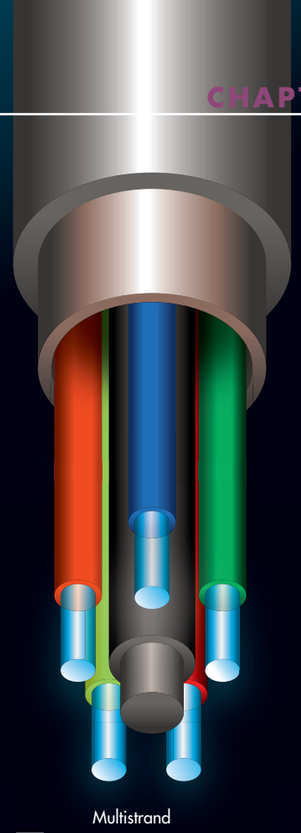
How Fiber Optics Lights Up the Future

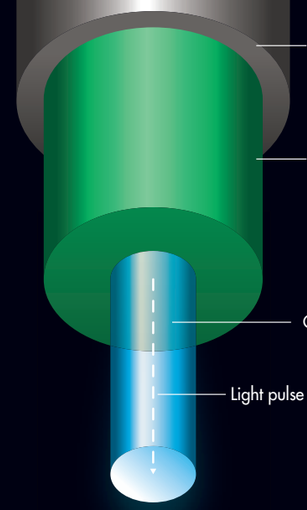
FIBER OPTICS have been around since 1930, but it's just now that they are massing for a frontal blitz on the old networks, TV services, and the Internet itself for a change that is more revolution than evolution. Fiber optic networks can already bring download speeds of 1 gigabit a second to a few selected cities. That's 33 times the bandwidth of the fastest cable connection. In the lab, fiber optics have moved 26 terabits a second, or 26,000 gigabits. And that's just on one strand of optical fiber. Imagine a 12-strand bundle. It could move 5,000 two-hour HD movies in one second. Amazing.

1 Digital information—video, music, text, or other data—goes through an **encoder/modulator**, which converts the data into pulses of light, a smaller and extraordinarily faster version of the way ships in World War II used to send each other Morse code messages by opening and closing shutters in front of a spotlight.

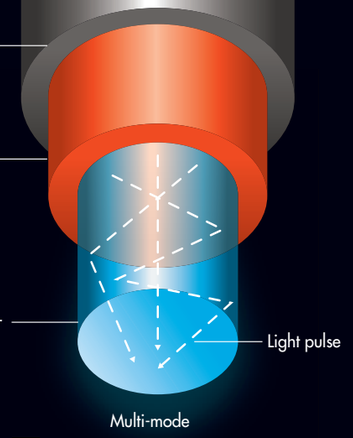
2 A **transmitter** pushes those light pulses into the optical fiber, which consists of a core made of a flexible, exceptionally pure strand of glass surrounded by **cladding glass** and an outside protective coating. The cladding has a different **index of refraction** from that of the core glass. This turns the junction of the two layers into a long, cylindrical mirror that guides the light pulses by bouncing them along the length of the fiber. This process is named **total internal refraction**.



3 Optical fibers come in two configurations: **single strand** and **multi-strand**, which is a collection of single strands bound to a central core to form a cable. Individual fibers in the cable can branch out to serve different destinations. Single strand fibers are subdivided into multimode and single mode.

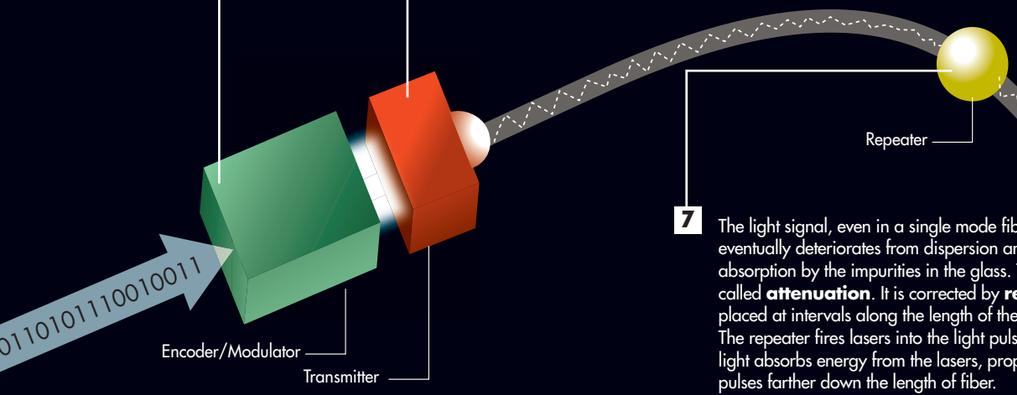


4 **Single mode** fibers have a much smaller core—typically 10 micrometers that permits only one light signal at a time to bounce through the fiber.

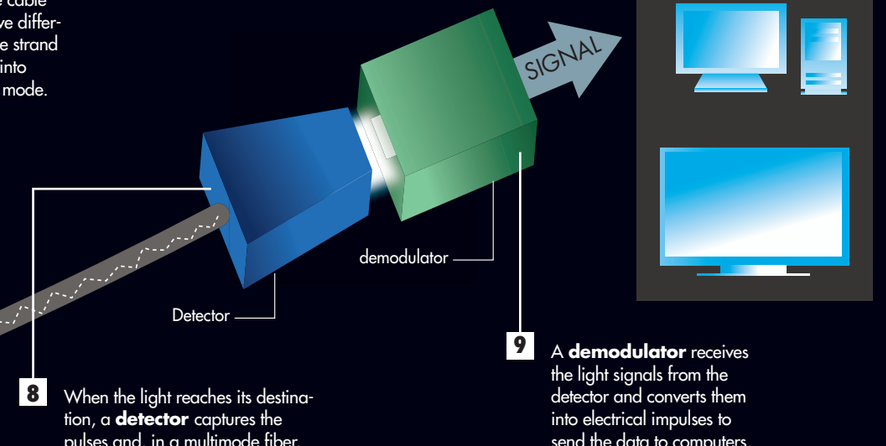


5 **Multimode** fibers have a larger core, allowing several pulses of light of different frequencies to travel the fiber at the same time.

6 Contrary to what you might imagine, single mode has a larger bandwidth than multimode. The multiple light pulses in multi-strand grow wider in what's known as **dispersion.** Eventually the different frequencies of light create interference for each other and become indistinguishable. Single mode fiber carries a transmission with fewer errors and the ability to cover greater distances.



7 The light signal, even in a single mode fiber, eventually deteriorates from dispersion and from absorption by the impurities in the glass. This is called **attenuation**. It is corrected by **repeaters** placed at intervals along the length of the fiber. The repeater fires lasers into the light pulses. The light absorbs energy from the lasers, propelling the pulses farther down the length of fiber.



8 When the light reaches its destination, a **detector** captures the pulses and, in a multimode fiber, sorts them according to their frequencies and angles of travel.

9 A **demodulator** receives the light signals from the detector and converts them into electrical impulses to send the data to computers, TVs, and other electronic equipment.