TWO

Will Satellites and Optical Fiber Collide or Coexist?

ROY A. LAYTON

Satellite and optical fiber systems may be on a collision course. Announcements of planned satellite launches as well as announcements for millions of miles of fiber-optic circuits raise a serious question: Will sufficient demand exist to use such huge oversupply of transmission capacity? If all of the announced projects get off the ground, the total capacity of the long distance market will grow nearly eightfold over the next five years.

COLLIDING SUPPLY FORCES

Since price is a function of supply and demand, these colliding supply forces may create fierce competition and declining prices that could shake the foundation of deregulated telecommunications. On the other hand, innovation might create new demands extending beyond the range of applications in use today. Can we avoid a telecommunications San Andreas Fault?

The French poet Paul Valéry once remarked that the future isn't what it used to be. His words stand as both a caution against history's capacity to blindside us and as a challenge to look ahead.

As satellite and fiber-optic supplies progress down similar paths, a look at the history of these technologies will serve as a benchmark for future growth comparisons. Comparing the facilities available today to the projected growth for 1990 will help you see the extent to which evolving technology will shape twentieth-century demand.

Looking at the historical perspective first, the paradox of the late twentieth-century telecommunications evolved from the genius of Alexander Graham Bell. Among his many patents, four covered his invention of the photophone and two the selenium cell. In 1880, Bell demonstrated that a beam of sunlight reflected off an acoustic horn-mounted diaphragm could be used to carry sound to a distant speaker that was equipped with a selenium photocell. In a single demonstration, Bell laid the foundations for lightwave transmission and remote solar-driven relays, which are components of satellite systems.

Art imitated research when, in 1945, science fiction writer A. C. Clarke first proposed satellite communications. In 1954, J. R. Pierce suggested that you could accomplish such communication by bouncing signals off passive satellites or relaying them through electronically equipped units. Pierce concluded that you could place a satellite in geostationary orbit so that its position would be fixed in relation to a ground point if its orbital velocity were to match the earth's rotation at 22,300 miles above the equator.

The Edge of Space

Three years later the Soviet Union astounded the world and partially realized Pierce's vision with the launch of Sputnik, a primitive orbital radio transmitter. The United States responded with an accelerated program that resulted in the successful 1960 Echo I experiment using a 100-foot diameter passive, low altitude reflection balloon.

Following construction of the advanced earth station at Andover, Maine, in 1962, the Bell System launched its first Telstar satellite, ushering in the age of the full communications relay satellite. Further milestones in the development of satellite technology for commercial communications include:

- First satellite in a series of launches by the international consortium INTELSAT, organized in 1964 to develop a world satellite network. This series of satellites refined the technology later used to produce Westar I and most satellites in use today. (1966)
- First geosynchronous orbit commercial communications satellite launched by the Canadian Government—ANIK-A. (1972)
- Western Union launched what Newsweek president Gibson McCabe called "The Golden Spike of the American Skies." The launch provided an alternative to AT&T for long-distance voice, data, and video telecommunications and served to rejuvenate the cable television industry. It provided a new source of programming for broadcast stations, revolutionized electronic news gathering, and set the stage for satellite broadcast to homes—Westar I. (1974).
- Satellite Business Systems (SBS), a venture of IBM, COMSAT, and the Aetna Insurance Company launched the first commercial communications satellite primarily designed for use by private earth stations—SBS-I. (1980)
- The Spaceshuttle Columbia pioneered the concept of a reusable "space trunk" for satellite launch, maintenance and replacement with its first communications satellites—SBS-III and ANIK-B. (1984)

A $3.1 billion satellite industry has emerged from the U.S. space program. The market-share players: the American Satellite Company, a partnership between Continental Telecom, Inc., and Fairchild Industries; RCA; SBS; Western Union; Telstar (AT&T); Galaxy (Hughes); and Comstar (COMSAT).

Harnessing Light

Just as the pace of satellite service development was quickening with the formation of INTELSAT during the mid-1960s, a breakthrough occurred in harnessing light for future telecommunications applications. At ITT's Standard Telecommunications Laboratory in England, C. K. Kao and G. A. Hockham suggested that light waves could be guided by glass to where they were needed, solving the distance limitation of Bell's photophone. By 1970, scientists at Corning Glass Works had made the idea work.

Hair-thin pieces of silica glass could bend easily to serve as "waveguides" for light waves. At the same time, advances in semiconductor technology made possible the fabrication of efficient light sources which could be modulated with an external digital signal. The convergence of these two technologies through field trials starting in 1975 harnessed light as a source for telecommunications transmission.

In an optical fiber, light is funneled in one end, is repeatedly reflected at a low critical angle off the walls of the fiber, and emerges at the same angle at the other end—as if it had been placed in a pipeline. In contrast with our everyday experience with sunlight, this property of optical fiber holds true no matter how many turns and twists the fiber makes along its length.

A fraction of the diameter, lighter weight, and circuit-for-circuit cheaper than copper wiring, fiber-optic cable provides transmission capacities beyond any conventional medium. A single pair of glass strands can transmit more than 14,000 32k-bps voice conversations, more than 50,000 data channels, or a variety of voice, data, and video combinations at 560M bps, limited only by user need and matched electronics at each termination point.

For nearly two decades the promise of transmitting information over fiber hovered on the telecommunications horizon. By 1978 some 600 miles of fiber optics had been installed worldwide.

Confronted with the realities of the marketplace and recognizing the potential of fiber optics, many companies concentrated on the growing telephone market. Significant milestones in this development include:

- General Telephone installs nearly six miles of fiber for telephone service between Artesia and Long Beach. (1977)
- Illinois Bell connects two central offices approximately one mile apart. (1978)
- AT&T announces a 611-mile system that could connect major cities in the Boston-Washington corridor. (1980)
- MCI announces a New York to Washington link along Amtrak right of way. (1983)
- Lightnet, a venture between CSX and Southern New England Telephone, announces initial plans to lay fiber alongside 5000 miles of railroad track. (1983)
- AT&T announces a $2 billion construction program to expand its digital communications network. Included are 21,000 miles of fiber-optic cable. (1984)

The possible collision between satellite and fiber systems was interrupted when a five-year-old antitrust suit between AT&T and the Justice Department was settled on January 8, 1982.

With a target date of January 1, 1984, AT&T and the Department of Justice settled what had been the largest antitrust suit in history and agreed to sweeping changes in the telephone marketplace. Life for America's telephone users changed irrevocably.

The Modified Final Judgment (MFJ) ruling opened the door fully for competition and, on both the supply and demand sides, its provisions removed the major economic structural barriers that had existed in the industry. The cornerstone of the settlement—equal access to local facilities—established competition as the substitute for regulation of interstate facilities. Clearly, the forward trend in U.S. telecommunications is competitive, cost-effective transmission at prices forged in the crucible of supply and demand.

Aftershocks from divestiture further destabilized a telecommunications industry still recovering from what Prime Minister Thatcher's former aide, Sir John Hoskyns, termed "insurmountable opportunities."

The end-user market has been placed in a four-way crossfire between AT&T's public network, established microwave, new competing satellite, and a growing number of fiber-optic carriers. Claims and counterclaims abound over the application superiority of each respective technology. And prospects of economic gain to "buy in" attract users of long-haul services.

COMPARATIVE ADVANTAGES OF SATELLITE AND FIBER OPTIC TECHNOLOGIES

Satellites and fiber optics each have salient technological and economic advantages which will bear on future competition for international transmission.

Satellites are insensitive to distance. All transmissions travel 44,600 miles via spacelink and are insensitive to distance between uplink and downlink locations within the footprint. Operating locations can be changed as business requires. This allows freedom from concern over available terrestrial facilities and long lead times.

Additionally, with only a few switching points between locations, compared to the hundreds of relay points involved in using terrestrial facilities, satellite signals stay neat and clean. There is much greater signal clarity than for conventional transmissions which tend to pick up noise.

Fiber optics, in comparison, allow freedom from the propagation delay which has been problematic for satellites. Fiber transmissions travel point to point at a fraction of the time it takes for the satellite transmission's round-trip distance. No pause between voice intervals occurs, nor are there lapses in data transmission.

Fiber optic transmission is not weakened by heavy rain and snow problems that affect satellite earth stations and nor is it affected by sunspots. Fiber optics have interference immunity, avoiding the radio, microwave, and airport interference that can cause site selection or hardware location problems that exist for C-band earth stations. Moreover, optical fiber eliminates costly foundation or roof reinforcement. All commercial buildings have three or more rights of way—telco, power, fuel—that can be used to install the fiber cable.

Cost considerations will no doubt continue to be relevant to decisions about these two technologies. The potential cost savings for satellites are greatest when the distance between serving points exceeds 1,100 miles compared to microwave, 120 miles when compared to fiber for DS-1 equivalent increments. The potential cost savings for fiber optics, on the other hand, are greatest when the distance between serving points is less than 700 miles compared to microwave, and 2,500 miles compared to satellite for carrier increments of 2,700 circuits.

A Surplus of Satellites

A surplus of satellite transmission capacity continues to define the marketplace. According to the FCC Common Carrier Bureau, twenty-one domestic satellites are now operating and ten more are scheduled to be launched this year. It has been estimated that only two-thirds of current domestic capacity is being used.

Transponders have moved from the attempted auction prices of 1980 to the $3.5 million to $4 million each that is rumored to be the prevailing rate. Compared to a transponder price of $13 million in 1981, the current rate means an opportunity era for entrepreneurs with new applications such as Equatorial Communications and end users who welcome declining prices.

Firms comprising the industry's brain trust have generated a stream of research reports projecting supply, demand, and comparative costs. Among these, a projection by International Resource Development shows the change in use of domestic satellites from 1983 to 1990. Of 356 transponders in 1983, 53 percent were used for voice, 28 percent for video, and 19 percent for data. By 1990, voice is projected to be 43 percent of 1,050 estimated transponders, data will increase to 40 percent, and video will drop to 17 percent.

The basis for evaluating projected capacity is the total circuit miles available at year-end 1984. According to Compucon Inc., AT&T totaled 811 million circuit miles, MCI's microwave, cable, and fiber totaled 265 million circuit miles and GTE's network comprised 100 million circuit miles, for an overall total of 1.18 billion circuit miles.

In addition, NASA reported 356 operational transponders, of which 72 percent or 256 were in use for voice and data transmission, according to International Data Resources. If you use a ratio of 300 circuits per transponder and an average of 1,000 miles per "equivalent" transponder circuit, you add an additional 76.8 million circuit miles of satellite capacity to the terrestrial capacity just outlined. Therefore, the total terrestrial and satellite capacity at year-end 1984 is estimated at 1.25 billion circuit miles.

Several estimates of transponder growth are available. International Resource Development projects 1,050 by 1990. James Martin, speaking at the Communications Network 1985 conference, projected 1,072 in 1987. NASA projects 1,145 by 1990. These figures are well within the 1,254 transponder capacity available at two degree spacing within the orbital arc. If you estimate transponder availability at 1,000 in 1990 and convert it to "equivalent" terrestrial capacity, the result is approximately 300 million circuit miles of satellite capacity available in 1990.

Fiber capacity will grow sixfold by 1988 if approximately $6 billion worth of announced projects are installed. For example, United Telecommunications plans a 23,000-mile system. MCI and GTE have announced plans that total 22,000 miles. AT&T announced a 21,000-mile network. Fibertrack, a joint venture of Norfolk Southern Corp. and Santa Fe Southern Pacific Corp., plans an 8,100-mile network. Lightnet plans a 4,000-mile system serving 43 cities. Many other projects have been announced and more are on the drawing boards.

Transmission Capacity in 1990

By 1990, it is conceivable that 8.19 billion circuit miles of terrestrial capacity could collide head-on in the marketplace with 300 million circuit miles of satellite capacity. If total capacity approaches 8 billion miles by 1990 as estimated, then capacity will shift from S to S1. Demand is expected to increase at a lower rate than supply and thus would shift from D to D1. As a result, the market price per circuit would gradually sink along an arc, Point A to Point B, determined by the relative time for the supply and demand shifts to occur.

Synthesizing the supply and demand projections, prices should decline gradually into the early 1990s as competition intensifies and new applications fail to keep up with supply. Ultimately, market forces will take care of the imbalance.

A Sampling of Opinions

"You have to look at this in two time frames," contends Ray Fentriss, executive vice president of Gartner Group.

> For this decade, satellite transmission should continue to be viable and competetive. Beyond 1990, the emerging fiber-optic facilities will provide ubiquitous high bandwidth capabilities for the highest volume traffic routes. Even if fiber proves to be more economical on the heavy traffic routes, satellites will enjoy success in providing transportable earth stations that allow instant connectivity and broadband capacity where no other communications facilities exist.
>
> These two technologies can co-exist in the future and their unique characteristics will be exploited to meet the growing need for pervasive, easy-to-connect bandwidth.

At the Newport Conference on Fiber-optic Markets, Charles Wakeman, vice president and general manager of Siecor Corp., predicts a hesitation in the market, a downturn in the growth curve between 1987 and 1990 as dust settles from the competitive battles now starting.

James Martin, widely regarded as the foremost spokesman on the social and commercial impact of computers in communications, said at the Communications Networks 1985 conference, "I doubt whether we will have a serious bandwidth glut in fiber or satellite. When technology permits taking the brakes off 9.6 transmission, the need for faster speeds will require large amounts of bandwidth."

"With the advent of fiber-optic technology, many people believe that it has become a ubiquitous communications link for long-distance traffic and that the role of satellite technology is declining," says Arthur Parsons, senior vice president of American Satellite. "In actuality we've seen very little fiber laid and only along high-density routes which can support its high cost."

INFORMATION AGE OPPORTUNITY

"In the future," Parsons says, "fiber will complement satellite technology and a trend toward integrated networks which use fiber for short distances will occur. Satellites are uniquely suited for such services as broadcasting and it will be virtually impossible to replace them. As larger satellites with enormous transmission capacity and power are launched, space segment cost will drop dramatically and antenna sizes will shrink. I predict a very bright future for satellites in the business communications marketplace."

Howard Anderson, managing director of the Yankee Group, says, "The only way we will be able to use all of this capacity is if Congress passes a law requiring every American to participate in five videoconferences a day."

As you evaluate these opinions, remember the words of John W. Gardner: "We are all faced with a series of great opportunities brilliantly disguised as insoluble problems."

The United States already leads the world in research and development, spending more than $70 billion per year. Communications and electronics are among the top five investment areas.

As the domestic economy moves forward from the industrial to the information age, telecommunications is fast becoming the new strategic variable for every business enterprise. Entrepreneurial spirit will raise capital and build capacity. Visionaries will develop new applications not conceivable today. The fault plane in the foundation of deregulated telecommunications should remain stable as the forces of technology and growth propel demand to fill new satellite and fiber systems. The race is on.

Reprinted with permission from *Telecommunication Products Plus Technology*, (Littleton, Mass.: PenWell).