LIGHTING UP THE SWITCHBOARD

Communications by light rather than electricity may prove the wave of the future

BY DIETRICK E. THOMSEN

Exactly when a kind of technology ceases to be experimental and becomes a routine application is not always easy to determine, but it seems a good bet that future historians will look back on the early 1980s and pick one of these years as the time when fiber optics went into routine application in the world's information transmission systems.

Fiber optics is the transmission of messages by light waves along specially designed light-conducting fibers. Such an optical system has many analogies to the traditional use of electrical waves in wires, and fiber optics can be interconnected with electrical systems by use of proper transducing elements. Thus it is possible for the purposes of testing to insert piecemeal fiber-optic circuits into telephone systems that are over all traditionally electric. Testing can easily become routine use, and that seems to be on the verge of happening to fiber optics. Some of the systems planned for installation in the next few years look like major communications networks rather than simple field trials in randomly selected places.

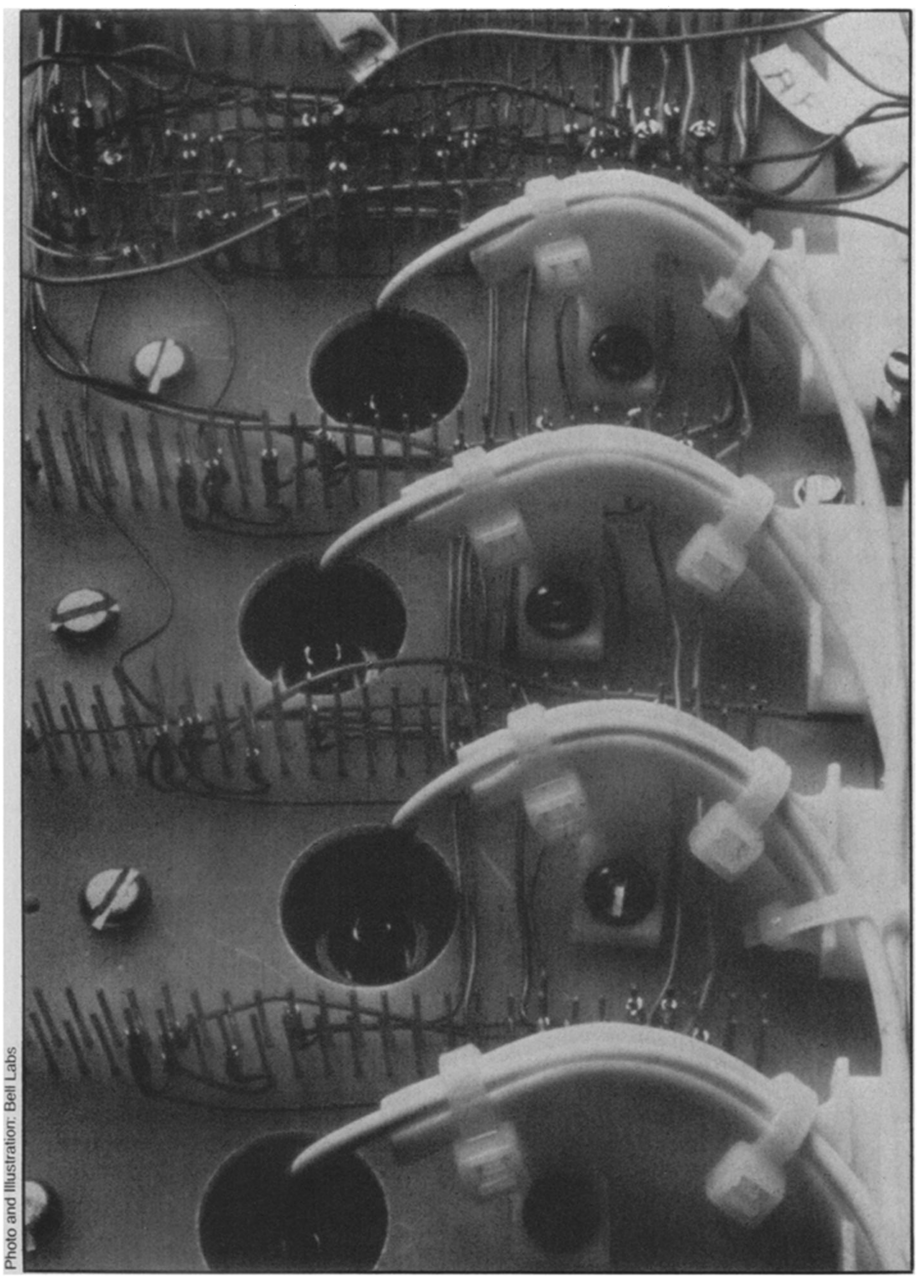


Photo and Illustration: Bell Labs

A long-wavelength lightwave system in Sacramento uses these lightguides connected to light-emitting diodes (LED's) instead of lasers. The LED's provide less light but last longer.

The main advantage that fiber optics promises is more communications channels proceeding through a much thinner conductor than electric transmission. The problem of getting more channels into the same lateral space is already acute in the world's largest cities, and so it is hardly surprising that many of the trials are in and between some of the world's talkiest urban areas: New York, Washington, Los Angeles, Tokyo, Shanghai, Beijing, Berlin, Paris, London. The installations discussed at the recent Third International Conference on Integrated Optics and Optical Fiber Communication held in San Francisco may not be an exhaustive list of all the trials under way in the world, but they do seem to be a representative sample of what is being done in North America, Western Europe and Eastern Asia.

Exactly where it seems feasible to insert fiber-optic technology into the world's telephone circuitry depends on the density of traffic. Traffic is counted in millions of bits or megabits per second. A bit is a basic binary information unit, a yes or no, an up or down, a left or right command for a switch, a single digit (0 or 1) in a binary number that codes some word or concept or some telephonic sound pattern.

Circuitry with different maximum transmission rates is employed for different purposes. J. E. Midwinter of British Telecom Research Laboratories in Martlesham Heath, Ipswich, United Kingdom, who reviewed developments in Western Europe, pointed out that the Europeans generally rank circuits according to whether their capacity is 2, 8, 34, 140, 280, 560 or 1,120 megabits per second. Of these, fiber-optic systems are available in 8, 34 or 140 megabits per second in one country or another.

Eight megabits per second is the rating for circuitry used in local switching. A fiber-optic system of this capacity is just barely economic, Midwinter says, so interest in 8-megabit fiber-optic systems for telephony is greatest in countries that have a lot of locations with high-density local switching, Italy and Great Britain in particular.

In addition there is a good deal of interest in this level of circuitry for providing individual subscribers with a wide variety of new services at the press of a button: telephony, of course, plus picture phones, pay television, interactive television, interactive police and fire alarms and various information services. It would no longer be just dialing up the time or the weather. Stock market reports, commodity market reports, the time of the next train to Frankfurt or Milano might be available, along with connections to reference libraries or archives for answering questions or retrieving documents without leaving home. For this collection of services, Midwinter says, the French have coined two useful words, *télématiques* and *informatiques*.

By 1983 the French Ministry of Posts, Telephone and Telegraph expects to provide 1,500 subscribers in the resort city of Biarritz with a fiber system running right into their homes (with messages both in and out by fiber). This will bring them picture phone, color video, data services and telephony. A much smaller system, serving 28 homes with TV, stereo music, data, etc., is operating in West Berlin. Another that offers several TV channels is running in Canada, in Elie, Manitoba. A system that would provide interactive TV is expected to begin in the city of Milton Keynes in Great Britain in 1984. Midwinter remarked that he hoped that 1984 as a date for starting interactive TV in a British city is not an evil omen.

All the West European countries seem to be interested in fiber-optic circuitry at 34 megabits per second. This is useful for short- and medium-distance trunks. Every system is likely to have some of those where optical transmission would be an advantage. Circuitry rated at 140 megabits is, by European standards, for long-haul trunk lines, in the tens to hundreds of kilometers. Interest here is largely also in Italy and Great Britain. Great Britain plans a nationwide network of 140-megabit lines.

One advantage of using light waves as carriers, as Midwinter pointed out, is that they're not subject to the electromagnetic interference that disturbs ordinary wire transmissions. They are thus not much affected by the proximity of high-power electric transmission lines, and so fiber-optic lines can readily share the rights of way of electric railways. According to Midwinter's report, this is being done successfully with lines in the tunnels of the Paris metro and the London tubes. A line 7.9 kilometers long is now being installed in the BART tunnel under San Francisco Bay to connect San Francisco and Oakland. J. S. Cook of Bell Laboratories, who reviewed field tests in the United States, reminded his hearers that the meeting hotel stands above the Embarcadero station, one of the termini of this installation.

One of the three Chinese field trials mentioned by Chi-ming Wang of the Institute of Semiconductors of the Academia Sinica in Beijing also shares the path of an electric railway. In this case it is above ground. The fiber cables are hung from the poles that carry power lines for the trains. It runs for 10.6 kilometers in Beijing. An installation under the streets of Shanghai provides facsimile and photo transmission, TV pictures and picture phone. It uses fibers made in China. Finally, Wang mentioned a 13-kilometer line in Wuhan.

The first West European field experiment started in 1977, according to Midwinter. Wang says Chinese field trials started in 1976. The United States was a year ahead of that with an installation in Atlanta in 1975. This was followed by another test under the streets of Chicago. Both those installations are now dismantled, but others are operating in Colorado Springs, Sacramento, San Francisco and Trumbull, Conn. One in downtown Manhattan (laid in compressed air ducts because the telephone ducts were too crowded) connects the computer that takes service orders with the computer that decides what to do. The longest now operating for the Bell System goes from Pittsburgh to Greensburgh, Pa., a 40-mile run that uses a total 2,800 kilometers of fiber.

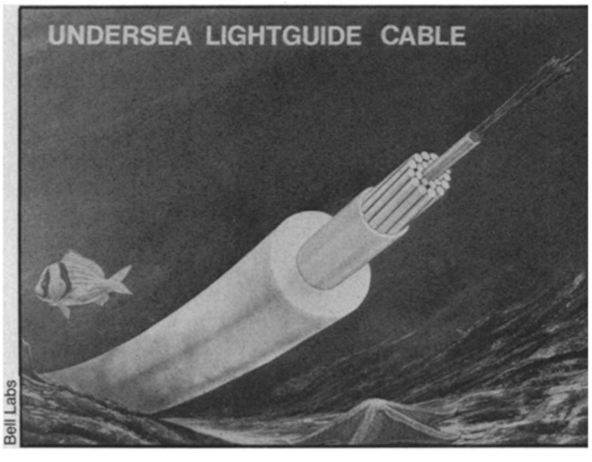
Lines will generally get longer. Planned for 1981 is a line in New York between White Plains and East 38th St. in Manhattan, a line between Newark and New Brunswick in New Jersey and the BART tunnel line. A system is being built for the 1984 Summer Olympics to provide ABC television with digital video transmission linking 23 game locations around Los Angeles with TV studios in Gardena and Sherman Oaks. At the Lake Placid Winter Olympics Bell provided a somewhat less complex system, also for ABC (the television concessionnaire for both games). "If you saw the famous Russian-American hockey game, you saw it on optical cable," Cook says.

By 1983 long lines connecting the major cities of the Northeast and the major cities of California are expected to be in place. In the East that means lines between New York and Washington and between New York and Boston. In California it includes Oakland to Stockton, Stockton to Sacramento, Stockton to Bakersfield to Los Angeles and Hayward to San Jose.

The light sources for these things are tiny solid-state lasers or light-emitting diodes (LED's). They have to be able to couple to fibers that are characteristically a tenth of a millimeter thick. Developing them was itself an interesting chapter in the recent history of physics and technology.

Most of the fiber-optic systems now operating use wavelengths from the long-wave end of the visible spectrum. Midwinter says most of the European systems use 850 to 900 nanometers, which is red. Some U.S. systems push down into the orange. It happens that the optimum wavelength for use in these fibers is about 1.3 micrometers (1,300 nanometers), somewhat into the near infrared. There, power loss by absorption in the fiber material is at a minimum and so is distortion of the pulse shapes by dispersion of the waves in the material.

In recent years both lasers and LED's that emit 1.3-micrometer light have become available, and this wavelength is now being tested in all three of the main categories of telephone circuitry. Bell Systems say they were the first to use it, having put it into their fiber-optic local switching circuit in Sacramento in 1980.



Bell Labs

Continental Telephone Co. of Virginia claims the first interoffice trunk line, 20 kilometers from Woodbridge to Triangle, Va. (SN: 5/2/81, p. 277). Nippon Telephone and Telegraph reports the first use in a long-haul line, 80 kilometers in the environs of Tokyo (SN: 5/2/81, p. 277).

Light at 1.3 micrometers seems especially attractive for long-distance use. Nippon Telephone and Telegraph is planning to begin installing such circuitry in its long lines in the next few years. British Telecom is considering 1.3 micrometers for its national network of 140-megabit lines, and Bell is considering 1.3 micrometers for long lines in the United States. Finally, 1.3 micrometers is the recommendation of the people planning a transatlantic fiber-optic cable.

That's right, a transatlantic cable. P. K. Runge of Bell Laboratories, who described the project at the conference, sought to disarm scoffers by pointing out how fast transatlantic telephone traffic has grown since 1956 when a cable carrying 50 voice circuits was in place. It has been a growth of between 21 and 27 percent annually. In 1983 a 12,000 circuit cable will be needed, and the need for much more will soon follow.

There is already some underwater fiber-optic cable being tested. Midwinter mentioned a 10-kilometer line across Loch Fyne in Scotland. He stresses that it uses a real cable ship and real cable with a repeater at the 5-kilometer mark. "It's not just playing around."

A repeater is an element that restores the power and signal shape lost to absorption and dispersion in the cable. The cable being designed for the Atlantic would have repeaters every 30 to 35 kilometers. They would get power from a metal conductor threaded through the center of the optical fiber weaving. This cable is planned to carry 12,000 channels or 24,000 circuits total, and it would run from Tuckerton, N.J., to a branch point off the European coast, from which lines could go to several countries, Great Britain, France, Spain, etc. The first fiber-optic test installation was a couple of kilometers long. This proposal is for a 6,500-kilometer line. The technology seems to have a scintillating future. □