Record-speed wireless data bridge demonstrated: Takes high-speed communications the 'last mile'

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A team of researchers in Germany has created a new way to overcome many of the issues associated with bringing high-speed digital communications across challenging terrain and into remote areas, commonly referred to as the "last mile" problem. The researchers developed a record-speed wireless data bridge that transmits digital information much faster than today's state-of-the-art systems.

These unprecedented speeds, up to 20 billion bits of data per second, were achieved by using higher frequencies than those typically used in mobile communications—the wireless bridge operates at 200 gigahertz (GHz) (two orders of magnitude greater than cell phone frequencies).

The team will present their research at the Optical Fiber Communication Conference and Exposition/National Fiber Optic Engineers Conference (OFC/NFOEC), taking place March 4-8 at the Los Angeles Convention Center.

"An inexpensive, flexible, and easy-to-implement solution to the 'last mile' problem is the use of wireless technology," explains Swen Koenig, a researcher at Karlsruhe Institute of Technology's (KIT) Institute of Photonics and Quantum Electronics, who will present the findings at OFC/NFOEC. "Instead of investing in the cost of digging trenches in the ground and deploying ducts for the fibers, data is transmitted via the air—over a high-speed wireless link."

In this type of setup, the optical fiber infrastructure is used up to its ending point and then connected to a wireless gateway. This gateway converts the optical data to electrical millimeter-wave signals that feed an antenna. The transmitting antenna "illuminates" a corresponding receiving antenna. At the receiving point, the electrical signal is directed toward its final destination, either using another wireless channel in a relay technique via copper wire or a coaxial (TV) cable or with an optical fiber. Wireless links also serve as a bridging element in fiber optic networks, if obstacles and difficult-to-access terrain such as lakes, valleys, or construction sites are in its pathway.

"The challenge in integrating a wireless link into a fiber optic environment is to ensure that the wireless link supports data rates comparable to those of the optical link—ideally about 100 gigabits per second (Gbit/s)—and that it's transparent to the data," notes Igmar Kallfass, a researcher and the project's leader at the Fraunhofer Institute for Applied Solid State Physics IAF, as well as a professor at KIT. "Besides optoelectronic conversion, no further processing must be involved before the signals reach the antenna. This also holds for the receiving part in a reversed sequence."

Multi-gigabit wireless transmission demands multi-GHz bandwidths, which are only available at much larger frequencies than mobile communications normally use. Millimeter-wave frequencies—radio frequencies in the range of 30-300 GHz—fulfill this need. By comparison, laser light, as used in optical communications, provides bandwidths of many terahertz (THz).

Indeed, free-space optical point-to-point links that use laser light for data communication between two optical gateways are already commercially available. However, free space optical links don't work or only work with limited quality and stability under adverse atmospheric conditions such as fog, rain, and dust. In contrast, a wireless link at millimeter-wave frequencies remains operational under such conditions.

"For our experiment, we use state-of-the-art electronic up- and down-converter modules developed at the Fraunhofer IAF. Previously, wireless data transmission at frequencies greater than 200 GHz with electronic up- and down-converters was virtually unexplored," Kallfass says.

After the first fiber span, the optical signal is received in the first wireless gateway and converted to an electrical signal. The electronic up-converter module is then used to encode the electrical signal onto a radio frequency carrier of 220 GHz. This modulated carrier then feeds the antenna that radiates the data. The antenna of a second wireless gateway receives the signal.

"In our first indoor experiment, the wireless transmission distance was limited to 50 centimeters, which we've now increased to 20 meters," notes Kallfass. "The second wireless gateway performs the inverse operation of the first gateway by an electronic down-converter module. Eventually, the electrical signal is again encoded onto laser light and transmitted over the second fiber span."

This experiment was carried out within the framework of the MILLILINK project led by the Fraunhofer IAF and funded by the German Federal Ministry of Research and Education. Other partners include: KIT, Siemens Corporate Research and Technologies, Kathrein, and Radiometer Physics. The consortium is supported by Deutsche Telekom and Telent.

More information: Koenig's presentation at OFC/NFOEC, titled "High-speed wireless bridge at 220 GHz connecting two fiber-optic links each spanning up to 20 km," will take place Monday, March 5 at 1:30 p.m. in the Los Angeles Convention Center. (www.ofcnfoec.org)

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