

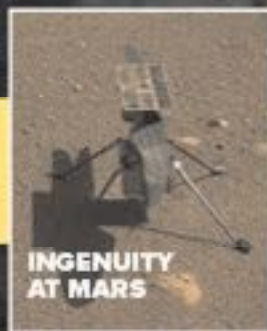
# AEROSPACE

★ ★ ★ AMERICA ★ ★ ★

## 2021 Year in review



247 kilometers on one charge  
and dozens of other breakthroughs



INGENUITY  
AT MARS



BILLIONAIRES  
IN SPACE



## Low-Earth orbit megaconstellations reach record capacity

BY TOM BUTASH

The **Communications Systems Technical Committee** is working to advance communications systems research and applications.

▲ The low-Earth orbit communications satellite megaconstellation in this illustration includes orbital satellite shells at multiple altitudes.

ESA Science Office

**T**he year was the first in which the aggregate throughput capacity of all operational low-Earth orbit communications satellites eclipsed that of all geosynchronous Earth orbit communications satellites. Indeed, **SpaceX Starlink** and **OneWeb** alone were conservatively expected to have launched 1,016 and 316 LEO satellites by the end of the year, bringing their megaconstellation totals to 1,969 and 420 satellites, respectively, with a total gross aggregate capacity of more than 36 terabits per second. Even if this gross capacity were derated by 75% to reflect the percentage of Earth's surface covered by water or in remote regions and reduced another 66% to conservatively account for LEO satellites without access to an uncongested ground station or optical intersatellite link, the net aggregate throughput capacity of these LEO megaconstellations was to conservatively exceed 3 Tbps by year's end. This easily eclipses the 2.7 Tbps aggregate throughput capacity of the 400 GEO communications satellites in orbit.

The predominance of these megaconstellations is unlikely to end soon. The total numbers of LEO broadband satellites planned, approved and under development by **SpaceX Starlink** (42,000), **OneWeb** (7,088), **Amazon Kuiper** (3,236), **China GW** (12,992), **Telesat Lightspeed** (298) and **Inmarsat Orchestra** (150-175) for deployment before the end of this decade ensure

this. As of mid-November, Starlink reportedly had 140,000 users across 20 countries.

The specter of LEO megaconstellations' impending growth, together with ceaseless expansion of terrestrial broadband networks' reach and capacity, undoubtedly explains, in part, **commercial GEO broadband satellite system operators' continued hesitance** to add fleet capacity. As of the end of September, only six GEO awards had been made: two to Airbus Defense and Space, two micro-GEOs (each with less than one-tenth the mass and capacity of full-sized GEOs) to San Francisco-based Astranis and two digital radio broadcast satellites to Colorado-based Maxar Technologies (one to replace a predecessor that failed in orbit in December 2020 before it could be placed in service). This downturn in GEO awards began in 2015, before which the average annual GEO award rate during 2012-2014 was 26 satellites.

Given the LEO communications satellite industry's dramatic manufacturing and launch efficiency advances in deploying unprecedented numbers of small satellites, and the inherent flexibility, responsiveness and resilience of LEO megaconstellations, the U.S. Department of Defense's **Space Development Agency issued an August request for proposals** for the development and production of 144 LEO communications satellites. These satellites will form Tranche 1 of a Defense Department "Transport Layer" — a space-based mesh network for reliably transmitting data from sensors to end users.

For 60 years, the communications satellite industry has developed and leveraged innovative technologies to repeatedly extend the reach, expand the capacity and increase the reliability of terrestrial communications networks. Aware of the 5.2 billion worldwide cellular subscribers at the start of 2021 and the 1.7 billion 4G and 5G mobile phones to be shipped this year, the industry again innovated to meet a clear need: the provision of service to these phones when they are beyond the reach of terrestrial networks.

Virginia-based **Lynk** and Texas-based **AST SpaceMobile** are developing LEO communications satellite constellations to provide cellular service directly to standard (unmodified) mobile phones, thus expanding terrestrial cellular network coverage without the need for new phones or towers. Lynk deployed its production design satellite in July and planned to launch the first of its 4G text messaging LEO communications satellites in December to initiate commercial service in 2022. AST SpaceMobile is developing **communications satellites with 64-meters-squared deployable antennas** to provide 5G broadband cellular service directly from its LEO constellation. Its first demonstrator satellite was scheduled for launch in March 2022. ★

**Contributor:** Roger Rusch