Improvements to free-space optical networks enable wireless transmission in urban settings

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Free-space optical (FSO) communications has the potential for wide use in the license-free, interference-free transmission of data in unenclosed areas. By using laser beams to propagate through an open-air medium, FSO transmission eliminates the need for wire links.

Previous work on terrestrial FSO transmissions focused on either indoors or areas with little atmospheric effects, like between two mountain peaks. Twenty years ago, there were nascent activities in FSO communications for urban settings, which faded because of technical challenges and competing RF wireless and wireline solutions. Interest in FSO communications is growing again with improved technologies and the drive for higher bandwidth services where wireline solutions are difficult.

At the forefront of these new developments, Yueying Zhan and her team of researchers achieved the real-time FSO transmission of 1,000 seconds of an ultrahigh-definition video stream between two buildings in Beijing. Zhan will report the results of their demonstration during a session at the Optical Fiber Communication Conference and Exhibition (OFC), being held virtually from 06—11 June 2021.

"In urban [settings], due to the influence of factories, automobile exhaust, and other factors, there are more particles, molecules, dust, and so on in the atmospheric channel than in other places, such as mountains," said Zhan. "These factors lead to serious attenuation of optical signals, resulting in very low received power."

The group used standard single-mode optical fibers on the transmitter side of the system to launch 16 ultrahigh-definition video streams as free-space optical signals. The key upgrade they made to the system for it to work was at the receiver, where they used an OM4 multimode fiber rather than single-mode fiber, resulting in a 10-decibel improvement to the signal coupling efficiency.

Video transmission with few errors was demonstrated in different parts of the day, different seasons, and different weather conditions.

The test range was limited to 2.1 kilometers because of obstructions in the high-density urban setting. From the high power margin in the 2.1 km link demonstration, the researchers expect to be able to easily extend this distance.

"Free optical communication can be regarded as the supplement of optical fiber communication," Zhan said.

For example, FSO communication can be used to extend communication access to areas where bandwidth is insufficient or where complex terrain limits the use of wired communications, providing a fast and flexible solution for broadband access.

Additionally, a large-scale implementation of this technique can help eliminate dark zones between adjacent networks. FSO communication can also be crucial in a pinch, when backup or temporary emergency links may be necessary.

"In the unexpected natural or manmade disasters, when the original communication lines are damaged and it is difficult to recover immediately, emergency communication is needed," said Zhan. "Wireless laser communications can be rapidly deployed."

Furthermore, Zhan anticipates laser communications will soon be the primary method of intersatellite and deep space communications, augmenting RF and microwave communications.

Currently, the group is focusing on improving the performance of their system using channel coding for error correction and applying it in both terrestrial and space communications.

More information: "Demonstration of 100Gbit/s Real-Time Ultra High Definition Video Transmission Over Free Space Optical Communication Links" will be presented Wednesday, 09 June 2021, 19:30 to 19:45 PDT (UTC—07:00). Session ID -W7E.3.

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