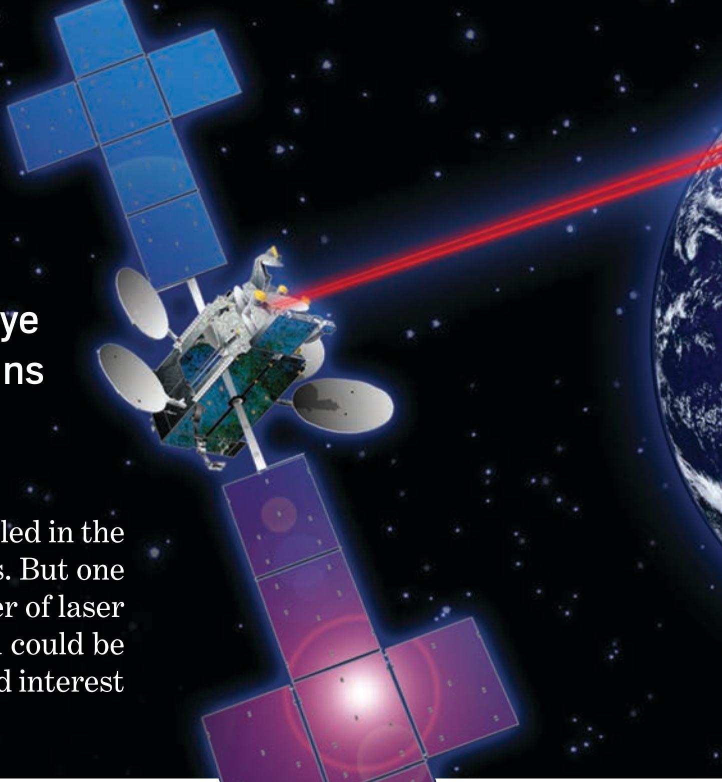
SPACE TELECOM



Light Touch

European, U.S. laser comm suppliers eye Silicon Valley's satellite broadband plans

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Satellite Internet startup Teledesic Corp. failed in the late 1990s largely due to technical setbacks. But one of its key vendors—a small German supplier of laser communications technology—has pressed on and could be uniquely poised to support Silicon Valley's renewed interest in space-based global connectivity.

With companies such as Google, OneWeb and LeoSat planning rival constellations of hundreds, or even thousands of low-Earth-orbit (LEO) broadband spacecraft, some of which may utilize laser comm for inter-satellite links, Tesat Spacecom of Backnang, Germany, could see its persistence pay off.

A subsidiary of Airbus Defense and Space, Tesat has spent the past quarter-century maturing high-bandwidth optical communications for inter-satellite transmissions, an effort that is starting to bear fruit: This year, Tesat's first commercial laser communications terminal (LCT) is set to enter operational service under the European Data Relay Service (EDRS). The public-private partnership valued at around €600 million ($643 million) is cofinanced by Airbus, the European Union and the European Space Agency (ESA) and is already delivering very high data-rate, bidirectional relay between remote-sensing satellites in LEO and the ground, via a satellite in geostationary orbit (GEO).

"It started with Teledesic, but the German Aerospace Center DLR and Tesat have stuck with it, and now it's the policy of Germany that laser comm is a core capability in space," says Matthias Motzigemba, head of laser products at Tesat. "We have been taking the different intermediate steps over 25 years to develop the product we have today."

Through EDRS, Tesat has been demonstrating optical links with LEO-to-GEO laser transmissions using an experimental LCT aboard Inmarsat's Alphasat commercial communications satellite and an operational terminal on the European Sentinel-1A synthetic aperture radar spacecraft launched last year. Alphasat then relays the data in K_a-band to the ground.

With their shorter wavelength, laser-based data transmissions offer several advantages over conventional radio frequencies (RF), including the ability to achieve higher data rates than radio signals for the same aperture. Laser terminals tend to be lighter than their RF counterparts, and laser beams require less power for data transmission. Due to the higher efficiency and low beam divergence of a laser, the link is a secure point-to-point connection. Laser optics also eliminate the need to coordinate RF spectrum allocation with regulators.

The downside of laser comm is that the beams cannot penetrate clouds, and transmissions are easily disrupted or terminated by dust or other atmospheric elements, making optical communications better suited to the vacuum of space.

Tesat is now under contract to develop additional LCTs for future Sentinel spacecraft and is producing four per year using its standard 1,064 nanometer wavelength and BPSK modulation. The company is also preparing to launch its first commercial LCTs as hosted payloads on commercial communications spacecraft, starting with EDRS-A on the Eutelsat 9B satellite this year.

Airbus, ESA and the EU also recently finalized plans to fund the completion and launch of a second geostationary data relay payload, EDRS-C, to launch on the Hylas-3 telecommunications satellite owned by Avanti Communications of London.

A third and final commercial LCT node, known as EDRS-B, could be launched in the future to give the system global coverage, although the 22-nation ESA has not funded the effort.

Tesat has also teamed with General Atomics to cofinance a demonstration of ground-to-GEO and aircraft-to-GEO links using Alphasat and an MQ-9 Reaper unmanned aerial vehicle (UAV), with trials planned in 2016 and 2017, respectively.

"We are flying over 65 Predators and Reapers at all times around world. If we bundled up all the data, all the video and [command and control] C2 on those aircraft, that would still be only 40% of the bandwidth that we have on a laser communications terminal," says David Robie, director of electro-optical systems at General Atomics. "That gives you an idea of what the potential is."

The partnership stems from a U.S.-German government initiative in 2008 to test space-based laser links between the U.S. Missile Defense Agency's Near Field Infrared Experiment (Nfire) and Germany's TerraSAR-X radar spacecraft. The long-running experiment—demonstrating the ability of the plat-

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forms to establish a laser link at a distance of 40,000 km (25,000 mi.) and transmit data at 5.6 gbps—is expected to end this year.

As Europe makes headway in the area of inter-satellite links, NASA is developing new technologies that could bring high-bandwidth laser signals down to Earth. The U.S. space agency sent laser signals from the Moon to Earth with the Lunar Atmosphere and Dust Environment Explorer (Ladee) in 2013 and is preparing to demonstrate a high-bandwidth point-to-point laser-comm link via a hosted payload on a GEO commercial communications satellite.

U.S. AIR FORCE

Tesat Spacecom and General Atomics will demonstrate laser links between an MQ-9 Reaper and Inmarsat's Alphasat in GEO.

The Laser Communications Relay Demonstration (LCRD) is to fly on a to-be-determined Space Systems/Loral spacecraft late in 2018 or early 2019, says Donald Cornwell, technology director for NASA's Space Communications and Navigation (SCAN) program office. It will use the same ground stations at White Sands, New Mexico, and Table Mountain, California, used in the Ladee demonstration, upgraded with adaptive optics to permit even faster signaling through the atmosphere.

NASA's Laser Communications Relay Demonstration could fly as soon as 2018.

Despite the challenge of cloud cover and atmospheric interference, that kind of bandwidth has attracted a lot of commercial interest. SCAN received so many responses to a request for information on possible experiments to include in the LCRD payload that "we plan to have something like a guest investigator program on the mission, where industry can come in and try some things," says Cornwell.

Also in the works is an LCRD package for the International Space Station, to gather data that could support the hoped-for commercial infrastructure NASA is trying to foster in LEO in the coming decade. "Once you show that you can master the atmosphere and the pointing and the acquisition and tracking, there's nothing that then says you couldn't launch a system that could do 100 gbps or a terabit per second from the ground up to the sky," he says.

Weather is likewise the elephant in the room whenever Laser Light Communications' plans for an end-to-end satellite system are discussed. But the company has an answer, tied to its plans to be a long-haul telecom carrier that uses space as its medium.

Although Laser Light has yet to secure a major financial backer, the U.K.-based startup plans 8-12 satellites in medium Earth orbit (MEO) and up to 100 ground nodes connected by a lattice of fiber-optic links creating continent-sized wide-area networks. Data will go by laser beam from ground node to satellite, spacecraft to spacecraft, and satellite to ground node with speeds, frequencies and waveforms compatible with terrestrial fiber-optic networks.

System capacity will be 6 tbps, and minimum performance level 100 gigabits up and down. The company's business plan is to locate ground nodes where undersea cables and fiber-optic networks come together and offer telecom carriers a way to extend their long-haul networks at lower cost.

The hybrid fiber/laser nature of Laser Light's network is key to circumventing weather. As the footprint of each MEO satellite covers a continent-size area, there will be multiple ground nodes in sight at all times, all connected to a terrestrial fiber-optic network.

"Say we have to deliver service from Hong Kong to Marseilles," says CEO Robert Brumley. "If Marseilles is impacted by weather, then the system automatically acquires the ground node in Milan and drops the data there, where it goes by the lowest-cost, lowest-latency terrestrial route to Marseilles." This will be done automatically using algorithms for which patents are pending, he adds.

"We will have transport agreements with other carriers—and something to offer them to offset when they are off-net," he says.

To demonstrate the capability on the ground, Laser Light plans to build the High Articulation Laser Optics (HALO) Center with a 100-gbps hybrid fiber-laser-fiber loop to validate free-space optics performance and interoperability with terrestrial fiber-optic networks.

Laser Light is using free space optics technology developed for the U.S. Air Force's canceled Transformational Satellite Communications (TSAT) program, and in 2014 selected one of the companies involved in TSAT, Ball Aerospace, to supply its laser-comm payload and off-the-shelf satellite bus.

The ground-segment provider will be announced shortly, says Brumley. Both suppliers have signed fixed-price contracts. The first customer to sign up is regional carrier Hong Kong-based Pacnet Services Asia Pacific.

Brumley says the system will use the same 196.5-THz frequency and 1525-1550-nanometer wavelengths as terrestrial fiber optic. "In terrestrial communications, the further you push data on the transport layer the more expensive it gets," he says. "It's an operating expenses challenge. With our system, the further you go the cheaper it gets because of the operating efficiency of the satellite."