk of

collisions, requiring higher levels of cooperation and coordination. At the same time, the various national, regional, and global players will likely continue to fight over spectrum, orbital slots, launch capacity, and access to terrestrial markets. Among the major competitors:

SpaceX's Starlink: More than 2,600 working Starlink satellites serving almost half a million subscribers are currently in orbit.² Beyond typical consumer use, Starlink has demonstrated its utility for emergency services in a number of recent natural disasters.³ Multiple airlines have begun exploring and testing the system for high-speed in-flight internet access.⁴ SpaceX also received FCC approval to provide mobile connectivity for boats, planes, and other vehicles, fulfilling one of the company's early promises.⁵

Amazon's (Project) Kuiper: Although none of its planned 3,236 satellites are currently in orbit, Amazon announced a multibillion-dollar agreement with three providers in April 2022 to launch most of these satellites over five years.⁶ But Amazon will need to hurry: It must have half of its satellites in place by 2026 and the entire constellation in orbit by 2029, or it will lose its FCC authorization.

OneWeb: More than two-thirds of UK-based OneWeb's planned 648 satellites are currently in orbit, and the company is aiming to start global operations by the end of 2023.⁷ OneWeb also recently combined with France-based Eutelsat in a US\$3.5 billion deal.⁸ The combined company intends to focus on enterprise and government connectivity by integrating Eutelsat's geostationary satellites with OneWeb's LEO network.⁹

Additional players include Canada's Telesat, which plans to start launching its 188-satellite Lightspeed network in 2025.¹⁰ Another is Telco-backed AST SpaceMobile, which is planning a constellation of 243 satellites that will allow mobile devices to connect directly to its LEO network.¹¹ And China,

as part of a national plan, launched six test satellites in March 2022 for the private firm Galaxy Space. China's network may eventually contain up to 13,000 satellites.¹²

The big challenge for these companies? Keeping their satellites out of harm's way. Space surveillance networks currently track more than 31,000 orbiting objects, including more than 6,000 operating satellites.¹³ On top of that are an estimated hundreds of thousands of untracked debris fragments, ranging from pieces of destroyed satellites to paint flecks. To keep satellites from colliding with each other and from being struck by debris, it's necessary to know where all those objects are in real time, and with great precision, a discipline known as space situational awareness (SSA). Also essential is effective space traffic management (STM)—that is, robust technical and regulatory standards around launching, operating, and returning satellites to Earth.¹⁴

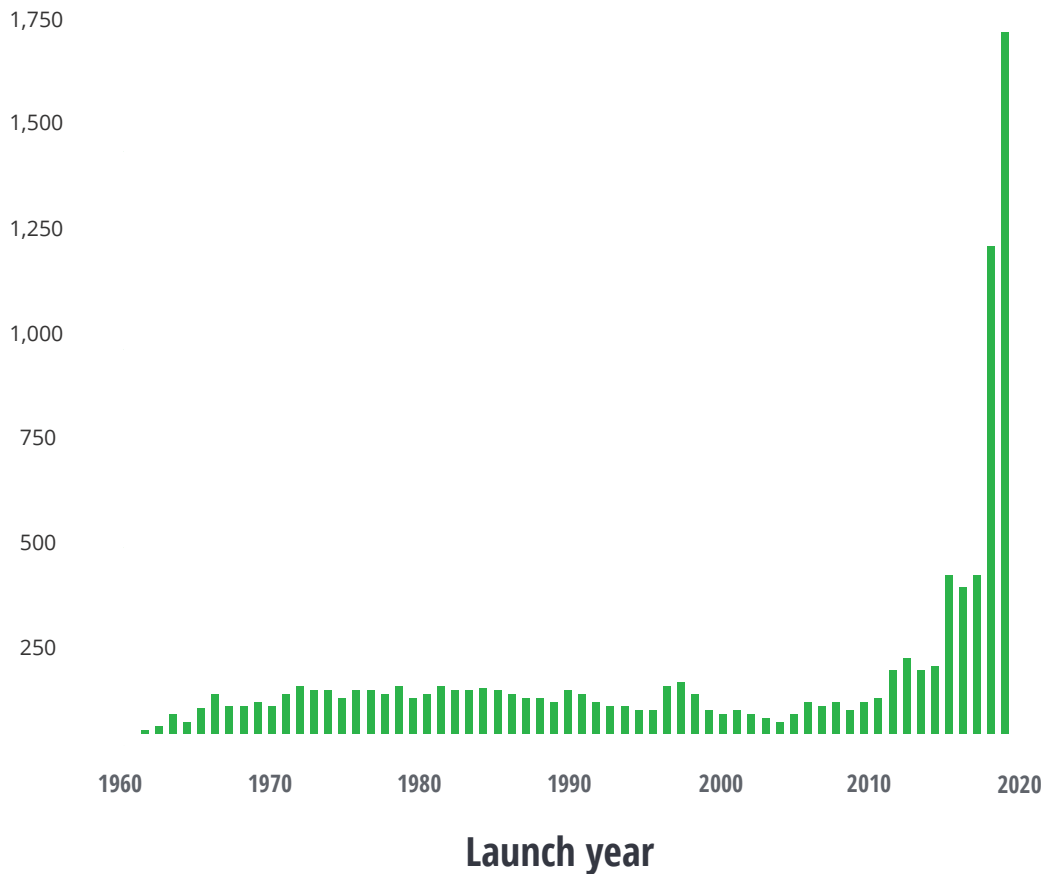
Currently, governments generally provide data for SSA, but there are challenges.¹⁵ Dramatically increasing the number of satellites to track could overload the current system from both a technical and operational standpoint. The number of near-collisions—satellites passing within 1 kilometer of each other—has already risen significantly since LEO broadband constellations have started going up.¹⁶

This challenge is driving the creation and growth of new markets. Prime among these is commercial SSA, which, while niche today, could grow to US\$1.4 billion by 2032.¹⁷ SSA providers are building a combination of ground- and space-based sensors along with powerful computer models to track objects in space and predict their orbital paths.¹⁸ A well-developed commercial SSA capability could augment government data and feed a trusted common operating picture. This market can be helped by the funding of the US Office of Space Commerce, which will work to take over civil space traffic management responsibilities as early as 2024.¹⁹

FIGURE 1

The number of objects launched into low Earth orbit has dramatically increased, driven by commercial satellite constellations

■ Number of objects



Source: European Space Agency, *ESA's space environment report 2022*, April 22, 2022.

In-orbit satellite servicing and space-debris removal could also receive a boost from LEO satellite constellations. In space-debris removal, a specialized satellite rendezvouses with a dead satellite or object, captures it, and pushes it into a different orbit or the atmosphere to safely burn up. Several proof-of-concept space debris-removal missions have already occurred,²⁰ and many more are planned in the coming years.²¹ In-orbit satellite

servicing aims to prolong satellite life: A servicing vehicle could refuel a satellite to extend its usefulness or, if a malfunction occurs, swap out a part to avoid having to scrap the whole thing. The industry-led Consortium for Execution of Rendezvous and Servicing Operations (CONFERS) is currently working to develop standards for this emerging industry.²²

THE BOTTOM LINE

If the industry continues on its current trajectory, the LEO broadband market will not only grow but also drive the expansion of supporting markets, creating a new and dynamic ecosystem. However, for this ecosystem to be viable in the long term, all involved should focus their attention and resources on protecting the commons of space. Critical uncertainties include:

- How much global cooperation will there be in space traffic management? To what extent will all the players be able to establish and follow formal “rules of the road”?
- Will better-quality SSA data become widely available and used before satellite operators become overwhelmed with managing potential collisions?
- How effectively will improvements in spaceborne computing and processing power, such as those enabled by advanced radiation-hardened chips,²³ facilitate real-time avoidance of debris or other satellites?
- How many more debris-creation events can LEO absorb before things get unsustainable? How will the market respond if things get worse?

So back to the original question: Are LEO satellite constellations a revolution or a bunch of space junk? As we said at the start, the jury’s still out. With lots of players in the game and lots of launches to come, the potential for both outcomes still exists—perhaps simultaneously.

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