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Level (3) Communications in 2001: The 'Pivotal Year'

> "We think that technological change is in the process of blowing the telecommunications industry apart and that we can be the dominant, low-cost player in the business of transporting data." --Jim Crowe, Chief Executive Officer, Level (3) Communications[1]

Founded in 1997, Level (3) Communications pursued a vision of pushing down the cost of long-distance communications bandwidth faster than its competitors.[2] Level (3) had two simple strategems: build its fiber network differently from competitors to drive down its costs, and aggressively drive down the price of bandwidth to increase demand. The "fiber backbone" company completed construction of its 16,000-mile U.S. fiber network in January 2001, three months ahead of schedule. By February, Level (3) provided service to more than 60 cities in the United States and Europe, and carried more than six billion minutes of traffic per month.

While other networks typically lay one or two conduits (pipes in which fiber would reside) in the ground, and filled them with fiber, Level (3) lay 12 during its initial network construction and left several empty. Level (3) anticipated that it would be able to "blow" a new fiber through an empty conduit at a small fraction of its rivals' costs to dig a new trench and lay new conduit as well as fiber. As a result, the firm expected to be able to take advantage of technological advances in fiber – particularly associated with lower costs – in ways that its rivals could not. In turn, Level (3) would aggressively cut prices – on the order of 50% per year, in the expectation that reductions in price would yield a threefold increase in demand.

Analysts and financial markets had consistently applauded Level (3)'s vision. Yet in early 2001, skeptics took a different perspective on the recent decline in prices charged for transmitting data over fiber cables. Some predicted that the race to build massive new networks was leading to a glut of capacity, with potentially catastrophic effects for the industry. After spending more than $10 billion on construction, Level (3) found itself under increasing pressure to cut a significant deal with at least one "anchor tenant" on its network.[3] As 2001 entered its fourth month, "the feeling around Level (3)'s Broomfield, Colorado headquarters [was] that this is the pivotal year for the company."[4]

Telecommunications Technology

For decades, telephony relied on the conversion of sound into electromagnetic waves at one end, the transportation of these waves along wires, and the re-conversion of these waves into sound

Professor Brian S. Silverman and Research Associate Briana Huntsberger prepared this case from published sources as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

at the other end. From 1877 until the 1970s, copper was the material of choice for long-distance wireline telephony.

The primary challenges in long-distance communication revolved around diminution of the electromagnetic waves or the inclusion of extraneous noise. As one industry expert described:

> "Sending [a] telephone signal is analogous to sending water through a pipe. Rushing water loses force as it travels through a pipe. The further it travels…the more force it loses and the weaker it becomes. Similarly, [a signal] weakens as it travels over distance [as it] meets resistance in the media over which it is sent…. In addition to becoming weaker, the signal picks up electrical interference, or "noise" on the line."[5]

To address the problem of weakening signals, telephone companies installed amplifiers and regenerators at regular intervals along the copper line to boost the signal. The purchase and installation of amplifiers on a telephone line typically cost far more than the purchase and installation of the copper wire itself. Over the decades, technological innovation reduced substantially the number of amplifiers needed on a long-distance line, thus reducing dramatically the cost of a long-distance network.

The advent of fiber

By the 1970s, new technologies began to replace copper in long-distance networks. Advances in microwave transmission and reception provided the means for the first long-distance rivals, such as MCI, to enter the long-distance market. Microwave technology greatly reduced the need to make significant capital expenditures to duplicate AT&T's wireline network.

The 1970s also witnessed the advent of optical fiber, which converted sound into light. Oddly enough, four years after developing the copper-wire telephone, Alexander Graham Bell himself created what he called a "photophone" that carried voice signals on a beam of light. Ultimately, though, Bell found that using copper wires was more workable.[6]

Bell Laboratories – AT&T's R&D subsidary – developed a method to mass produce optical fiber cable, and by 1977, the first full-service fiber telephone system began operating in Chicago.[7] Optical fiber, which converted sound waves into light, proved particularly suitable for long-distance communication because it required fewer amplifiers and offered better sound quality than copper (see Appendix A). In addition, fiber had a much greater capacity than copper wire. Whereas a copper wire could carry up to 12 conversations simultaneously, a single fiber in 1980 could carry many thousands of conversations at once.

Subsequent technological advances increased the capacity of fiber and also reduced the capital and operating cost of fiber. In the late 1990s, a technique called dense wavelength division multiplexing (DWDM) allowed telephone carriers to split each existing fiber strand into multiple wavelengths or "channels," each of which could carry as much traffic as a single fiber formerly did.[8] Early implementations of DWDM split each fiber into eight channels. By 1998, this was extended to 40 channels. By early 1999, DWDM raised capacity to 96 channels; by the end of 2000, this was extended to nearly 160 channels.

An alternate avenue of technological advance increased fiber capacity by increasing the speed with which electronics at the endpoints of a fiber could transmit data. This technique, known as time division multiplexing (TDM), had increased the speed of transmission along a fiber from 622 Mbps (megabits per second) in 1996 to 2.5 Gbps in 1998 and 10 Gbps in late 1999 (see Appendix B for a description of bandwidth measurement).

Technological advances in new fibers also increased capacity and lowered operating costs. Fiber manufacturers, notably Lucent and Corning, introduced new generations of fiber roughly every 18 to 24 months. Each generation typically could carry a greater capacity of information and was better able to handle increased TDM speeds. Newer generations of fiber also had lower failure rates and allowed fewer errors to creep into signals being carried, thus offering better quality carriage of traffic. Finally, newer generations of fiber typically had better signal retention characteristics – or less signal attenuation problems – than older generations. Since a signal did not weaken as quickly in newer fibers, amplifiers and regenerators could be spaced further apart on new fiber lines, and fewer amplifiers and regenerators were needed. At up to $50,000 per amplifier and $400,000 to $1 million per regenerator, this could represent a significant savings on capital costs.

In all, from 1980 to 2000, technological improvements raised the potential capacity of a single fiber strand 18,000 fold, to nearly 1,600 Gbps (10 Gbps per channel * 160 channels per strand).[9]

Exhibit 1 provides a simplified diagram of a long-distance fiber network.

Packet switching vs. circuit switching

Traditional wireline telephony involved "circuit-switching" technology. Circuit-switched communication devoted an entire channel to an exchange between two parties for the duration of the exchange. In contrast, the development of the Internet led to Internet protocol-based communications relying on "packet switching." In IP-base communication, the data being transferred during a call was disassembled into small packets. These packets were then routed to the desired destination by whichever channels had room at that particular moment and reassembled at the other end.

IP-based communication provided two advantages over circuit switching. First, although most calls entailed stretches of "downtime" – due to pauses in conversation or to pauses in data transfer – this unused capacity was wasted in circuit-switching communication. In contrast, packet switching used the downtime in a channel to send packets associated with other communications. As a result, IP-based networks had greater effective capacity than circuit-switched networks.

Second, the capital equipment associated with IP-based networks – for example, routers – was far less expensive than the equipment needed for circuit-switched systems.

Until the late 1990s, packet-switched voice communication was unwieldly, often requiring pre-arrangement of dedicated lines. By 1997, however, a small firm called XCOM developed software that converted IP signals into a form that conventional phones would accept as circuit-switched calls, thus enabling such communication to take advantage of conventional long-distance networks. Other innovations improved the quality of IP-based voice communication to approximate that of circuit-switched calls.

The economics of fiber networks

Building and operating a fiber network consisted of three separate tasks, each with its own attendant costs. The cost of constructing a "typical" network of, say, 18,000 miles, was approximately $3 billion. Physical construction costs – the labor, heavy moving machinery, etc. required to dig an 18,000-mile trench and lay conduit and fiber – accounted for more than 70% of this cost. Fiber cable, which typically contained 96 separate strands, accounted for the bulk of the remainder, with conduits representing a few percent of total costs.[10]

When first installed in a conduit, fiber was "dark" fiber – that is, it was not equipped with the appropriate electronics to carry signals. To actually carry traffic, a fiber would have to be "lit." The cost of lighting a channel on a fiber was approximately $90 to $100 million. The purchase of amplifiers and regenerators accounted for the bulk of this cost. In 2001, amplifiers were placed roughly every 60 miles along a fiber, and regenerators roughly every 350 miles.[11]

Finally, there was the cost of maintaining and operating an already-lit channel. Maintenance cost about $30 million per year.[12] A carrier also incurred SG&A costs associated with trying to obtain customers and encourage them to route traffic along its network. For each piece of traffic carried (i.e., each call made or each bit transported), a carrier incurred access fees if that traffic traveled over local exchange carriers' systems. Aside from these access fees, and theoretically an infinitesmal amount of wear and tear on its transmitting equipment, a carrier did not incur incremental costs with each call made or each bit transported.

The Telecommunications Industry

The First 100 Years [13]

The first century of telecommunications in the United States was largely the story of American Telephone & Telegraph (AT&T), originally called Bell Telephone Company. In 1876, Alexander Graham Bell invented the telephone. After an unsuccessful attempt to license the resulting patents to Western Union, Bell and several businessmen organized the Bell Telephone Company the following year. During 17 years of patent protection, Bell enjoyed a monopoly over phone service in the U.S., and established local exchanges, and long-distance connections among them, in thousands of cities and towns.[14]

Yet by 1902, eight years after Bell's patents expired, more than 4,000 phone companies operated in the U.S., with most focusing on providing service within a specific town or village. In many communities, residents had to keep two telephones in their houses – one from AT&T for long-distance service and a second from the local telephone company for calls within the town.

Beginning in 1907, J.P. Morgan (who had acquired control of the firm) and AT&T President Theodore Vail launched an initiative to systematically erode independents' market share through a combination of aggressive price cuts and acquisition of financially straitened independent operators. Vail defended the strategy in AT&T's annual report: "[AT&T's] 'universality of service and connection [is] of infinite value to the business world, a service which could not be furnished by dissociated companies."[15]

In 1913, facing possible antitrust action, the company agreed to submit its activity to regulatory oversight in exchange for immunity from near-term antitrust litigation. From then until 1984, AT&T was a regulated monopoly, protected from competition in most aspects of telephony, but prevented from diversifying into new businesses (for fear that AT&T would use its monopoly profits to subsidize its non-monopoly businesses). Economists (and more importantly, perhaps, politicians) frequently perceived phone service to be a "natural monopoly" – in other words, the presence of two phone companies would be inefficient because they would need to duplicate all the facilities necessary to provide telephone service.[16]

In 1969, the government ended AT&T's monopoly in long distance – but not its monopoly in local exchange – by allowing entry by rivals such as Microwave Communications, Inc. (MCI). Yet long-distance calls still had to originate and terminate through the local networks. Amid complaints from long-distance competitors that AT&T was using its local monopoly to disrupt their ability to gain business, the FCC filed an antitrust suit against AT&T. In 1984, after several years of litigation initiated by the Department of Justice, AT&T was broken into several separate entities. According to the terms of the AT&T Consent Decree, the company agreed to divest its 22 local phone subsidiaries, which were aggregated into seven regional Bell operating companies (RBOCs) also known as the "Baby Bells."

After the breakup, then, phone service was divided between long-distance carriers (also known as interexchange carriers or IXCs) such as AT&T and MCI, and local exchange carriers (also known as RBOCs, incumbent local exchange carriers or ILECs). Long-distance service was competitive, while local service was provided by a regional monopolist. Under the terms of the breakup, ILECs were prohibited from entering the long-distance segment and AT&T was prohibited from providing local phone service. Other long-distance carriers, while not legally barred from entering the local business, stayed out of that market due to the enormous economic impediments.

The 1990s: Telecommunications Act of 1996 and the Rise of the Web

Over the next decade, long-distance telephony became increasingly competitive, while local telephony continued to persist as a collection of regional monopolies. The Telecommunications Act of 1996 set the stage for greater competition among providers by encouraging ILECs, IXCs, and cable television operators to enter each other's markets. Although a number of factors led to the passage of this Act, an important motivation was legislators' belief that innovation in high-capacity telecommunications infrastructure would occur most speedily in a competitive environment. Under the terms of the Telecommunications Act, an RBOC would be allowed to compete in the long-distance market – but only after it could provide sufficient evidence that its own local market was freely open to competition. An RBOC could do this most readily by allowing other providers to hook their lines up directly to its central office switches.

Following the passage of the Telecommunications Act, hundreds of new companies were created to provide local phone service. Competitive local exchange carriers, or CLECs, began trying to take market share from the Bells.

Almost concurrently with the passage of the Telecommunications Act, the "Internet era" was born. In 1994, Netscape launched its first browser. By 1997, more than 40 million users were regularly logging on to the Internet. The rise of the Web increased dramatically demand for high-bandwidth telecommunications.[17] This, in turn, increased demand for communications networks based on optical fibers rather than copper wire, thanks to the broadband capacity of optical fibers.

Incumbent long-distance carriers such as AT&T had installed fiber lines in their long-distance networks as early as the 1970s. Sparked by the advent of the Web, however, several new firms entered what they called the "high-bandwidth fiber backbone" business. Firms such as Level (3), Qwest, Williams, and Global Crossing each undertook ambitious plans to construct fiber networks, thousands of miles long, to connect major metropolitan areas. Incumbents responded by adding fiber, and upgrading old fiber, more quickly.

In most cases, the resulting networks consisted of "rings" encircling cities, with connections between rings. These firms typically did not build new connections for the "last mile" – that is, from the ring into each house or building. Rather, they contracted with local exchange carriers to enable origination and termination of calls.

Thus, by 2000, the once stable and simple telephone system had become a complex landscape, populated by a bewildering variety of firms (see **Exhibit 2**).

Suppliers

In 2000, the optical fiber industry posted sales of more than $9 billion. Corning and Lucent accounted for 75% of the industry's sales.[18] These firms conducted significant R&D, in order to capture perceived benefits of being first to market with new technological advances in fiber.

Within a given generation of fiber, fiber cable was a largely undifferentiated product, available to all comers at about the same price. Although each new generation of fiber was better technologically than its predecessors, manufacturers typically sold it at the same price as earlier generations. Thus, the quality-adjusted cost of fiber fell steadily throughout the 1990s, from approximately $600 per Gb-mile per second in 1995 to approximately $100 in 2000. This downward-sloping price curve was expected to continue.[19] By the fall of 2000, fiber manufacturers tended to have a 16-month lag between fiber orders and delivery, a shortage that was expected to continue at least through 2002. Manufacturers were therefore in a position to pick customers, favoring those who could provide cash up-front and offer a firm commitment with orders.[20]

The electronics required to light fiber networks consisted of terminal equipment such as multiplexers, and equipment installed along the line such as amplifiers and regenerators. Although expensive, this equipment was small and easy to install, consisting primarily of "cards" that could be snapped into a fiber system. Lucent, Nortel Networks, Fujitsu, and Alcatel were among the larger suppliers of these electronics.

Customers

Purchasers of fiber network services (and sometimes of dark fiber installed by fiber backbone firms) could be divided into four groups. Fortune 1000 corporations typically relied heavily on extensive voice, intranet, and internet services. A large corporation might dedicate dozens or hundreds of servers to link its geographically disparate plants and offices through an intranet. Such a firm might employ additional servers to handling Internet traffic from customers, suppliers, and other external parties. The intranet and Internet demands on this type of customer had risen significantly between 1994 and 2000, from thousands of "hits" per day to millions or tens of millions of hits.[21]

Dot.com companies represented a second type of customer. Although small, these firms required an unusually high level of broadband capacity to handle their operations. A major dot.com company such as Yahoo attracted over 625 million hits per month.[22] By October 2000, Yahoo had 166 million unique users.[23] In January of 2000, Jupiter Research predicted that top 10 content sites, would experience a 250% increase in page views over the next four years.[24]

The third customer segment consisted of smaller web-centric companies such as application service providers (ASPs), Internet service providers (ISPs) and Web hosting firms. Although small, these firms' operations consumed large amounts of bandwidth. These types of firms were expected to continue their dramatic growth.

Finally, the hundreds of long distance resellers – carriers that did not have their own networks – would purchase fiber service from backbone firms in bulk to obtain volume discounts, and then attempt to resell the service in smaller increments at higher prices.

In 2000, global demand for bandwidth was estimated to be approximately 5.4Tbps. 70% of this traffic originated and/or terminated in the U.S.[25] Demand was driven by the level of Internet use, the average bandwidth available to each user at their local connection, and usage patterns (i.e., the proportion of total users who were online at peak times), among other features.[26]

Demand for bandwidth, both in the U.S. and globally, increased at a dramatic rate through the late 1990s. In the late 1990s, fiber backbone providers predicted that Internet demand was doubling every three to four months, although other analysts estimated that demand would more likely double every twelve to 16 months. By 2001, analysts predicted demand growth during 2001 of 60-70%.[27]

In part, these discrepancies in demand growth estimates were attributed to a slackening in Internet use. By late 2000, the number of "active users" of the Internet had declined to 70 million from 77 million at the beginning of the year.[28] Users were also spending about 20% less time on the Internet, on average.[29] In part, they were attributed to carriers' desire to perpetuate an unrealistically optimistic view of "hypergrowth" to appease Wall Street.[30]

Reaching the end customer

Long distance carriers were traditionally dependent on local exchange carriers to reach their customers, whether residences or businesses. The attendant access fees were often the largest cost on an IXC's income statement, accounting for as much as 40 cents of every long-distance revenue dollar. In addition, local exchange carriers – particularly the RBOCs – were perceived to be slow in their deployment of fiber in the "last mile" into homes and office buildings. Fewer than 10 million homes were expected to move beyond narrowband, or dial-up, connections by 2001. Similarly, businesses served by competitive local exchange carriers (CLECs) might have access to high-speed networks in urban centers, but most in suburban and rural areas had no access to local fiber.[31] Forecasts of future DSL and cable modem penetration varied, with several industry observers estimating that these technologies would rise from their current penetration of 6% in 2001 to 70% in 2005.[32]

The larger long-distance companies looked for alternate ways to cover the last mile. AT&T purchased the cable companies TCI and MediaOne in order to gain broadband access to more than 17 million subscribers over cable lines. Similarly, Sprint and MCI WorldCom bought multipoint multichannel distribution services (MMDS) licenses, hoping to redeploy this wireless technology for high-speed access to consumers' homes.[33]

Competitors

The long-distance telecommunications industry in 2000 was dominated by three firms: AT&T (with 42% of long-distance revenues), MCI (26%), and Sprint (12%). The remaining 20% of the market was divided among 400 smaller companies, with Qwest and Global Crossing the largest among them.[34]

In the mid-1990s, a number of new entrants as well as incumbent long-distance firms began ambitious projects to construct vast fiber communication networks. These firms typically built their networks by digging trenches, laying down conduits, and running fiber through these conduits. By the end of the 1990s, a large number of players had embarked on massive construction projects to lay down thousands of miles of fiber (see **Exhibit 3**).

Due to the high labor costs of deployment, many companies had decided to install more fiber than they currently needed. The networks installed by Level (3) and its competitors, as well as by the large long-distance companies like Sprint and AT&T, all contained large quantities of dark fiber.[35]

Most network carriers leased or sold large amounts of their installed dark fiber to other firms that wished to light and use internally, or perhaps resell, this fiber capacity. These carriers were able to sell the dark fiber for as much as six times their cost of installation. For example, in 2000 Global Crossing sold 3% of the fiber in its Asian cable, and recouped 18% of its total expenditure on that cable.[36]

As demand grew sharply with the Internet, it threatened to overwhelm existing broadband supply in the mid-1990s. Carriers responded with ambitious construction projects, adding more than 300,000 fiber miles within the U.S. in 1996, 1.5 million more by 1998, and 5.6 million in 2000. In-process projects were expected to generate one million new fiber miles in 2001, and more than 700,000 in 2002.[37]

These figures represented dark fiber, and consequently did not reflect actual lit capacity. In 2000, less than 7% of all laid fibers were lit.[38] Nevertheless, lit capacity was expected to increase by 100% to 110% in 2001.[39]

Throughout the late 1990s both the cost to provide fiber-based communication and the price charged for it had fallen. In 1999 and early 2000, wholesale bandwidth prices declined at a rate of 20% to 30% per year. On more competitive routes, prices were falling by 40% to 60%.[40]

During the latter half of 2000 and the early months of 2001, the price of bandwidth fell more rapidly. The price paid to purchase dark fiber from a carrier declined by more than 40% in the U.S. and 60% in Europe, and as much as 80% on more competitive routes.[41] Whereas the price for telephone service was about five cents per minute in AT&T's 1999 contract with the General Services Administration, the 2000 contract set a price of two cents per minute.[42] By March 2001, the price of a dedicated line between New York City and Los Angeles had fallen to $15 per month, or 50 cents per day.[43]

AT&T

AT&T had a broader scope of products than perhaps any of its competitors. In 1998, AT&T appointed C. Michael Armstrong, an outsider, to be CEO. After an intensive, three-month review of AT&T's businesses, Armstrong articulated four principles to guide the firm's strategy: First, AT&T needed to control the "last mile" to provide connectivity directly to its customers. Second, this connectivity had to be broadband (not narrowband). Third, AT&T needed to offer a range of bundled services over its networks. Finally, AT&T needed a wide geographic footprint.[44] As AT&T President John Zeglis described this vision, "AT&T is going to connect you over any distance, in any form, to anybody, in anyplace."[45]

In April 1999 AT&T became the largest cable provider in the U.S. – with cable passing 33 million homes – by acquiring cable giants Tele-Communications, Inc. and MediaOne. The firm anticipated that these cable connections would enable AT&T to offer integrated bundles of services, including long distance and local telephony, digital television, and Internet access. AT&T believed that these bundles would make customers more loyal, reducing long-distance customer "churn" by as much as 33%.[46]

In October, 2000, AT&T announced that it would break up into four separate entities: a Wireless unit, a Cable unit, a Business unit, and a Consumer unit. The four pieces would continue to share the AT&T brand, AT&T Labs, and the AT&T Network – which remained the world's largest communications network. The firm expected to reap several advantages associated with this breakup, including fuller exposure of each unit to market discipline and higher stock prices for the broken up "pure plays." Under various contractual arrangements, they would try to offer customers the same vision of integrated, bundled services.

Global Crossing

Founded in 1997, Global Crossing emphasized transoceanic communication. The firm had an undersea fiber optic network connecting the United States and Europe, and planned to build cable routes connecting the U.S. with Asian and Latin American cities. The company positioned itself as a "pipe provider" – a transmission path for services provided by other telecommunications firms. In

1999, Global Crossing acquired Frontier Communications, including Frontier's telephone subsidiaries in 14 states.[47] Analysts predicted that Global Crossing would continue to acquire CLECs in major U.S. and European financial centers. [48]

In May, 2000, Global Crossing and Level (3) announced a "co-build" agreement granting Global Crossing a 50% ownership in Level (3)'s transatlantic fiber-optic system. Under the agreement, the companies would each separately own and operate two of the four fiber pairs on the network, and Level (3) would acquire capacity on Global Crossing's Atlantic Crossing transoceanic cable.[49]

Qwest

Founded in 1988, Qwest had built a fiber network linking 150 U.S. cities and had ambitious plans for international expansion. Qwest also owned undersea cable connections in Europe.

Qwest aquired US West, an RBOC, in July 1999 in a $48 billion deal. With this acquisition, Quest gained direct access to US West's 25 million customers across 14 mid-western and western states, and vaulted into the ranks of "super-carriers."[50] By 2001, the firm offered a wide variety of bundled telecommunications services. One observer noted, "don't tell Qwest CEO Joe Nacchio I told you this, but behind all the talk of being a next generation broadband carrier, Nacchio has built something rather resembling a regular telephone company."[51]

Williams Communications

Founded in 1994, Williams was expected to complete its 30,000-mile fiber network in early 2001. The network would connect the largest 125 U.S. cities, which accounted for the origin and termination of more than 90% of all U.S. telecommunications traffic. Williams focused on wholesaling its capacity to resellers.

Level (3)

Founded in 1997, Level (3) Communications, Inc. began as a wholly-owned subsidiary of Peter Kiewit Sons', Inc. (PKS), a 114-year-old construction, mining, information services, and communications company headquartered in Omaha, Nebraska. In some respects, it had its antecedents in another telecommunications venture undertaken by PKS.

In the late 1980s, executive James Crowe convinced the company to invest in a fledgling telecommunications venture, MFS Communications. MFS Communications was devoted to building fiber-optic networks in the business districts of major cities, in the hopes of selling local telephone access to long-distance carriers at prices 10 % to 15 % below the prices of incumbent local exchange carriers. Crowe reminisced:

> "[Our backers] listened to all of the vision talk and politely nodded but wanted to know what would happen if I was wrong. If I was wrong, we would have had broadband fiber in the largest cities in the country connected to the best customers in the country, and they were convinced that those facilities would have value to a third party even if we couldn't do anything with them."[52]

MFS Communications went public in the early 1990s, and by 1996 had built local fiber loops in more than 50 cities. In August 1996, Crowe sold MFS to WorldCom for $12 billion – a 37% premium over the firm's stock price – and became the second-in-command at WorldCom. But amid rumors of difficult relations with WorldCom CEO Bernard Ebbers,[53] Crowe returned to PKS, where he next convinced the firm to invest in a new venture: the fiber backbone entity that came to be known as Level (3). Level (3) became an independent corporation in 1998, and underwent an initial public offering in April of that year.

Level (3) was a communications and information services company building an upgradeable, international, all IP-based network. The network was intended primarily to serve business customers. This network, consisting of both local rings around cities and long distance connections among these rings, was completed in early 2001.

The Level (3) network was distinct among fiber backbones in at least two ways. It was the first international communications network that used IP technology exclusively. It was also the only network built with a large number of empty conduits, to allow for low-cost insertion of new generations of fiber in the future.

Company Strategy

As described in a January 2000 article in *Telephony*, "Level (3)'s economic model works on two basic assumptions: The unit costs for telecom are dropping every year, and the opportunity for price flexibility on traditionally fixed costs, such as fiber, are high…."[54] As a result, Level (3) lay 12 conduits in its network and ran fiber in only a few of them, leaving room for expansion. Crowe explained the rationale:

> "What we do is blow the fiber in the first conduit…. [Then maybe] Corning, Lucent, others, introduce a generation of fiber that looks like it's better [e.g., higher bit rate or you can space your electronics further apart].
>
> "So the next fiber comes out and you do an economic analysis and say that fibre…is much cheaper… Remember the fibre in the first conduit though, you've already paid for, the capital costs. You bought it. So it only costs you operations and maintenance for the traffic that's already there.
>
> "For the new service that you sell, though [if it requires lighting more capacity], you have to buy electronics and install them every 100 km. But you've got the choice now of pulling a new fiber, which may (and let's make up a number) only have to have electronics every 150 km and you say that's a much cheaper proposition for the new service. So I'll pull that one in. Now 18-24 months you do the same thing.
>
> "You continue to do it until the point at which, even with the cost of installing the fiber and buying the fiber and the operations and maintenance, it's cheaper than just the operations [and maintenance] on the first cable."[55]

As a result, Level 3 expected to be able to provide broadband service at lower cost than any of its rivals. Several analysts agreed (see **Exhibit 4** for one model of Level 3's cost advantage).

In addition to the above cost reduction, some analysts believed that Level (3)'s reliance on an all-IP (packet-switched) network would further strengthen its low—cost position. Due to lower capital costs, it was estimated that packet-switched communication could cost as little as 1/15th that of circuit-switched communication.[56]

In tandem with its pursuit of low-cost operations, Level (3) cut prices aggressively in an attempt to drive demand up. Arguing that bandwidth would follow a "silicon economic model" – in which demand is sufficiently "elastic" that each 1% decrease in bandwidth price would spark a 3% increase in bandwidth demand, the firm asserted its commitment to cutting prices 40% to 60% per year.[57]

In addition to lowering prices overall, in August 2000, Level (3) also inaugurated destination-sensitive billing. Under its new (3)CrossRoads billing system, the firm charged a lower rate for traffic that originated and terminated on the Level (3) network, and a higher rate for traffic that traveled off of its network.[58]

Finally, Level (3) actively sold dark fiber to recoup its construction costs. In 2000 alone, the firm generated dark fiber revenues of $2 billion (see **Exhibit 5** for financial statements).[59]

Scope of operations

Whereas many of its rivals were expanding their range of operations, Level (3) was committed to pursuing a narrow, horizontal focus on fiber backbone wholesaling. Rather than be all things to all people, the firm aimed to become the "network of choice" for horizontally segmented, network-centric computing companies, in anticipation that these companies would likely generate the bulk of growth in the datacom market.[60] In its 1999 Annual Report, Level (3) justified its approach by citing John Chambers, Cisco Systems' CEO: "When a horizontal business model meets a vertical business model, the horizontal wins every time."[61]

One area in which Level (3) did expand its range of operations was in provision of colocation services. Unlike many network-building companies, Level (3) built metropolitan rings in business districts of major and second-tier U.S. cities, and connected these directly to its network. To facilitate this connection, the firm built "Gateway" sites in 56 major U.S. markets. Business customers could plug equipment directly into Level (3)'s network at the Gateway sites, thus bypassing local exchange carriers.[62] Some industry observers believed that offering value added services such as colocation offered a way for a carrier to differentiate its bandwidth from that offered by rivals.[63] By 2000, Level (3) had 6.7 million square feet of colocation facillities, more than any of its rivals (see **Exhibit 6**).

2001 and beyond

By April 2001, Level (3)'s network was up and running, and the space at many Gateway facilities was sold out. Yet fears of an imbalance of bandwidth supply and demand led to industry-wide concerns about increased competition within the industry, with potentially catastrophic implications for many players. James Crowe remained upbeat, advising Wall Street that the company would double revenue in 2001 and enjoy gross margins of 50% -- leading one observer to note: "If Level (3) fails, its credibility with investors is likely to be shot, the company demoralized and management victimized."[64]

Pressed by those who contended that Level (3)'s relatively late entry into the business might end up hurting it in the newly pessimistic environment, Crowe reflected:

> "There's no one else building a multiconduit, upgradeable network. There's no one else with the financial structure that assumes much more rapid asset turnover, much more capital intensity, but much higher margins…. So if we're wrong about that we're not late to market, we're wrong. If we're right about it, we've got one of the biggest opportunities in global business today."[65]

Appendix A: Copper vs. fiber

Copper wire carries telephone signals as electromagnetic waves. The electric properties of copper-based creates several disadvantages as compared to fiber. First, copper creates increased resistance to the signal, weakening the signal rapidly. Second, any other signals near the copper wire can introduce interference and noise. Third, copper has much lower capacity than fiber. Although amplifiers can strengthen a weakened signal, they also will strengthen the noise. (In the 1970s, most long-distance transmission became digital instead of analog. Among other advantages, this reduced the noise problem. Since each bit of information in a digital signal must be a 0 or a 1 – as opposed to analog signals, which can take any value within a wave range – noise can be filtered out more easily during amplification, by discarding all information that is not a 0 or a 1. Nevertheless, fiber retains its advantages over copper.)

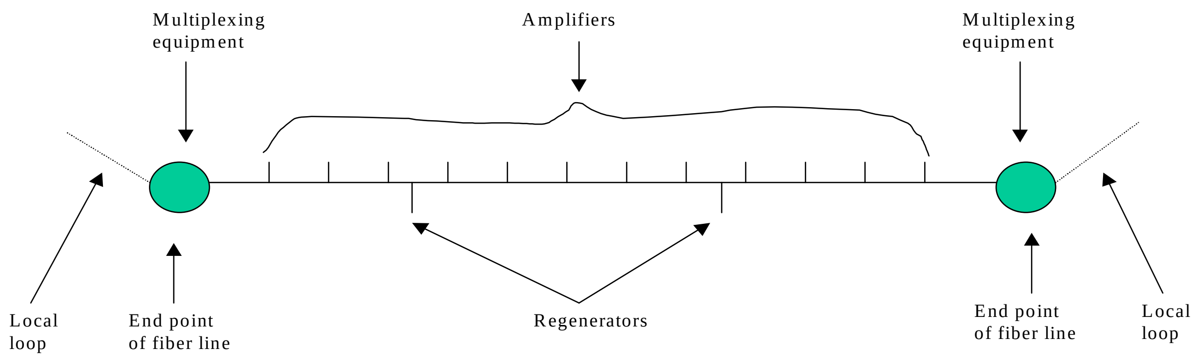
Optical fiber is a thin glass filament that transmits information as pulses of light. Unlike electrical pulses, light pulses are immune to electrical interference and encounter less resistance, so they can travel much further than electrical signals without "attenuation," or loss of signal strength. As a result, higher sound quality is maintained without less reliance on repeater devices.

Appendix B: Bandwidth

In telecommunications, bandwidth refers to capacity. For analog signals bandwidth is measured as a wavelength, in Hertz, or cycles per second. A coaxial cable with a bandwidth of 400 MHz operates at 700 million Hertz, or 700 million cycles per second. Voice typically has a bandwidth of 3KHz.

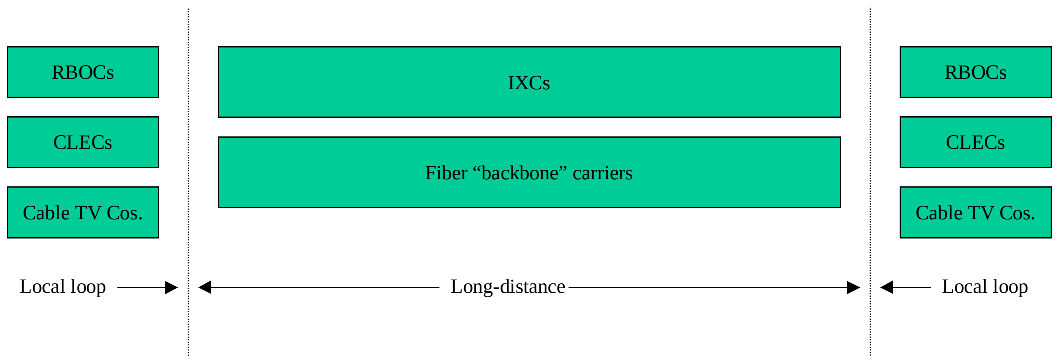
For digital signals, bandwidth is measured as the maximum amount of data that can be transported in a given amount of time, typically written as bits per second. State-of-the-art fiber can carry 10 Gbps per channel, or 10 gigabits (a gigabit is one billion bits!) per second. A fiber strand with 100 channels lit would have a bandwidth of one terabit per second, or one trillion bits per second. By comparison, a standard T-1 line has a bandwidth of about 1.5 Mbps.

Exhibit 1: Fiber Network Technology Overview



Source: Casewriter

Exhibit 2 Industry Structure



RBOCs, also known as incumbent LECs or ILECs: Regional Bell Operating Companies (e.g., Ameritech; BellSouth)
CLECs, or competitive LECs: new providers of local connection (e.g., Teleport)
Cable TV Cos: e.g., Tele-Communications, Inc.; RCN
IXCs, also known as interexchange carriers: Long-distance carriers with own networks (e.g., AT&T; MCI Worldcom)
IXC resellers: Long-distance carriers that buy and resell capacity from other providers (e.g., xxxxx)
Fiber "backbone" companie: New firms building high-bandwidth long-distance fiber networks (e.g., Level 3; Williams)

Source: Casewriter

Exhibit 3 Announced Construction Goals of Major Fiber Network Firms

As of December 1999:

Company	Expected U.S. intercity route miles	Date of completion	Fibers retained	2000E revenue ($million)
Qwest	18,850	1999	48	4,600
GTE	17,000	1999	24	1,570
Global Crossing [a]	19,500	1999	24	2,250
Broadwing	18,000	2000	28	850
Williams [b]	22,000	2000	24	1,050
Enron [c]	20,000	2000	12	125
INTERTEXT [d]	16,000	2000	24	NA
Level (3)	16,000	2001	12	500

[a] represents North American Crossing network only
[b] excludes route miles associated with 1 fiber retained from WilTel network sold to WorldCom 1995
[c] combination of constructed and acquired fiber
[d] fiber purchased from Level (3)

Source: Davis, R.M. and J.N. Altobello, "Level 3 Communications," Schroders, New York, December 28, 1999, p. 6.

As of February 2001:

Operator	Planned intercity fiber miles	Network reach	Market cap. ($B at 12/26/00)
Metromedia	200,000	67 US & European cities	5.5
Global Crossing	100,000	200 cities worldwide	11.8
360networks	88,000	100 cities worldwide	9.6
FLAG	40,000	20 cities worldwide	0.9
Williams	31,000	125 US cities	5.8
Qwest	26,000	150 US cities	62.7
Level (3)	20,000	150 cities worldwide	11.2
Aerie	20,000	200 US cities	NA
GTS	16,000	50 European cities	0.9
Enron	15,000	40 US, European cities	NA
COLT	9,000	32 European cities	15.0
Viatel	6,000	64 European, US cities	0.1
KPNQwest	4,100	50 European cities	8.6

Source: Lynch, G., "The Coming Bandwidth Bubble Burst," *America's Network*, Feb 1, 2001, p. 36.

Exhibit 4 Fiber Network Cost Estimate

Assumptions:

Fibers lit:	12
Channels lit per fiber:	32
Cost to purchase fiber:	$16,000 / mile [a]
Route miles in system:	17,000

Analysis of the Payback from Installing Multiple Conduits ($ millions)

		Initial conduit -- using the same fiber as was originally installed		2nd conduit -- using the most current generation of fiber		Savings associated with using most current fiber in 2nd conduit	
	Cost in current dollars	Annual price / perf. improvement of components	Cost to add capacity in three years	Annual price / perf. improvement of components	Cost to add capacity in three years	Savings on one channel	Total savings over all lit channels
One-time costs:							
Purchase cost of fiber	$272	NA	NA	-5% [d]	$233	NA	($233)
Labor cost to install fiber	$26	NA	NA	4.5%	$29	NA	($29)
Avg cost to light one channel	$90	-45% [c]	$15	-50% [e]	$11	4	
Total lighting cost [b]			$5,750		$4,320		$1,430
Total			$5,750		$4,582		$1,168
Annually recurring costs:							
Maintenance cost	$30	-2%	$28	-4%	$27		$2

[a] Price of current generation of fiber cable containing 96 fiber strands (commonly used by carriers in 2000)
[b] Avg cost to light one channel * total number of channels lit (12 * 32 = 384 channels, per assumptions above)
[c] Assumes continuation of current trends in price / performance improvements. This is driven by cost-reducing or input-reducing improvements in the electronics needed to light fiber – e.g., regenerators and amplifiers – among other items
[d] Assumes continuation of current price / performance trends in fiber
[e] Assumes improvements in fiber properties that further reduce lighting cost, for example by requiring fewer electronics to be used

Source: Davis, R.M. and J.N. Altobello, "Level 3 Communications," Schroders, New York, December 28, 1999, p. 14; casewriter estimates

Exhibit 5 Level (3) Communications selected financial statements, 1996-2000 (calendar year)

	2000	1999	1998	1997	1996
Sales	1,185.0	515.0	392.0	332.0	652.0
Cost of Goods Sold	794.0	360.0	199.0	163.0	268.0
SG&A	1,152.0	668.0	332.0	106.0	173.0
Depreciation	584.0	228.0	66.0	20.0	124.0
Operating income	-1,345.0	-741.0	-205.0	43.0	87.0
Interest expense	-282.0	-174.0	-132.0	-15.0	-33.0
Other (net)	123.0	208.0	214.0	7.0	53.0
Pre-tax income	-1,504.0	-707.0	-153.0	35.0	107.0
Income taxes	-49.0	-220.0	-25.0	-48.0	3.0
Net income before DO	-1,455.0	-487.0	-128.0	83.0	104.0
Discontinued operations (DO)	0.0	0.0	932.0	165.0	117.0
Net income after DO	-1,455.0	-487.0	804.0	248.0	221.0
Current assets	5,045.0	3,938.0	3,877.0	1,494.0	1,246.0
PPE, net	9,383.0	4,287.0	1,061.0	184.0	642.0
Other long-term assets	491.0	681.0	584.0	588.0	616.0
Total assets	14,919.0	8,906.0	5,522.0	2,779.0	2,504.0
Current liabilities	1,947.0	1,090.0	370.0	89.0	247.0
Long-term debt	7,318.0	3989.0	2,641.0	137.0	320.0
Other long-term liabilities	1,105.0	422.0	346.0	323.0	680.0
Total liabilities	10,370.0	5,501.0	3,357.0	549.0	1,247.0
Common stock & addtnl paid-in capital[a]	5,098.0	2,499.0	772.0	431.0	1,257.0
Retained earnings	-549.0	906.0	1,393.0	1,799.0	0.0
Total stockholders' equity	4,549.0	3,405.0	2,165.0	2,230.0	1,257.0

[a] includes "other equity"

Source: Level (3) 10-K reports.

Exhibit 6 Web Host Estimated Revenue ($ million)

	2000	2001 (fcst)
Exodus Communications	810	1810
IBM	172	703
Level (3)	117	489
AT&T	131	425
Qwest	108	393

Source: Salomon Smith Barney, reported in “AT&T’s Ace: Hosting Space,” *Interactive Week*, September 4, 2000, p. 52.

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