

INFORMATION AT A MUCH FASTER RATE

Brazilian researchers break fiber-optic data transmission record without using electronic signal amplifiers

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A group of Brazilian researchers has set a new fiber-optic distance and data transmission rate record. Using 10 channels on the same fiber, each with a traffic capacity of 400 gigabits per second (Gbps), the team, coordinated by electrical engineer Jacklyn Dias Reis of the Center for Research and Development in Telecommunications (CPqD) in Campinas, was able to send an enormous amount of data along 370 kilometers (km) of optical fiber without the occurrence of errors. This is the first time that light-encoded information has travelled so far, through such an optical fiber configuration, without the use of repeaters — equipment installed along the path for signal amplification. The data transfer rate used in the test would be sufficient to download 170 hours of definition (HD) films or TV series in no more than one second.

Usually, signal amplifiers are needed to send data over optical fibers for distances of over 80 km. This is because the light's intensity diminishes as it travels along the fiber. Installed at specific distances, these amplifiers provide energy for the signal, ensuring the information arrives at its destination intact. The need to use amplifiers for transmission over distances greater than 80 km makes it hard to provide high-quality, high-speed Internet services to remote communities, such as on islands or in the Amazon forest. There are no energy sources along the path with which to supply the amplifiers, and periodic maintenance is practically impossible. The cost of infrastructure to provide high-quality Internet in these regions could render this type of service impossible, according to Reis, coordinator of Optical Technologies at the CPqD. The study also involved researchers from the School of Electrical and Computer Engineering (FEEC) of the University of Campinas (Unicamp).

In the experiment, the researchers used a configuration with three laser sources: one to send data and two at either end of the fiber, acting as pumps and providing energy for two optical amplifiers located along the connection pathway. These optical amplifiers do not run on electricity, like electronic amplifiers, but instead receive energy from an optical fiber that



runs parallel to the transmission fiber, in parallel. This amplifies the laser signal and provides the same performance as before. The optical amplifiers are known in technical jargon as Erbium-Doped Fiber Amplifiers (EDFA). Each of them consists of a 10-meter fiber containing the chemical element erbium, which facilitates the transfer of energy from the additional laser sources at either end of the other two fibers to the signal, increasing its intensity. This strategy relies on a technique called remote pumping, which allows the elimination of electronic amplifiers. “The signal that was sent arrived exactly at the same at the receiver, with no errors,” says João Carlos Soriano Sampaio, an electrical engineer at the CPqD and one of the researchers involved in the experiment.

The optical fibers used are thicker than those used by telecommunications companies in their networks and have a lower signal attenuation. Approximately 40% more expensive than standard optical fibers, these devices are the same as those used in submarine connections between continents and they reduce the loss of signal energy along the route.

MARKET NEEDS

Marcelo Martins Werneck, the electrical engineer who coordinates the Photonics Instrumentation Laboratory (LIF) at the Federal University of Rio de Janeiro (UFRJ), believes that the transmission achieved by the CPqD group is innovative because of its high transmission speed and its distance. Werneck states that several research groups are working on achieving similar results because the market needs transmission technology without electronic amplification. For a submarine connection between continents, for example, an amplifier has to be installed along the ocean floor, together with a cable for power supply, explains the engineer. When there is a defect, maintenance is performed by us-

ing a robot to find the cable on the ocean floor and raise it to the surface so that technicians can repair it onboard a ship. This service costs about \$100,000 a day. “When transmission occurs without the use of electronic amplifiers, the risk of defects is lower. There would be fewer pieces of equipment distributed along the pathway to cause problems.”

One potential market for devices that enable ultra-high-speed data transmission over long distances, according to Sampaio, is high-sea oil exploration. Oil companies need to connect their platforms to land bases, CPqD’s strategy would allow them to eliminate the need for amplifiers— a number of Petrobras platforms, for example, are more than 200 km away from the coast. Padtec, a company in Campinas that develops, manufactures and markets optical communication systems and is associated with the CPqD, has already tested this electronic-amplifier-free transmission technology on the market, although their solution works over shorter distances and at lower speeds.

THE EXPERIMENT REACHED THE 370-KM MILESTONE AND WAS CARRIED OUT INSIDE A CPQD LABORATORY WITH OPTICAL ON 50-KM SPOOLS

In addition to improving the system as a whole, the researchers also used mathematical models in order to analyze the factors that influence the transmission of information. The group, consisting of nine researchers from different specialties, chose the best combination of transmission, digital signal processing and error correction techniques to reproduce the experiment in the laboratory. The transmission and reception systems, plus the 370 km of optical fiber rolled into 50-km spools, were installed in one of the CPqD’s laboratories in Campinas. The result of this experiment was published online on July 18, 2016, in the journal *IEEE Photonics Technology Letters*. And the researchers do not intend to stop here. “We want to send signals at greater transmission rates over even longer distances,” says Sampaio. ■

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JANUÁRIO, J. C. S. S. *et al.* Unrepeated transmission of 10x400G over 370 km via amplification map optimization. *IEEE Photonics Technology Letters*. On-line, July 18, 2016.