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HIGH-SPEED FREE-SPACE OPTICAL COMMUNICATIONS VIA AN AIRBORNE PSEUDO-SATELLITE

Abstract

Free-space optical (FSO) communications are poised to play a crucial role in the future of space research and industry as orbital technologies and sensors advance and data-downlinking via traditional radio- and micro-wave frequencies becomes an increasing bottleneck. The higher directionality and bandwidth possible with FSO communications enable greater inherent security and data-transfer, respectively, making the technology ideal for overcoming today's data-downlinking bottleneck. However, connecting with satellites in the presence of atmospheric turbulence remains a major difficulty in practical FSO communications. Beyond the geometric challenge of tracking a satellite with a narrow optical beam, atmospheric turbulence adds additional deleterious beam-wandering and scintillation to the propagating optical signal, further degrading an already challenging link margin.

We report on our development of a transportable and field-deployable optical ground station capable of overcoming atmospheric and tracking challenges. This optical ground station relies on: a transportable astronomical mount for wide-field pointing, acquisition and tracking; and a high-speed tip-tilt mirror to suppress first-order atmospheric turbulence, thereby maintaining active tracking with urad accuracy. The optical ground station feeds light to and from a single mode fibre, allowing the use of commercial-grade fibre communications technologies to transmit and receive data at high data-rates. We demonstrated this capability, in the presence of atmospheric turbulence, by transmitting and receiving 100Gb/s coherent FSO communications from a low-altitude airborne drone, in emulation of a low earth orbit (LEO) satellite. This demonstration used a single optical C-band channel to achieve 100Gb/s transfer speeds, and with established dense wavelength division multiplexing technology, this optical ground station could facilitate coherent optical transmission at data-rates up to 7.2Tb/s.