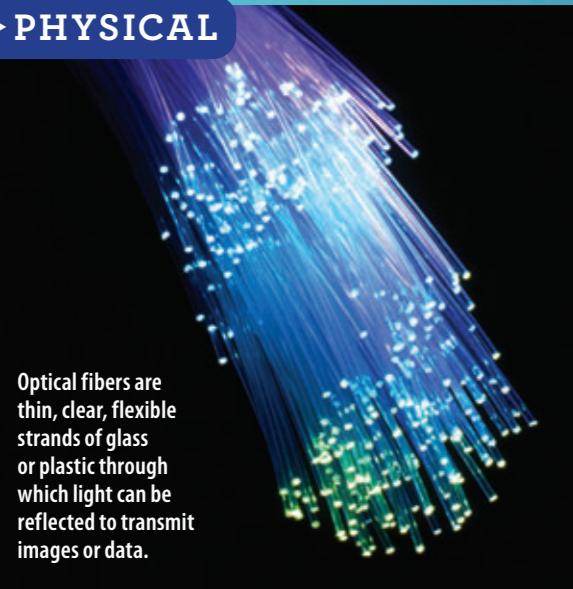


## ► PHYSICAL

Edi Zubakoff/Stock Connection/Science Faction/Corbis; Background: Shutterstock



Optical fibers are thin, clear, flexible strands of glass or plastic through which light can be reflected to transmit images or data.

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**T**wo teenagers—Mika and Koby—are downloading the new Coldplay album, *Mylo Xyloto*. They have similar computers, are downloading from the same virtual music store, and pay about the same each month to their Internet service providers.

Already, though, Mika has the entire album, whereas Koby barely has the first song. What made the difference? Why is Mika's Internet connection about 20 times faster than Koby's?

The answer is simple: location. Mika lives in Tokyo, and Koby lives in New York City. Faster Internet access is more common in Japan than it is in the United States.

That may come as a surprise, considering that America was built on speed. Major innovations that shaped the United States—the transcontinental railroad, the telephone, the automobile—all have one thing in common: They connect people, goods, and ideas quickly.

Lately, though, the States has fallen behind. A recent Harvard University study placed the country 13th for Internet connection speed. "Our lead has slipped," President Barack Obama acknowledged in his 2011 State of the Union address.

England, South Korea, and Japan have Internet connections that leave the States in the dust. The problem is more than waiting a few extra minutes for a Coldplay album to download. "It has an effect on our overall well-being," notes Judith Chevalier, an economics professor at Yale University whose focus is e-commerce. Internet connection speed could dictate the future of the American economy, and right now, both are lumbering. To compete with countries such as Japan and England, the U.S. needs to invest in the latest Internet technology: fiber-to-the-home (FTTH) broadband.

# BATTLE OF THE BANDS

**Why is the United States losing the Internet race?**

By Bobby Oerzen

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## DIAL-UP DAYS

Back in the *dial-up* era, computers connected to the Internet through telephone lines. An Internet signal was simply an electronic pulse traveling through the copper wires of a phone line.

Those wires were meant to carry phone conversations, not Internet signals. Kim Winick, a professor of electrical engineering at the University of Michigan, explains: "Copper has a limited *bandwidth*." Bandwidth is how much data a connection can transmit each second.

Limited bandwidth kept the Internet moving at a crawl until the late 1990s. Then providers began offering affordable broadband connections, giving the Internet a turbo boost. "Bandwidth limitations are much less severe with broadband," says Winick.

Broadband gets its speed from *fiber optics*, which transmits light signals via glass cables. And those light signals aren't just any form of light—they're laser light.

A typical fiber-optic cable contains about 1,300 *optical fibers* (strands of glass or plastic). Each strand is no thicker than a human hair, yet, as Winick points out, "one strand can deliver tens of *terabits* [1 terabit equals 1 trillion bits] per second. Copper can deliver only a few million bits per second. That means fiber optics can deliver *much* more information." A single fiber can stream the equivalent of 800 video channels.

## COMPUTER TALK

Whenever a computer connects to the Internet, its messages stream in *binary code*—a long string of *bits* (the 0s and 1s) that make up the data for music, movies, and Web pages. The light pulses through fiber optics extremely fast, with each pulse representing either a 0 or a 1.

An optical fiber traps and guides laser light in a process called *total internal reflection*. Only a small percentage of the signal is lost as the light travels through the fiber. Over vast distances, however, the losses can add up. To overcome such losses in long-distance Internet links, "doped" fibers are inserted along the route. When pumped by external lasers, the doped segments amplify the traveling signal. "This allows Internet signals to even travel between continents using optical fiber cables placed under the ocean," Winick says.

## TRAFFIC JAM

Fiber-optic cables crisscross the United States, conveying Internet signals between hubs located in numerous towns and cities. More often than not, though, the final hub-to-home connections consist of copper. That fiber-to-copper transition creates a bottleneck, which slows connection speeds dramatically.

In countries such as Japan, the Netherlands, and South Korea, optical fibers run directly into homes and offices. Such FTTH broadband connections are costly to install, but they keep the Internet moving at the speed of (laser) light.

## Falling Behind

The percentage of broadband subscribers in the United States lags behind many other countries. This graph compares the number of subscribers per 100 inhabitants in the U.S. with those of the top five countries.

1. Netherlands	38.1
2. Denmark	37.0
3. Norway	34.5
4. Switzerland	33.8
5. South Korea	32.8
13. United States	26.7

Source: Organisation for Economic Co-operation and Development; Graphic by Pat Carr, Paul Trap/MCT/Newscom

A powerful Internet attracts businesses and skilled workers. Today's work environment is part of the *knowledge economy*, in which people use computers to communicate, conduct research, download entertainment, and shop. That's why experts regard a country's Internet connection as part of its *infrastructure*—the set of facilities that enable the country to function. "A faster Internet increases productivity, opens competition, and even improves the environment because people don't have to travel as much for meetings," says Chevalier. More than 6 million FTTH broadband subscribers in Japan would probably agree.

In the United States, a country with two and a half times the population of Japan, only 1 million subscribers have FTTH broadband. Will Americans finally see the light at the end of the fiber? Or will we continue to let last century's copper impede our Internet connections, dividing us from the rest of the world? Chevalier warns: "The digital divide creates inequality in the workplace. Those with a good Internet connection have a clear advantage over those who don't." **CS**



Construction workers unwind a long, hollow strand of shielding through which a fiber-optic cable will be threaded.