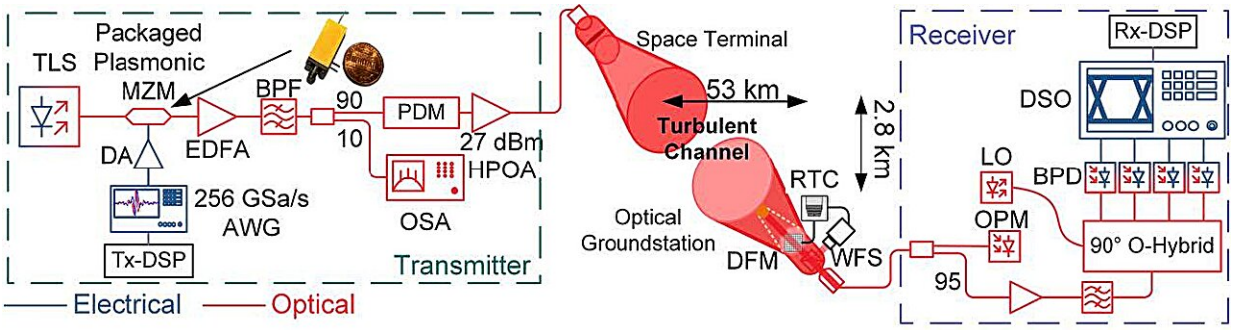
Plasmonic modulators could enable high-capacity space communication

September 6 2024



Experimental setup of the FSO outdoor experiments. Tunable laser source (TLS), driving amplifier (DA), arbitrary waveform generator (AWG), transmitter digital signal processing (Tx-DSP), erbium-doped fiber amplifier (EDFA), bandpass filter (BPF), optical spectrum analyzer (OSA), polarization division multiplexing emulator (PDM), high power optical amplifier (HPOA), real time controller (RTC), deformable mirror (DFM), wafefront sensor (WFS), optical power meter (OPM), local oscillator (LO), balanced photodetector (BPD), digital storage oscilloscope (DSO), receiver digital signal processing (Rx-DSP). Credit: Laurenz Kulmer, ETH Zurich

Researchers have achieved data rates as high as 424Gbit/s across a 53-km turbulent free-space optical link using plasmonic modulators—devices that use special light waves called surface plasmon polaritons to control and change optical signals. The new research lays the groundwork for high-speed optical communication links that

transmit data over open air or space.

Free-space-optical communication networks could aid space exploration because they can provide high-speed, high-capacity data transmission with lower latency and less interference than traditional radio frequency communication systems. This could lead to more efficient data transfer, better connectivity and enhanced capabilities for space missions.

Laurenz Kulmer from the Leuthold group of ETH Zurich will present this research at Frontiers in Optics + Laser Science (FiO LS), which will be held 23–26 September 2024 at the Colorado Convention Center in Denver.

"High-speed free-space transmission is an option to connect the world, or it may serve as a backup if underwater cables break," said Kulmer. "Nevertheless, it is also a step towards a new cheap high-speed internet that may connect all locations across the world. This way it may contribute towards a stable, high-speed internet for millions of people who are currently unconnected."

Plasmonic modulators are ideal for space communication links because they are compact while also operating at high speeds over a wide temperature range with low energy consumption.

In free-space optical outdoor experiments, the researchers achieved information rates of up to 424 Gbit/s below a 25% SD FEC threshold—the point at which a system can still fix errors in transmitted data despite interference or noise. Experiments using a plasmonic IQ modulator in a standard fiber system achieved an even higher throughput of up to 774 Gbit/s/pol while staying below a 25% SD FEC threshold.

Based on these results, the researchers say that combining plasmonic modulators with coherent free-space optical communication could help

increase overall throughput, with speeds potentially reaching 1.4 Tbit/s. The findings also show that it is favorable to operate free-space optical links at the highest speeds, rather than using higher order modulation formats and low speeds. With additional improvements in device design and photonic integration, the researchers say it should be feasible to reach polarization multiplexing data rates above 1 Tbit/s for each polarization channel.

"In a next step we are going to test the long-term reliability of our devices," said Kulmer. "High-speed performance has been shown, but we have to make sure they can operate for years to come in the harshest of environments, space."

Provided by Optica

Citation: Plasmonic modulators could enable high-capacity space communication (2024, September 6) retrieved 7 September 2024 from https://phys.org/news/2024-09-plasmonic-modulators-enable-high-capacity.html