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Federal Communications Commission
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FCC RELEASES FIBER DEPLOYMENT UPDATE

The FCC has released a report entitled *Fiber Deployment Update - End of Year 1997*. This report presents fiber deployment data and associated information for interexchange carriers, incumbent local telephone companies, and competitive providers of exchange access or local exchange service who have constructed their own fiber facilities.

Current estimates indicate that interexchange carrier fiber miles of fiber in place increased by more than 16% in 1997, to a total of over 3.4 million fiber miles at year's end. Incumbent local telephone companies reported more than 14 million fiber miles in place at the end of 1997. Of that amount, the Bell companies reported 12.2 million fiber miles -- an increase of about 13% during 1997. Competitive providers of local telephone services who are included in this year's study had in place about 1.8 million fiber miles by the end of 1997.

The report presents additional data, such as fiber investment and lit fiber, to the extent such information is available. For the largest incumbent local telephone companies, the report also includes limited information on the use of fiber and copper in the plant associated with subscriber loops.

This report is available in the reference room maintained by the Common Carrier Bureau at 2000 M Street, N.W., Room 575. Copies may be purchased by calling International Transcription Service, Inc. (ITS) at (202) 857-3800. The report can also be downloaded [file name fiber97.zip] from the FCC-State Link internet site, which can be reached through a link from the Common Carrier Bureau home page (http://www.fcc.gov/ccb/stats) on the World Wide Web. The report can also be downloaded from the FCC-State Link computer bulletin board at (202) 418-0241.

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FIBER DEPLOYMENT UPDATE
END OF YEAR 1997

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Federal Communications Commission

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FIBER DEPLOYMENT UPDATE

End of Year 1997

Introduction and Overview

This report, which presents data about fiber optic facilities and capacity constructed for use by certain telecommunications common carriers, has been issued annually since 1986. In the first part of the report we provide an overview of the data and we discuss the methods and procedures we used to collect the data. We also discuss certain shortcomings of the data as received and how these shortcomings may affect the significance of the data as presented. The following parts of the report present selected statistical data that may illustrate trends in fiber deployment by surveyed carriers.

Earlier reports -- as well as this updated report -- are available on the FCC-State Link electronic bulletin board which can be reached by dialing (202) 418-0241. These files also can be accessed *via* the World Wide Web at http://www.fcc.gov/ccb/stats. The bulletin board and the web site also contain other related infrastructure information, such as the Automated Reporting and Management Information System (ARMIS) 43-07 reports for the mandatory price-cap local exchange carriers and another Commission publication, *Preliminary Statistics of Communications Common Carriers*.[1]

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[1] *See Infrastructure of the Local Operating Companies Aggregated to the Holding Company Level*, released March 13, 1997, which appears on the *FCC-State Link BBS* under the name INFRA95.ZIP and the preliminary domestic information from *Preliminary Statistics of Communication Common Carriers (PSOCC)*, released May 29, 1998, which appears under the file name 97PSOCC.ZIP.

This Fiber Deployment Report surveys fiber deployment by three types of carriers: interexchange carriers (IXCs), incumbent local telephone companies, and certain competitive access providers (CAPs), *i.e.*, entities that provide access services using their own fiber facilities. In many cases, companies that began as CAPs now provide a wider range of telecommunications services including local exchange service. These companies may, therefore, also be referred to as competitive local exchange carriers (CLECs). We continue to use the term CAPs in this report, however, to distinguish the surveyed companies from CLECs of more recent vintage who have not yet deployed substantial fiber facilities of their own.

IXCs experienced fiber mileage growth of about 16 percent in 1997. Fiber mileage of all incumbent local telephone companies included in this report increased about 14 percent, and the Bell companies experienced fiber mileage growth of about 13 percent (down slightly from the previous year). CAPs also significantly expanded their fiber deployment in 1997. The actual amounts of fiber deployed in CAP systems remain much smaller than the amounts deployed by major local telephone companies. Nevertheless, the rate of overall fiber growth for CAPs is quite dynamic and has typically exceeded 50 percent annually over the past several years. Finally, while other entities such as electric utilities and cable TV companies also have been deploying fiber, this report does not directly include such entities *per se*. Instead, we present data for telecommunications fiber and electric utility fiber used by IXCs.

Data Collection Techniques

We contacted carriers by telephone and also provided carriers with written descriptions of the specific elements of data that we sought to collect. (These descriptions are summarized in the notes to the accompanying tables.) Our surveys have led, in some cases, to adjustments of prior year data. Several elements of the data request are common to all carriers surveyed, namely, (1) route-miles of backbone fiber systems, (2) fiber miles deployed, (3) sheath miles of fiber cable deployed, and (4) fiber miles of equipped (or "lit") fiber. (To assist the reader to distinguish between these different measures, we note that two fiber cables extending 100 miles along the same route, each containing 10 fibers, would result in 100 route miles of fiber, 200 sheath miles, and 2,000 fiber miles.)

We also note that the number of circuits that can be multiplexed onto the same fiber will vary depending on the terminal and repeater technologies that are employed. Therefore, underlying fiber data can be used in conjunction with updated estimates of available terminal and repeater technology to arrive at updated estimates of maximum available capacity. For example, a carrier employing 1.76 gigabit terminal technology using a single optical wavelength would find that this technology supports up to about 25,000 two-way circuits on a single fiber pair, more than triple the capacity of earlier systems. Although up-front costs for fiber deployment are high, a significant portion of the total investment can be deferred until actual demand materializes. Once such demand materializes, carriers may make use of the most up-to-date equipment available for equipping their fiber. Of course, because different carriers employ different technologies to equip their fiber, their abilities to cope with unexpected changes in traffic levels will vary.

For example, carriers have upgraded capacity on existing fiber systems by employing equipment that offers, on the same fiber, multiple optical channels using different wavelengths or optical frequencies (also called "rails"), each operating at data rates over 1 gigabit per second. In some cases, carriers have replaced or augmented older types of fiber with newer fiber, called "dispersion shifted fiber," which is specifically designed to support multiple wavelength operation. In addition, in-line optical amplification is also being used to reduce cost in two ways. First, it reduces the requirement for repeaters by increasing repeater spacings. Second, by eliminating the need for traditional repeaters that require conversion of optical to electronic signals and back to optical signals again, it allows for future upgrading of capacities without requiring costly changes to repeaters. The use of optical amplification and multiple wavelength operation reduces the cost of long haul fiber systems while allowing for lower cost upgrading of capacities as demand dictates. Our tables show the combined total of "dark" (i.e., non-equipped) fiber and lit fiber capable of supporting telecommunications services. Also shown in a separate table is the percentage of activated or lit fiber.

Although we requested several basic data items from all surveyed carriers, we requested certain other data items that are specific to the category of carriers surveyed. Thus, we requested data from IXCs about their total number of points of presence -- or points of interconnection -- to local telephone companies or CAPs, including interconnection locations not owned by the IXC. The number of points of presence, like fiber route mileage, provides a very basic measure of network coverage. Some carriers, however, did not provide this data. AT&T provided point-of-presence data only for its switched services.

We had asked for data about IXC deployment of backbone facilities and traffic in connection with Internet use. Not all entities operate Internet backbone facilities using facilities that they own.[2] Of those that do, too few are presently providing adequate data for such information to be included in this report.[3]

We also solicited information from IXCs about sharing of electric utility fiber. This data is summarized in Table 4. Given the limited responses to our survey on this question, this data should be assumed to reflect only a portion of this shared capacity.

From local telephone companies we sought specific information about the application of certain associated technologies to fiber deployment. For example, we sought information about fiber-to-the-curb systems that allow fiber employed by multiple residences to be shared to the pedestal or drop wire. We also sought information about the use of technologies that enhance the capability of existing copper loops, and information about the use of pair gain systems, along

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[2] The following Internet backbone providers had been identified, which do not necessarily own fiber facilities: PSINET, BBN Planet/AT&T Worldnet, MFS/UUNET Technologies, Inc., CRL Network Services, InternetMCI, AGIS, Sprint IP Services, ANSnet, NetCom and IBM Global Network.

[3] Based on available information, we had (very roughly) estimated in last year's report that as much as 20,000 terabytes (*i.e.*, *twenty thousand trillion* bytes) of originating Internet traffic may have been handled on backbone networks during 1996.

with statistics on local loop length. (The data indicate that presently local loops average about 2.5 miles in length and typically utilize dedicated copper facilities from the customer all the way to the central office.) Finally, we requested information about DS-3 mileage on fiber facilities and T1 mileage on copper facilities and total T1 customer terminations in order to gain some insight into the overall customer demand for T1 data rates and the utilization of fiber facilities at the local level, where carriers have less opportunity to take advantage of economies of scale.

From CAPs we sought information about the number of buildings served since this continues to be a useful index in evaluating the extent of CAP-deployed fiber. Most CAPs provided this information and it is reported in Table 15. We note that some of these entities, particularly those not contacted previously or those owned by cable TV companies, either chose not to provide data, were unable to separate telecommunication fiber from their total figures of deployed fiber, or were unable to provide data in time for this publication. For further information we direct the reader to the notes to Tables 14 and 15, *infra*.

Source Methods and Data Limitations

The purpose of the Telecommunications Act of 1996 (1996 Act)[4] is to open all telecommunications markets (including both the local and long distance markets) to competition. While the information in this report was gathered only from entities currently deploying their own fiber transmission facilities, the current and historical data may have some usefulness in forecasting future fiber deployment by newer CLECs.[5]

Generally, as noted above, we employed telephone interviews and a survey item description sheet as the primary method of data gathering for this report. (We initially contacted the Bell operating companies by letter.) We used follow-up discussions to clarify initial responses from carriers as well as to ask additional general questions about current developments and trends. We have informed carriers that responses to our Fiber Deployment survey are voluntary and in a number of instances carriers have declined to provide some of the requested data. We note that a number of trade associations, including the Utilities Telecommunications Council (representing electric utilities), the National Cable Television Association (NCTA), and the Association for Local Telecommunications Services (ALTS) (representing competitive access providers), have provided us with useful and relevant information. We greatly appreciate the support and cooperation of all of the participating entities who made this report possible.

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[4] *See* Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996 Act).

[5] Carriers commonly referred to as competitive local exchange carriers or CLECs that do not own fiber facilities are not included in this report. Such excluded CLECs primarily use incumbent local telephone company unbundled network elements or resold services, as provided for in section 251 of the 1996 Act, to deliver switched local service to consumers. To the extent that use of unbundled network elements or resold services is a CLEC entry strategy to build a customer base of sufficient size to justify investment in transmission facilities, such CLECs may choose to deploy their own fiber facilities in the future.

Many entities provided nearly all requested data; however, a few of the entities provided data later in the year than previously. In some instances certain data have been excluded from this report where we detected inconsistences or where too few of the reporting entities provided the requested information. We have attempted to correct certain previously identified reporting problems and to improve the survey by modifying and augmenting some of the surveyed items, while deleting others. For example, we requested both route mileage and cable sheath mileage data from IXCs and CAPs in order to help ensure that carriers with multiple cables in a route properly distinguish these data items. Also, as noted previously, we confined our data requests to owned fiber in order to minimize the possibility of double counting. Finally, we have refined the use of data gathering that is specific to the three carrier groups surveyed.

Nevertheless, we express certain caveats for the reader's benefit. First, a number of factors continue to make it difficult to gather -- and interpret -- data about fiber deployment. Mergers, acquisitions, joint ventures and other sharing arrangements among service providers make it difficult to ensure that no double counting of capacity has occurred. In addition, some IXCs count fiber constructed and shared with electric utilities as owned fiber, even though they in fact employ long-term leases or right-to-use arrangements. Nevertheless, because we do not directly survey electric utilities in preparing this report, fiber capacity obtained through long-term agreements with such entities would not be expected to result in double counting. Therefore, we have decided to include such fiber as "owned fiber" for the relevant IXCs we have surveyed.

The objective of this report has been to primarily focus on the nonmovable and nonfungible backbone cable transmission plant elements of the plant infrastructure that are owned by each reporting carrier. The inherent ability that fiber had from the outset to support data rates that could not yet be achieved in practice and the steady improvement in terminal and repeater technologies over the years have increasingly made the variable costs of large fiber networks more a function of the number of terminal elements than distance.[6] Furthermore, terminal elements are movable and their cost is primarily a function of the number of links on which they are used rather than the length of the link over which they provide service. In addition significant capacity increases made possible by state-of-the-art terminal facilities whose cost should decline over time will tend to make the incremental costs of adding network capacity even lower. Nonetheless, there may be significant differences among carriers in the structure of their underlying network, their embedded investment for a given size network and the robustness of their networks in responding to changes in demand. There are also both embedded capacity and investment differences that are a function of the mix and capability of the various types of terminal and repeater equipment currently installed. While the data in this report can be a very useful tool to assess the potential capabilities of the carriers surveyed, the complexity of these issues makes it important that the user augment this data source with other information and exercise caution when comparing the carriers.

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[6] The cost of the underlying fiber network is mileage sensitive. Once constructed the cost of adding terminals is less a function of milage than the number of network links. It should of course be noted that the number of terminal elements required in providing service is partially a function of the structure of the underlying fiber network.

Another problem in evaluating the data is the widespread use by carriers of redundant paths or routes. Redundancy, in general, makes it more difficult to interpret data on activated or lit fiber, since all carriers do not deploy redundant facilities in the same manner or to the same extent. As mergers and overbuilds occur, there is also increased likelihood of ambiguity in connection with data on route mileage. To some extent, we guarded against this problem by requesting that carriers provide sheath mileage data in addition to route mileage data. Fiber cross-section data, calculated by dividing the fiber mileage by the sheath mileage or route mileage, provides a check for data errors or misinterpretations, since erratic fluctuation of fiber cross section would not generally occur. Nevertheless, the carriers' tendency to estimate fiber mileage based on route mileage data and an estimated fiber-count factor may have limited the usefulness of this approach. (Similar factors are also used in some cases to generate the DS-3 mileages and to provide lit fiber mileages.) Redundancy tends to increase the lit fiber percentage over the level that would otherwise exist. In general, abrupt changes in the amount of lit fiber on a year-to-year basis could be caused by significant fiber growth or by problems in the reporting of this data. Corrections to previously provided lit fiber data are reflected in the tables. In some other cases, we have found evidence to indicate that reporting entities themselves have made appropriate corrections.

One more general caveat about methodology and data quality is necessary: growth rates are based on year-to-year differences in reported quantities of deployed fiber and are thus especially sensitive to reporting errors which may be introduced by carrier estimation. Since project completion dates are often estimated, care must be exercised in interpreting growth rate data.

Finally, as with previous reports, this Fiber Deployment Report includes adjustments for data reported in previous years. These adjustments typically are highlighted in the notes associated with the appropriate tables. They include: rounding issues, acquisitions, overlapping routes, and improvements in data acquisition methods. Further details about adjusted data can be found in the relevant prior reports. For example, in the case of mergers or acquisitions, the merged entities are often shown on a consolidated basis over the period displayed in the tables even though the consolidation may not have been in place during the entire period.

Interexchange Carriers

We present IXC data in Tables 1 through 4. By year-end 1997, IXCs had deployed fiber networks exceeding 125,000 route miles. Growth in IXC fiber mileage was more than 16 percent in 1997. Total 1997 IXC fiber mileage is estimated at more than 3.4 million miles, as shown in Table 2. We note that a significant amount of long-haul interexchange fiber utilizes railroad rights-of-way, abandoned pipelines, or is simply buried. While some of the IXCs operate a significant number of microwave routes, these data are not reflected in the tables.

Although in recent years there have been significant advances in enhancing fiber capacity using opto-electronic equipment and multiple optical wavelengths, conservative estimates of the capacity of IXC fiber facilities assume the minimum widely used single wavelength data rate. For example, assuming 28 DS-3's or 18,816 circuits per fiber pair, using the older existing single wavelength 1.2 Gbit/second terminal and repeater technology, at least 40 to 50 million DS-3 equivalent miles are available using IXC fiber networks. Optical repeater systems also have improved fiber performance by eliminating costly electronic repeaters and by increasing the distance between repeaters.

As noted above, newer technologies using wavelength division multiplexing boost this capacity estimate significantly. Moreover, in some cases this technology can be overlaid on existing systems without requiring total replacement of terminal equipment. For example, IXCs have deployed Synchronous Optical Network (SONET) multiplexing systems at the OC-192 (10 Gbit/second) rate[7] that provide the capacity equivalent of 192 DS-3's per fiber pair. Even newer systems able to handle aggregate transmission at 40 Gbit/Second and higher have also been developed. MCI, for example, reported the construction of such systems for trials and new deployments.[8] While most newer systems primarily increase capacity by employing wavelength division multiplexing and so-called "dense" wavelength division multiplexing (which multiplies existing data throughput by using separate optical frequencies), it is also possible to provide two-way transmission (full duplex) over the same fiber rather than requiring the use of a fiber pair for two-way transmission. Of course, a portion of the capacity available using these new systems is typically allocated to facility redundancy and failure restoration. Many IXCs (as well as local telephone companies) have been using SONET rings for redundancy; when failures occur, transmissions can be rerouted in the reverse direction around the ring.

It is important to note that the increased fiber system capacity made possible by increased use of optical amplification and wavelength division multiplexing have reduced the need of existing carriers to construct new fiber. Because of this, the inherent cost of long haul transmission is becoming less a function of distance than of the number of terminations, since a greater portion of the cost of adding capacity is being directed toward fixed terminal capabilities that are required on each link, regardless of length. This, along with a desire to use existing fiber transmission facilities more effectively for varying bandwidth requirements, appears to be encouraging new networking strategies like so-called "distributed switching." In distributed switching, switching functionality and components are spread over a network rather than being concentrated in specific locations. Changes in the relative costs of distance and non distance sensitive network components, and new advances in router technology (used for internet and packet services), appear to be major factors in these kinds of developments.[9]

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[7] SONET systems provide advanced protocols for multiplexing or interleaving of data channels or streams and are becoming an increasingly attractive means for subdividing fiber capacity into manageable chunks. SONET system rates are prefixed by the letters "OC". The DS-3 used widely in backbone transmission systems is roughly equivalent in capacity to the OC-1 SONET physical interface rate of 51.84 Mbit/sec. An OC-3 SONET system is therefore capable of handling the equivalent of approximately 3 DS-3's. Each DS-3 in turn can support up to 672 voice grade equivalent circuits encoded at the 64 kb/second rate.

[8] *See Lightwave*, Mar. 1997, at 1.

[9] For example, Sprint has announced its plan to evolve towards an integrated network using Asynchronous Transfer Mode (ATM) links in a configuration of distributed switching that would facilitate the simultaneous transmission of services requiring different data rates, such as voice, internet, packetized data, and broadband services over the same backbone network. In such a

Table 4 contains the number of IXC points of presence and the extent of IXC facilities shared with electric utilities. We note that previous Fiber Deployment Reports have provided data by carrier on fiber investment. Since the amount of reported fiber in long haul systems has not grown significantly in recent years, and since investment data have not been provided by all carriers (and, in our experience, has often proven to be less accurate than other provided data), we did not include investment data as a separate entry for IXCs in this year's report. The reader may, however, refer to the notes to the tables in order to estimate investment based upon past reports.

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configuration, the entire network begins to look very much like the components of a single switch. What is now termed "internet voice" would become a seamless component of this kind of network.

Table 1: Fiber System Route Miles -- Interexchange Carriers *

Calendar Year:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AT&T	5,677	10,893	18,000	23,324	28,900	32,398	32,500	33,500	35,000	36,022	37,419	38,704	38,704
Consolidated	310	310	332	332	332	332	332	332	332	519	NA	621	621
Electric Lightwave	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	298	733	1,054
Frontier (RCI)	580	580	796	413	414	415	417	417	417	414	516	516	3,341
GST Telecom	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	106	769
IXC	382	382	803	803	803	914	914	914	1,257	1,357	1,365	2,025	4,647
LCI	881	950	1,210	1,210	1,210	1,210	1,406	1,406	1,406	1,408	1,408	1,408	2,743
MCI	3,025	6,752	10,267	12,467	13,839	16,000	16,700	17,040	19,793	21,460	21,049	23,096	25,234
Norlight (was MRC)	NA	NA	670	670	844	844	844	850	850	850	850	1,100	1,100
Qwest	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,569	4,358
Sprint	5,300	11,915	17,476	21,938	22,002	22,093	22,725	22,799	22,996	22,996	22,996	23,432	23,574
TCG	NA	NA	NA	84	84	84	84	84	84	84	84	84	NA
Valley Net	NA	NA	NA	NA	520	570	581	581	581	NA	NA	NA	NA
WorldCom	3,884	8,886	9,169	10,262	10,888	11,056	11,093	11,093	11,104	11,104	11,127	12,060	19,619
Total Reported:	20,039	40,668	58,723	71,503	79,836	85,916	87,596	89,016	93,821	96,214	97,112	106,454	125,765

* See accompanying notes to the tables and discussion in text.

Table 2: Thousands of Fiber Miles -- Interexchange Carriers *

Calendar Year:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AT&T	136.2	261.4	432.0	704.7	838.4	935.7	1,010.9	1,018.5	1,055.6	1,141.6	1,179.1	1,259.0	1,282.2
Consolidated	3.5	3.5	3.7	3.7	3.7	3.7	3.7	3.7	3.7	6.5	NA	15.6	15.6
Elec. Lightwave	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	14.9	30.6	30.6
Frontier (RCI)	7.0	7.0	7.2	2.6	2.7	2.7	2.7	2.7	2.7	2.6	3.3	3.3	71.1
GST Telecom	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.6	36.9
IXC	10.0	10.0	14.0	14.0	14.0	14.2	14.2	14.6	20.8	22.2	22.2	70.5	125.1
LCI	13.7	17.3	22.3	22.3	22.3	22.3	24.7	24.7	24.7	24.7	24.7	24.7	41.4
MCI	83.9	179.1	259.3	278.8	304.2	388.0	413.7	430.0	450.0	525.0	597.4	655.4	663.0
Norlight (was MRC)	NA	NA	8.0	8.0	10.1	10.1	10.1	10.2	10.2	10.3	10.2	19.2	19.2
Qwest	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	113.3	192.4
Sprint	122.4	249.3	343.2	449.5	450.8	453.4	466.7	466.7	467.2	467.2	467.2	468.7	471.5
TCG	NA	NA	NA	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	NA
Valley Net	NA	NA	NA	NA	6.1	6.8	7.2	7.2	7.2	NA	NA	NA	NA
WorldCom	79.0	190.8	203.5	237.9	245.5	254.6	255.9	255.9	256.2	256.2	266.2	276.9	470.9
Total Reported:	456	918	1,293	1,723	1,899	2,093	2,211	2,236	2,300	2,458	2,587	2,943	3,420

* See accompanying notes to the tables and discussion in text.

Table 3: Percent Fiber Miles Lit and DS-3 Miles -- Interexchange Carriers *

	Percent Fiber Miles Lit							Estimated DS-3 Mileage in Thousands of Miles						
Calendar Year:	1991	1992	1993	1994	1995	1996	1997	1991	1992	1993	1994	1995	1996	1997
AT&T	45%	50%	51%	53%	55%	53%	52%	4,383.9	5,188.9	5,203.3	5,243.5	5,864.0	6,864.5	10,354.3
Consolidated	53%	53%	58%	54%	NA	NA	NA	29.9	31.6	NA	29.7	NA	29.8	NA
Electric Lightwave	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Frontier (RCI)	56%	57%	57%	57%	46%	46%	18%	15.5	17.7	4.1	4.3	4.3	4.3	26.5
GST Telecom	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.1	NA
IXC	58%	66%	56%	NA	NA	NA	NA	34.6	38.2	39.2	NA	NA	NA	NA
LCI	60%	60%	60%	69%	71%	76%	59%	42.1	47.1	69.3	94.5	132.0	163.4	216.6
MCI	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Norlight (was MRC)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Qwest	NA	NA	NA	NA	NA	6%	7%	NA	NA	NA	NA	NA	NA	NA
Sprint	55%	55%	NA	56%	77%	80%	85%	1,705.5	1,740.6	NA	NA	1,840.7	2,386.2	3,930.2
TCG	NA	80%	80%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Valley Net	40%	40%	NA	NA	NA	NA	NA	11.6	NA	NA	NA	NA	NA	NA
WorldCom	90%	90%	NA	NA	69%	69%	67%	NA	NA	NA	NA	NA	NA	NA

* See accompanying notes to the tables and discussion in text.

Table 4: Other 1997 Fiber Data -- Interexchange Carriers *

	Points of Presence	Above Ground Sheath Miles	Avg. Fiber Cross Section	Fiber in Electric Utility Facilities Sheath Miles	Fiber in Electric Utility Facilities Fiber Miles
AT&T	839	1,393	33.1	1,194	28,656
Consolidated	11	NA	25.1	94	NA
Electric Lightwave	NA	NA	29.0	NA	NA
Frontier (RCI)	26	0	21.3	2	NA
GST Telecom	14	63	48.0	0	0
IXC Communications	NA	NA	26.9	0	0
LCI	61	220	15.1	220	NA
MCI	NA	NA	26.3	NA	NA
Norlight (was MRC)	15	601	17.5	596	7,157
Qwest Communications	23	NA	44.2	NA	NA
Sprint	NA	140	20.0	0	0
TCG	NA	NA	NA	NA	NA
Valley Net	NA	NA	NA	NA	NA
WorldCom	245	NA	NA	NA	NA

* See accompanying notes to the tables and discussion in text.

<u>Notes to Tables 1-4:</u> (NA indicates unavailable data)

In some instances, carriers may have estimated certain data. Accuracy may also vary depending on the carrier's method of collecting and assembling its data. Historical data may have been changed from prior reports to reflect adjustments made this year; historical data for merged entities typically have been combined. Carriers were requested to report owned facilities to avoid double counting of fiber; in some cases, however, leased fiber may have been included, particularly in connection with long term arrangements. The reader should refer to prior fiber deployment reports for previously reported data.

AT&T 1990 data included the effect of a downward adjustment of its 1990 fiber mileage and a proportional adjustment to its 1989 fiber mileage to correct for what had been characterized as rounding errors on components making up the total. Data shown in the tables include domestic fiber only. AT&T's points-of-presence data item is based only on its switched services. AT&T's 1996 fiber mileage and route mileage data have been adjusted to more closely correspond to survey definitions provided and to account for procedural errors in which testbed and other unspecified fiber had been previously included in the total. In accordance with these changes, AT&T has provided adjustments to its historical data starting with 1991 that are reflected in the attached tables. AT&T is one of the few interexchange carriers whose sheath mileage has generally been greater than its route mileage. AT&T reported its sheath mileage as 39,316 miles in 1997 and had previously revised its sheath mileage data to 39,689 miles in 1996, 38,042 miles in 1995, and 36,511 miles in 1994. AT&T's revisions may also affect the amount of lit fiber as presented in Table 3. Route and sheath mileage data for 1997 was lower than the 1996 data reported last year due to a slightly different tabulation methodology. Because AT&T route mileage essentially has been static, the 1996 figure has been revised to match the 1997 route mileage figure.

Consolidated Communication reports no significant changes in its facility base during 1997. It has merged with McLeod USA.

Electric Lightwave, a competitive access provider also has reported data on inter-city fiber facilities that is separately included in Tables 1-4.

Frontier Corporation has added fiber facilities in a Sonet network during 1997 which is now reflected in the aggregate data reported. The new facilities reflect recent expansion of its network that were built in connection with Qwest.

GST Telecom has an installed base of both interexchange and local facilities west of the Rocky Mountains and in Hawaii.

IXC Communications, Inc. was previously known as Communications Transmission Group, Inc.

LCI International was formerly Litel.

LDDS Communications, Inc. (Long Distance Discount Service), a reseller, acquired Advanced Telecommunications Corp. (ATC) which had previously been known as Microtel. The company merged with Metromedia, becoming LDDS Metromedia Communications, Inc. A second *acquisition of fiber systems operated by Williams Telecommunication Group was completed in 1995. In May 1995, LDDS changed its name to WorldCom, Inc. WorldCom acquired MFS, listed in tables 14 and 15, at the end of 1996.*

*Although WorldCom is acquiring MCI, the facilities of these entities are listed separately in the tables. In 1990, MCI acquired Telecom*USA which had previously been formed by the merger of Southland Fibernet, SouthernNet, and Teleconnect. Data provided by MCI for 1992 and revisions to its 1991 route mileage were inconsistent with previously provided data. The author made minimal adjustments to earlier historical data to minimize inconsistencies by using the company's revised route mileage data for 1991 and adjusting 1990 route mileage and fiber mileage data accordingly. Revised figures that also include MCI's downward adjustment to 1993 fiber and route mileage data are reflected in Tables 1 and 2. (The reader may also refer to previous fiber deployment reports.)*

Because MCI's historical data prior to 1995 could not be reconstructed, MCI's 1995 and 1996 data reported in Tables 1 and 2 include leased facilities to maintain consistency with earlier data. It appears that leased facilities had been included in submitted data since 1993. As of the end of 1996 MCI reported a total of 23,096 route miles of fiber facilities including 3,501 miles of leased facilities. Correspondingly, its reported figure of 655,410 fiber miles includes 135,494 fiber miles of leased fiber facilities. It also reported an additional 16,300 route miles of owned digital radio facilities. MCI had also revised its 1995 data and reported that it includes 2,281 route miles and 127,241 fiber miles of leased facilities. MCI did not provide any adjustments for data prior to 1995. MCI reported 13,690 route miles of digital radio at the end of 1997. Previously it had reported 16,350 route miles as of the end of 1995 and 13,815 route miles as of the end of 1994. Prior to 1991, MCI based its DS-3 mileage on its circuit mileage data and an assumption of 672 circuits per DS-3. MCI's DS-3 mileage was reported as 2.8 million miles in 1991. This was consistent with previously provided total DS-3 mileage including DS-3's on digital microwave radio facilities. The company reported 2.9 million miles of DS-3 facilities on fiber for 1992. In 1993, the company reported 5.29 million DS-3 miles including spare and restoration facilities. MCI estimated 6.8 million DS-3 miles for 1994. It appears that these data were not reported in a consistent manner. There are possible inconsistencies relating to the inclusion of DS-3's on MCI's microwave facilities, relating to the way spare facilities are accounted for, and relating to the reporting of capacity on leased facilities. (The reader should refer to prior fiber deployment reports for further details.) The company has been developing a program to construct an improved system for fiber restoration including the use of multistate fiber rings.

MCI previously reported 2,722 sheath miles and 65,328 fiber miles of facilities built in association with electric utilities as of the end of 1992. These systems typically use ground-wire fiber as described in prior fiber deployment reports. MCI makes extensive use of SONET systems in its network architecture and has systems in operation up to the OC-192 (10 Gbit/Sec) rate. These systems are configured to provide needed capacity with built-in redundancy. MCI has a significant Internet backbone capability and recently quadrupled its maximum link size from the 155 Mb/Sec OC-3 rate to the 622 Mb/Sec OC-12 rate.

Norlight was acquired in December 1991 by Midwestern Relay Co., was known as MRC Telecommunications, and previously listed in the tables as MRC. It is now called Norlight Telecommunications.

Qwest Communications has begun to construct interexchange fiber facilities in a joint venture with Frontier Corporation and other partners and is shown in the tables. If completed as planned, the network would eventually serve up to 80% of the nation's population centers. Qwest indicates that its reported fiber mileage does not include fiber used by other joint venture entities. Its status, however will increase the likelihood of some double counting of fiber mileage. Qwest's route mileages can be expected to overlap with other joint venture entities.

Several years ago, Sprint revised its historical data. Sprint's revisions are reflected in Tables 1 and 2 for the period since the merger of US Telecom and GTE toll facilities in 1986. In a press release dated March 14, 1994 discussing its deployment of SONET equipment in its network, Sprint reported that the new equipment would more than double capacity on its existing system without adding new cable, as well as provide for improved network restoration capabilities. Sprint also reported in its press release that, as of March 1994, the company had 338 points of presence throughout the country. Sprint has a significant Internet backbone capability.

TCG is shown in Table 14 and 15 as a competitive access provider, but it also operates inter-city facilities.

Most of the fiber facilities of Williams Telecommunications Group (Wiltel) were acquired by LDDS. The entity was called LDDS-WorldCom but the name has been shortened to WorldCom. The WorldCom entry in the tables reflect the combined data of the two companies. Prior historical data for Wiltel reflected acquisitions of LDX (1,379 route miles and 33,096 fiber miles reported by LDX for 1986) and Lightnet (5,300 route miles and 127,200 fiber miles. reported by Lightnet for 1988). LDDS did not acquire a small amount of fiber, typically 1 or 2 strands in Wiltel's 11,000 route mile network and this fiber now is used to support the operations of VYVX, a video service provider that is part of the Williams Telecommunications Group. VYVX is constructing additional fiber facilities that were not completed in 1996; data on these fiber facilities are not shown in the tables.

Data covering the percent of lit fibers lit may be distorted by route redundancy and the method used to report these data. Considerations affecting when a fiber pair is lit will vary from company to company; whether fiber is lit does not indicate how many circuits are presently operational. In a number of instances, prior data for percent lit fiber have been recalculated.

DS-3 mileage reflects actual equivalent DS-3 or Sonet OC-1 capacity in use on fiber facilities only.

Tables 1 and 2 are intended to reflect owned facilities. Fiber used in long-term arrangements with electric utilities may be reported as owned fiber by some of the carriers. New long haul entities identified this year include Level 3 and Five Com. Five Com, primarily a regional long haul entity, operates facilities in the northeast and owns both long haul and local facilities with an estimated 500 to 650 route miles and 40,000 to 60,000 fiber miles expected to be completed by the end of 1998. It is changing its name to Northeast Optic Network. Level 3 expects to have *approximately 230 route miles and about 33,000 fiber miles of its new planned network completed by the end of 1998. Its construction only began at the end of 1997. Level 3 indicates that it eventually expects to construct as much as 16,000 long haul route miles. Valley Net, is a long-haul network originally formed using facilities of several local telephone companies.*

General Definitions and Descriptions of the Items in Tables 1-4:

Route miles of fiber -- The total mileage of fiber routes.

Fiber miles of fiber -- The number of fiber strand miles used in all routes including both lit and unlit fiber -- the sum of the number of miles of each owned cable weighted by the number of fiber strands.

Sheath miles of fiber -- The total number of miles of fiber cable used. The sheath mileage is equal to or greater than the route mileage. A given cable sheath may contain widely varying numbers of fibers depending on the application and associated requirements. Often economic and environmental considerations lead to deployment of cables containing more fibers than needed to meet current demand.

Average fiber count or cross section -- Average number of fibers in a cable sheath or route. It can be calculated as the number of fiber miles divided by the number of sheath miles or route miles.

Fiber miles of lit fiber -- The number of fiber strand miles activated or equipped with optoelectronic equipment at terminal and repeater sites and capable of providing at least one voice-grade circuit.

DS-3 miles carried on fiber -- The number of miles of DS-3 equivalent system where each DS-3 system is capable of providing at least one circuit.

Fiber in electric utility facilities -- Sheath miles and fiber miles of fiber shared or used in conjunction with an electric utility, typically ground-wire fiber systems.

Point of presence -- Point at which an interexchange carrier interfaces with a local operating company or competitive access provider for access to its customers.

Local Telephone Companies

Tables 5 through 13 present data for local telephone companies including the Bell operating companies, companies affiliated with GTE, and Sprint. We also include a limited amount of information about fiber deployment by rural, independent telephone companies.[10]

Our survey focused on a number of aspects of the infrastructure owned by local telephone companies including a comparison of the relative amount of local telephone company owned fiber versus the amount of deployed copper. The surveyed infrastructure generally falls into several categories: (1) interoffice, (2) interexchange access, (3) feeder, and (4) distribution.[11] The total sheath miles, fiber miles, and average cable size of fiber facilities for local operating companies appear in Tables 5-7, respectively. By and large, the companies did not distinguish feeder from distribution plant, except that specific data on loop length and on deployments of feeder fiber in an arrangement called "fiber-to-the-pedestal" (or "fiber-to-the-curb") are shown in Table 8, along with data on bandwidth enhancing terminals. In this report we use the term "subscriber" fiber or plant to refer to the combination of feeder and distribution plant associated with subscriber loops. As a general matter, the data suggest that fiber deployment in the subscriber loop has been concentrated in feeder plant.

Table 9 includes information about the proportion of lit fiber as well as the equipped capacities of fiber and copper facilities and a limited amount of information on fiber subscriber investment. Information about the amount of subscriber fiber and copper plant deployed to date is shown in Tables 10 and 11. We remind the reader that, when attempting to compare fiber and copper, fiber strands inherently have much higher information carrying capacity than copper wires, and the per strand costs -- including initial investment and maintenance costs -- will differ. Accordingly, it is generally more useful to compare fiber and copper sheath miles rather than fiber strand and wire mileage.

Tables 12 and 13 provide useful comparisons of fiber and copper deployment, both for total plant and for subscriber plant. These tables indicate that, typically, fiber cable constitutes less than 10% of total cable deployed to date. Table 13 also highlights the use of pair gain systems (used as part of subscriber or loop plant to increase the number of loops where not

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[10] A number of independent operating companies which together comprise about 5% of the total fiber have not been included in the accompanying tables. Fiber data for rural carriers in 1995 and 1996 reported by the Rural Utilities Service (RUS) are included in Table 5. *See* Rural Utility Service, *1996 Statistical Report -- Rural Telecommunications Borrowers*, Informational Publication 300-4. Data for prior years were not available from this source.

[11] Interoffice facilities provide for the interconnection of telephone company central offices. Access facilities provide connection with IXCs, accomplished through an access tandem switch and through direct links to IXC points of presence. Feeder and distribution plant is associated with the connection between the subscriber and the central office, also known as the local loop. The feeder plant is that portion of the loop which is closest to the central office. The distribution plant, which is closest to the subscriber, is least able to take advantage of economies of scale.

enough copper pairs are available). Based on data submitted on loops not supported by pair gain equipment we estimate that roughly three-quarters of copper loops do not use pair gain systems and, instead, employ copper wire pairs from customers to the central office.

Cable-based loop plant generally is more costly than interoffice plant to provide on a per customer basis; deploying distribution fiber to individual residential customers is even more costly on a per customer basis. Of course, economies of scale can be realized where facilities are provided to large business customers or to other customers concentrated in large buildings. Further, deployment of cable-based loop plant is labor intensive. Deployment cost per subscriber -- for any given architecture -- is significantly driven by labor costs which, moreover, do not tend to decline with capacity increases brought about by new technology. This is contrary to the case of long-haul plant where lower per unit costs primarily result from greater facility sharing.

The expense associated with installation of loop plant perhaps helps to explain why competition has developed where it has and why CAPs have grown rapidly. CAPs have tended to target large customers whose total circuit requirements allow for test marketing of new goods and services, prior to more general introduction to customers with more modest requirements.[12] Further, the expense of loop plant installation also helps to explain interest in lower cost technology alternatives, such as wireless access, enhancements to copper facilities, and use of hybrid technologies employing more efficient architectures. Despite the risks associated with construction of cable-based loop plant there can also be significant rewards.

To cite just one example, fiber cable occupies considerably less conduit space than copper cable and thus economizes on the use of existing conduit facilities. Furthermore, once a decision to deploy fiber has been justified, the cost of the cable itself may actually contribute less to the total deployment cost than the associated labor costs. This space-saving aspect of fiber, coupled with the desire to avoid costly future redeployments, to minimize the environmental effects of redeployment, and to provide for future broadband digital capabilities, may contribute to a decision to construct fiber capacity that exceeds current demand. (Indeed, in the past, copper deployment was also affected by the costs and lead times needed to deploy the cable.) Fiber deployment data disclose that much of the fiber deployed to date has been in interoffice plant. Although the relatively small number of voice-grade circuits that connect central offices generally can be provided on a single pair of fibers, in some cases carriers have deployed interoffice plant cable containing more than 40 fibers for the reasons just described. (See Table 7.)

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[12] Where competitive activity exists in the manufacturing process, early users of new technologies, typically businesses, tend to pay more for a product. After development costs are recovered, production levels increase and manufacturing costs decline; consequently, the benefits tend to spread to all customers. In the case of telecommunications access through fiber, large business users have also been the first to reap the benefits of the new technology. However, the lack of inherent economies of scale in deployment of fiber to the small subscriber means that unlike manufacturing production cost, labor-intensive deployment cost does not tend to decline over time. Furthermore, competition in this area has driven costs down to the large subscriber, leaving less opportunity for large customers to stimulate development to smaller subscribers.

We note that aggregate fiber mileage data may not necessarily denote *coverage*, because fiber deployment may be concentrated in certain parts of a service area with little fiber deployed elsewhere. Sheath mileage is, therefore, a preferred measure of aggregate network coverage, while fiber mileage is a preferred measure of aggregate potential capacity.

Because many subscribers share interoffice fiber its inherent cost is lower -- on a per-customer basis -- than the cost of subscriber fiber. Nevertheless, any and all capabilities provided to the customer must be supported by the subscriber loop. For this reason, we have attempted to separate subscriber facility data from interoffice data, but with less than complete success.[13] Several of the companies stated that they have had difficulty providing interoffice data separately from subscriber fiber and copper data. Typically, they claim that many facilities are jointly used for interoffice and subscriber applications and that, in some cases, there are no readily available data sources for these separate categories. Many regulatory bodies have historically established exchange and toll classifications of local plant. U S WEST has therefore used exchange and toll categories as a substitute for the interoffice and subscriber categories that we requested. This would tend to result in an overestimate of the amount of subscriber fiber and copper. Ameritech, on the other hand, originally used engineering estimates to separate interoffice and subscriber fiber and copper, but no longer provides subscriber fiber information at all. Other companies either do not provide certain subscriber data or do not indicate where they have used estimates. Today, even with new competitive entrants, the subscriber loops tend to remain the most critical element distinguishing the monopoly carriers and greater public availability of subscriber loop data is needed. Tables 10, 11, and 13 set out currently available subscriber loop data.

As new technologies are introduced and existing technologies mature the significance of the data presented in this report may change.[14] In the preparation of this report, therefore, we have considered the use of several new technologies by the local telephone companies. For example, again this year we requested information about fiber-to-the-curb systems and technologies that expand the capability of existing copper pairs, such as HDSL (High-bit-rate Digital Subscriber Loop) and ADSL (Asymmetric Digital Subscriber Loop). Because HDSL and ADSL (often termed xDSL technologies) enhance the capabilities of existing copper outside plant by using movable equipment rather than deploying new fixed plant, they may be used in conjunction with hybrid fiber/copper architectures and elsewhere to provide interim applications at lower risk, allowing customer demand to develop before committing to more extensive

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[13] Much of the interest in local loop fiber has centered around interest in video services. There is also increasing interest in enhancing computer-to-computer interactive communications using graphical user interfaces that can require larger bandwidth than available using standard modems. While these applications do not generally require anywhere near the high data rates required by broadcast-quality video, they are facilitated by digital access to the network.

[14] Under the price cap regime the Commission instituted in 1991, cost-effective applications of new technology that increase efficiency could be an important way for local telephone companies subject to price cap regulation to enhance their profitability. Although we have not requested specific information about company-conducted fiber technology trials since 1994, our survey indicated that there appear to be important differences among the local telephone companies in their present deployments and deployment plans for new technology.

construction of fiber facilities.[15] It appears that the flexibility and ease of deploying these technologies may have contributed to research and development in this area, as well as implementation of technical standards.[16]

Moreover, although data rates that can ultimately be supported on copper facilities are considerably lower than on fiber, surprising advances have been made in recent years. Digital services, including services that employ data packets, can be supported on copper-based technologies used alone or in conjunction with existing fiber facilities. Further, because digital services provide customers with access to a growing array of creative applications, (such as interactive learning software, games, multimedia libraries), customer demand for such applications may stimulate modernization of carrier networks. Ultimately, combinations of fiber, coaxial cable, advanced copper, and other loop technologies including wireless may be used to enhance the access capability of the telephone network on an incremental basis in response to customer demand, thereby involving less investment than use of a single technology. The particular technologies chosen, and the speed with which they are deployed may depend on factors such as cost, user demand, available switching technologies, and specific applications to be provided, as well as structural issues such as the distance of the subscriber from the central office and proximity to existing fiber facilities.

We asked companies initially to provide general information about their ADSL, HDSL deployments. This year we again requested data about numbers of bandwidth enhancing terminals. Table 8 shows the results. While most surveyed companies apparently have been using HDSL equipment for some time to provide T1 service, ADSL technologies were initially deployed within the last year or two as trials.[17] Prior to its merger with Pacific Telesis, SBC Communications did not report the use of such technology, and had suggested that it had only limited plans for its use; however, such technology is used in merged Pacific Telesis operating areas. Because ADSL and HDSL technologies and ISDN services all require use of selected copper pairs in the loop plant, effective management of pairs suitable for use with these systems

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[15] Unlike new deployments of outside plant, which tend to be labor-intensive and which require sharing of facilities to lower the cost per customer, enhancements to existing copper plant are equipment-based solutions that often can benefit over time from advances in technology, as well as competition and economies of scale in the manufacturing process itself.

[16] *See* Philip Kyees, *et al.*, *ADSL: A New Twisted-Pair Access to the Information Highway*, IEEE Communications Magazine, Vol. 33, No. 4, Apr. 1995, at 52-60; Russell Hsing, *et al.*, *HDSL and ADSL: Giving New Life to Copper*, Bellcore Exchange, March/April 1992, at 3-7. Present and future Integrated Services Digital Network (ISDN) type offerings using HDSL or ADSL technology coupled with video compression technologies can provide video as well as an expanding list of computer applications, some of which have been used in local area networks of businesses. *See, e.g.,* Borko Furht, *et al.*, *Design Issues for Interactive Television Systems*, Computer (IEEE Computer Society Magazine), Vol. 28, No.5, May 1995, at 31-32.

[17] Availability of off-the-shelf equipment may tend to accelerate applications of ADSL technology. Other variations of this technology are also becoming available. Bell Atlantic and Pacific Telesis reported the first trials of ADSL.

coupled with new fiber loop deployment may become increasingly important. As usable copper pairs are exhausted, fiber predictably will become an increasingly important element in the local loop.[18]

Fiber rings provide desirable redundancy by connecting the customer with the central office through two distinct paths or by similarly interconnecting central offices to each other. Perceived competitive pressures and a desire to lower the cost of deploying fiber to business and residential customers are two factors that may have promoted such deployment. We have noticed distinguishing aspects of fiber rings as deployed by specific companies. For example, some of the BOC-deployed fiber redundancy arrangements differ from CAP-deployed fiber rings by using the existing plant structure to provide two separate access paths to the customer. U S WEST has tariffed such redundant arrangements.

Fiber architectures that could reduce outside plant needed to provide broadband services to large numbers of residential customers are also attractive to local telephone companies. One such architecture, called "fiber-to-the-curb," is a type of system hybrid that uses both copper and fiber. In hybrid systems, the interface point between the fiber and copper can vary depending on the system. In fiber-to-the-curb systems, fiber typically is deployed to an interface point near the customer which in newer construction sites is often referred to as a "pedestal." Coaxial or other copper wire systems can be used for the relatively short link to the customer. These systems provide for sharing of fiber and equipment to convert optical to electrical signals and are particularly promising for providing broadband services to large numbers of residential subscribers.[19]

Following its recent merger with NYNEX, Bell Atlantic reports the most significant deployment of fiber-to-the-curb technology. (Bell Atlantic also has begun to develop facilities to provide switched digital video capabilities in New Jersey and other states.[20]) U S WEST and BellSouth also report significant early fiber-to-the-curb deployments, while SBC initially reported the use of fiber-to-the-curb arrangements in Texas. Ameritech continues to report no use of this

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[18] Presently it does not appear that there is much investment directed toward fiber facilities associated with access to smaller customers. In the years to come investment in fiber facilities to customers and to pedestal or curb locations will become increasingly important, since ADSL type technologies for enhancing copper facilities, or even ISDN for that matter, cannot be used in many situations where loop quality is not acceptable or where pair gain equipment is currently installed on copper pairs. Greater area specific public availability of data on relevant characteristics of existing copper loops maintained by the monopoly carriers could help to stimulate fiber investment where it is needed most.

[19] In the area of optoelectronic equipment further cost reductions are expected. Such cost reductions will facilitate the development of optical networks and may affect design considerations used in fiber-to-the-curb systems. Fiber to the home applications, for example, will become more attractive as the cost of optoelectronic equipment continues to decline. *See Lightwave*, Mar. 1997, at 1.

[20] *See Lightwave*, Sept. 1996, at 1.

configuration. As demand for copper pairs suitable to support ISDN and ADSL/HDSL technologies increases -- and the number of available high quality copper access pairs declines -- fiber-to-the-curb and fiber-to-the-pedestal systems should become more attractive.

Companies have used fiber technology trials to test various fiber-to-residence arrangements and architectures, including systems with limited switched video capability. Carriers also have conducted trials utilizing other types of fiber technology. In past years, for example, BellSouth reported SONET trials as well as SONET 150 megabit loop trials. BellSouth, NYNEX, and GTE in the past also reported trials and research projects involving medical imaging applications. A number of carriers previously reported trials involving subscriber systems. In particular, Pacific Telesis reported trials of asynchronous transfer mode (ATM) along with prior information on a technology test of a loop optical carrier system and an associated software support system. Bell Atlantic reported bandwidth sharing trials and voice and video integration capability using off-the-shelf systems with future broadband upgrading capability.

Although, as mentioned above, we no longer request data about such trials, evaluation of previously-submitted data appears to suggest that per-fiber deployment costs of most systems that have undergone trials range from about $2,000 to an amount in excess of $6,000 per fiber. Aside from the fiber trials and fiber redundancy arrangements alluded to above, there presently appears to be relatively little distribution fiber in place, and it is unclear how much of the existing loop fiber deployed to date is actually in current use. Local telephone companies generally are continuing to deploy fiber to modernize their plant with limited deployment in the subscriber loop.

Table 5: Sheath Miles of Fiber Deployed by Local Operating Companies

	Sheath Miles in Thousands												
Company	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Ameritech	3.2	5.2	6.7	8.7	10.8	12.1	15.2	18.3	21.5	23.8	26.4	29.6	32.6
Bell Atlantic	1.2	4.4	6.7	9.2	11.9	15.0	18.4	23.7	28.2	32.3	35.7	39.0	73.9
BellSouth	3.8	8.7	11.7	15.6	19.8	24.2	29.7	35.2	40.5	45.6	51.0	56.0	60.2
NYNEX	1.6	3.2	5.0	7.4	9.2	11.9	14.7	17.7	20.5	23.1	25.5	27.9	NA
Pacific Telesis	2.3	2.8	3.0	3.5	3.8	5.1	6.6	8.3	9.8	10.9	12.2	13.4	14.6
SBC	1.9	4.4	6.0	7.3	9.1	11.7	15.0	17.7	22.1	25.4	29.5	34.4	36.9
U S WEST	3.5	5.0	6.9	10.0	13.4	17.6	22.2	27.4	31.3	34.7	38.5	38.7	39.6
Bell Totals:	17.6	33.6	46.0	61.9	78.0	97.6	121.7	148.4	173.9	195.9	218.7	238.9	257.8
GTE	NA	NA	NA	10.1	20.9	28.6	31.6	34.0	39.8	45.4	41.8	43.7	49.2
Sprint	NA	NA	NA	2.9	5.0	5.9	7.4	9.9	12.0	14.2	16.5	18.8	18.7
Rural	NA	0.5	2.6	4.7	6.4	8.7	NA	NA	NA	NA	51.3	59.3	NA
Total Reported:	17.6	34.1	48.6	79.5	110.3	140.8	160.8	192.3	225.6	255.5	328.3	360.7	325.7

* See accompanying notes to the tables and discussion in text.

Table 6: Fiber Miles Deployed by Local Operating Companies

	Fiber Miles in Thousands												
Company	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Ameritech	78	111	147	178	228	286	401	586	802	919	1,096	1,339	1,556
Bell Atlantic	83	151	228	311	373	523	810	1,193	1,569	1,919	2,169	2,403	4,374
BellSouth	51	170	218	319	445	609	769	939	1,121	1,381	1,685	2,012	2,293
NYNEX	83	130	207	291	358	473	637	807	964	1,112	1,265	1,423	NA
Pacific Telesis	84	98	101	110	127	185	246	312	375	424	482	540	605
SBC	70	151	183	215	270	352	478	576	775	971	1,235	1,504	1,724
U S WEST	47	70	108	164	235	352	542	798	1,043	1,239	1,483	1,615	1,668
Bell Totals:	497	881	1,192	1,588	2,037	2,780	3,882	5,210	6,649	7,965	9,414	10,837	12,219
GTE	NA	NA	NA	135	163	317	391	514	672	795	930	1,065	1,262
Sprint	NA	NA	NA	32	55	84	116	140	187	257	353	441	536
Rural	NA	2	14	29	42	68	NA	NA	NA	NA	NA	NA	NA
Total Reported:	497	883	1,206	1,783	2,297	3,249	4,389	5,863	7,508	9,018	10,698	12,343	14,017

* See accompanying notes to the tables and discussion in text.

Table 7: Average Fiber Cable Cross Section *

Company	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Ameritech	24.3	21.4	22.0	20.4	21.1	23.6	26.4	32.0	37.3	38.6	41.5	45.2	47.7
Bell Atlantic	67.0	34.5	33.8	33.7	31.3	35.0	42.2	47.0	56.4	59.4	60.8	61.7	59.2
BellSouth	13.3	19.6	18.6	20.4	22.5	25.2	25.9	26.6	27.7	30.3	33.1	35.9	38.1
NYNEX	51.9	40.4	41.8	39.2	38.8	39.8	43.4	45.6	47.0	48.2	49.6	50.9	NA
Pacific Telesis	36.4	35.2	34.1	31.7	33.7	36.0	37.5	37.4	38.2	38.8	39.5	40.4	41.5
SBC	36.8	34.5	30.6	29.2	29.7	30.1	31.7	32.5	35.1	38.2	41.8	43.7	46.7
U S WEST	13.4	14.0	15.5	16.3	17.5	20.0	24.5	29.1	33.3	35.7	38.5	41.8	42.2
Bell Companies	28.2	26.2	25.9	25.7	26.1	28.5	31.7	34.4	38.3	40.7	43.0	45.4	47.4
GTE Companies	NA	NA	NA	13.3	7.8	11.1	12.4	15.1	16.9	17.5	22.3	24.4	25.6
Sprint Companies	NA	NA	NA	11.1	10.9	14.2	15.5	14.2	15.6	18.1	21.4	23.5	28.7
Rural Companies	NA	4.0	5.5	6.2	6.6	7.9	NA	NA	NA	NA	NA	NA	NA
All Companies	28.2	25.9	24.8	22.4	20.8	23.1	27.2	29.9	33.3	35.3	32.6	34.2	43.0

* See accompanying notes to the tables and discussion in text.

Table 8:
Data on Fiber to the Pedestal of Local Operating Companies -- 1997 *

	Number of Pedestal** Locations	Fibers Serving Pedestals *	Fiber Miles Serving Pedestals	Customers Accessible to Pedestal Loc	Bandwidth Enhancing Terminals	All Access Lines Loop Length (miles) Average	Median	Maximum
Ameritech	0	0	0	0	93,800	1.4	1.9	5.7
Bell Atlantic	7,590	15,180	NA	124,900	46,600	2.4	2.3	9.9
BellSouth	21,459	25,751	NA	124,672	28,055	3.4	2.5	26.9
NYNEX	NA	NA	NA	NA	NA	2.4	1.8	10.2
Pacific Telesis	80	288	159	310	34,251	2.3	2.0	19.4
SBC	707	1,414	712	4,811	0	NA	2.7	24.6
U S WEST	8,903	9,493	24,866	53,512	35,098	2.7	NA	NA
Total Reported:	38,739	52,126	25,737	308,205	237,804			

* See accompanying notes to the tables and discussion in text.
** The term "pedestal" includes curb locations.

Table 9: Other 1997 Fiber Data for Local Operating Companies

Company	Percent Lit	DS-3 Miles on Fiber	T1 Miles on Copper	Customer Terminated T1 Lines	Aggregate Fiber Investment (Million $) Subscriber Plant	Total Plant
Ameritech	16.4%	799,700	167,700	68,800	NA	1,083.2
Bell Atlantic	40.0%	320,000	4,300,000	108,000	NA	2,735.6
BellSouth	28.1%	615,735	45,150	114,845	NA	1,812.3
NYNEX	NA	NA	NA	NA	NA	NA
Pacific Telesis	31.5%	287,517	679,502	168,247	NA	571.0
SBC	18.4%	605,940	466,292	144,408	803.5	1,231.0
U S WEST	37.0%	1,130,359	784,710	130,024	NA	1,133.6
GTE	NA	120,016	565,617	96,978	NA	1,145.2
Sprint	41.6%	NA	NA	NA	NA	116.0
Total Reported		3,879,267	7,008,971	831,302	803.5	9,827.9

* See accompanying notes to the tables and discussion in text.

Table 10 -- Fiber Subscriber Plant of Local Operating Companies

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Company	Sheath Miles									
Ameritech	2,800	2,600	3,300	3,700	4,300	NA	NA	NA	NA	NA
Bell Atlantic	NA	4,872	6,543	NA	NA	NA	NA	NA	NA	NA
BellSouth	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NYNEX	1,935	2,656	3,995	5,388	7,095	8,976	10,398	12,799	14,442	NA
Pacific Telesis	537	722	1,451	2,210	2,874	3,426	3,938	4,636	5,332	5,920
SBC	NA	2,500	2,800	4,498	5,409	8,008	9,866	16,479	NA	NA
U S WEST	2,816	3,484	4,714	6,595	8,706	10,879	13,047	16,340	NA	NA
GTE	NA	NA	NA	NA	NA	NA	NA	NA	20,420	22,998
Company	Thousands of Fiber Miles									
Ameritech	56.6	69.2	84.6	153.0	234.4	NA	NA	NA	NA	NA
Bell Atlantic	116.9	152.3	226.0	NA	NA	NA	NA	NA	NA	NA
BellSouth	185.8	267.3	355.2	440.4	NA	NA	NA	648.7	748.7	802.2
NYNEX	66.8	90.0	135.9	209.7	302.0	404.0	510.8	615.5	712.4	NA
Pacific Telesis	22.1	30.4	64.1	96.9	120.9	139.7	160.2	189.0	216.0	239.9
SBC	NA	95.4	135.6	185.3	221.8	365.4	514.6	878.2	NA	NA
U S WEST	84.8	112.4	113.8	295.2	452.6	618.2	761.9	968.6	NA	NA
GTE	NA	NA	NA	NA	NA	NA	NA	NA	563.8	668.8

* See accompanying notes to the tables and discussion in text.

Table 11: Copper Subscriber Plant of Local Operating Companies *

Company	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	Thousands of Sheath Miles									
Ameritech	242.7	245.2	244.4	242.7	243.5	NA	NA	NA	NA	NA
Bell Atlantic	280.3	290.8	291.3	288.9	NA	NA	NA	NA	NA	NA
BellSouth	560.0	564.2	566.1	570.4	NA	NA	NA	NA	NA	NA
NYNEX	225.5	229.5	232.7	232.9	233.2	233.9	234.5	235.5	236.7	NA
Pacific Telesis	170.3	167.5	184.1	185.2	192.7	207.9	187.9	189.0	190.3	191.7
SBC	NA	338.1	343.3	345.1	347.4	350.1	354.4	357.4	NA	NA
U S WEST	384.3	389.4	395.8	401.7	407.9	413.2	403.0	408.4	NA	NA
GTE	NA	NA	NA	NA	NA	NA	NA	NA	721.0	727.5
Company	Millions of Wire Miles									
Ameritech	139.6	140.4	141.9	142.4	143.2	NA	NA	NA	NA	NA
Bell Atlantic	187.4	191.7	194.4	194.4	NA	NA	NA	NA	NA	NA
BellSouth	238.8	241.2	243.5	243.6	NA	NA	NA	NA	NA	NA
NYNEX	130.9	134.2	137.9	140.0	141.6	143.2	144.3	145.2	146.4	NA
Pacific Telesis	128.8	127.5	134.3	136.3	140.6	158.1	156.4	141.4	139.4	140.6
SBC	NA	156.9	159.3	160.1	160.9	162.3	169.5	170.3	NA	NA
U S WEST	154.2	156.2	158.7	161.1	163.6	165.7	169.5	170.2	NA	NA
GTE	NA	NA	NA	NA	NA	NA	NA	NA	164.8	168.7

* See accompanying notes to the tables and discussion in text.

Table 12: Fiber and Copper in Total Plant in Relation to Access Lines -- End of Year 1997 *

Company	Access Lines (thousands)**	Total Plant Strand Miles (thousands) Copper	Fiber	Sheath Miles Copper	Fiber	Per Thousand Access Lines: Miles Copper Wire	Miles Fiber Strand	Miles Copper Sheath	Miles Fiber Sheath	Percent Fil Fiber Sheath
Ameritech	23,817	198,724	1,556	331,500	32,600	8,344	65.3	13.9	1.4	9.0%
Bell Atlantic ***	43,714	356,616	4,374	542,806	73,927	8,158	100.1	12.4	1.7	12.0%
BellSouth	25,733	249,465	2,293	591,394	60,181	9,694	89.1	23.0	2.3	9.2%
Pacific Telesis	22,111	158,041	605	204,476	14,589	7,147	27.4	9.2	0.7	6.7%
SBC	18,701	175,444	1,724	385,932	36,930	9,382	92.2	20.6	2.0	8.7%
U S WEST	25,294	176,310	1,668	399,970	39,557	6,970	65.9	15.8	1.6	9.0%
GTE	19,805	170,700	1,262	737,830	49,247	8,619	63.7	37.3	2.5	6.3%
Total reported:	179,176	1,485,302	13,481	3,193,908	307,031	8,290	75.2	17.8	1.7	8.8%

* See accompanying notes to the tables and discussion in text.

** Total Switched and Special Access Lines from ARMIS 43-08 data.

*** Bell Atlantic data includes NYNEX

Table 13: Fiber and Copper in Subscriber Plant in Relation to Access Lines -- End of Year 1997 *

Company	Access Lines (000) Total**	% Without Pair Gain	Subscriber Plant Strand Miles (000) Copper	Subscriber Plant Strand Miles (000) Fiber	Subscriber Plant Cable Sheath Miles Copper	Subscriber Plant Cable Sheath Miles Fiber	Per Thousand Access Lines Miles Copper Wire	Per Thousand Access Lines Miles Fiber Strand	Per Thousand Access Lines Miles Copper Sheath	Per Thousand Access Lines Miles Fiber Sheath	Per Thousand Access Lines % Fiber Sheath Miles
Ameritech	23,817	73%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bell Atlantic***	43,714	83%	NA	NA	NA	NA	NA	NA	NA	NA	NA
BellSouth	25,733	64%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pacific Telesis	22,111	78%	140,456	240	191,692	5,920	6,352	10.8	8.7	0.27	3.0%
SBC	18,701	73%	NA	NA	NA	NA	NA	NA	NA	NA	NA
U S WEST	25,294	75%	NA	NA	NA	NA	NA	NA	NA	NA	NA
GTE	19,805	76%	168,651	669	727,500	22,998	8,515	33.8	36.7	1.16	3.1%
Total reported:	179,176	75%									

* See accompanying notes to the tables and discussion in text.

** Total Switched and Special Access Lines from ARMIS 43-08 data.

*** Bell Atlantic data includes NYNEX

Notes to Tables 5-13: *(NA indicates unavailable data.)*

In some instances carriers estimate certain data. Accuracy may vary depending on the carrier's method of collecting and assembling its data. Historical data may reflect adjustments made this year. The reader should refer to prior reports for previously reported data. Data on recent subscriber copper for a number of companies are not available.

Ameritech has not provided data on subscriber plant since 1992. Data prior to 1993 are based on engineering judgment. Ameritech's HDSL terminals are shown in the tables. An additional 208,000 UDC terminals in 1997 used for pair gain were reported by the company.

BellSouth subscriber fiber mileage for 1989, 1990, and 1991, as shown in Table 10, was estimated as 60% of the total fiber mileage based upon data provided by the company for 1987 and 1988. Other companies separating subscriber and interoffice fiber on average show about half of the total fiber sheath mileage as subscriber and more than 90% of the copper wire as subscriber. BellSouth fiber investment does not include electronics at terminal or repeater sites. BellSouth data for 1990 fiber mileage reflect an earlier correction. BellSouth subscriber fiber mileage was reported as 182,627 lit subscriber miles in 1995 and 204,142 in 1996 and 225,416 in 1997. Total (lit plus dark) subscriber fiber mileage data shown in the Table 10 for BellSouth were estimated by dividing lit subscriber mileage by overall lit fiber percentages. BellSouth bandwidth enhancing terminals shown in Table 8 consist of HDSL installed central office circuit packs. According to the company, not all circuit packs are necessarily in current use.

Except as noted below, Bell Atlantic data now includes data for NYNEX. T1 miles on copper and DS-3 miles on fiber only include data for the pre merger Bell Atlantic entity.

Data in the tables reflect the fact that prior to 1989 Southwestern Bell (now SBC Communications) used interexchange and toll rather than interoffice and loop subcategories. Southwestern Bell's nonfinancial data for 1989 to the present properly reflect loop and interoffice subcategories which were originally requested. However, investment data under the subscriber heading actually represent exchange facilities, which also includes some interoffice plant. Investment data for 1994 were adjusted from the previously reported value to $804.4 million. Copper subscriber mileage for 1994 was revised from the previously reported value. The company confirmed an inconsistency in DS-3 mileage for 1994 and 1995 data and attributed the problem to manual data collection.

United companies are owned by Sprint. Data for Sprint also include data for the Centel companies which were acquired by Sprint in 1993. Sprint had provided revised 1992-1995 data along with its 1996 submission. These revisions are reflected in the attached tables along with newly provided data.

General Definitions and Descriptions of the Items in Tables 5-13:

Total access line counts (switched and special access combined) shown in Tables 12 and 13 were taken from the annual ARMIS 43-08 submissions of the carriers covering the 1997 calendar year *as reported in the preliminary domestic information from Statistics of Communication Common Carriers .*

Total strand miles of fiber and strand miles of copper -- The number of fiber strand miles used in all routes (including both lit and unlit fiber and inactive copper pairs), i.e., the sum of the number of miles of each cable multiplied by the number of strands. The terms "fiber miles" and "fiber strand miles" are used interchangeably.

Percent lit fiber -- The number of fiber strand miles activated or equipped with optoelectronic equipment at terminal and repeater sites and capable of providing at least one voice-grade circuit as a percentage of the total fiber miles of fiber.

Sheath miles of fiber cable and sheath miles of copper cable -- The total number of miles of fiber cable used. (A given sheath may contain as few as 12 fibers or more than 50 fibers. The average size of the cable sheath is given in Table 7.)

Fiber-to-the-curb systems -- Systems employing a fiber architecture where fiber and electronics is shared to a pedestal or curb location.

Subscriber fiber -- The sum of feeder and distribution fiber used in local customer or subscriber loops to establish access to the network.

Investment in fiber plant -- The total investment in fiber cable, deployment, and repeater sites (outside plant), not including electronic or optoelectronic equipment. Subscriber investment includes that portion of investment associated with subscriber loops.

Pair gain -- The use of terminal equipment to derive more than one voice channel on a single copper pair in subscriber systems.

Access lines without pair gain -- The number of subscriber access lines in which the connection between the customer and the central office is a dedicated copper pair or fiber facility. Percent not derived from pair gain was computed using the total of switch and special access line counts reported in the ARMIS 43-08 report.

DS-3 miles on fiber --Miles of DS-3 equivalent capacity equipped on fiber facilities. Each DS-3 link typically can support up to 672 64 Kb/s or equivalent links.

T1 miles on copper -- Miles of T1 or DS-1 capacity equipped on copper facilities. Each T1 link typically can support up to 24 64 Kb/s or equivalent links.

Competitive Access Providers

CAP data appear in Tables 14 and 15. Because entities must own facilities for inclusion in the tables, the term CAP (competitive access provider) is used as a more restrictive term than the term CLEC (competitive local exchange carrier) which includes entities that lease all their transmission facilities. Although there is evidence that CAPs are expanding their operations in order to compete more widely with local telephone companies, we focus on fiber deployment by CAPs in metropolitan areas where they have typically provided access services to large business customers including IXCs and financial institutions. Although small in comparison to the amount of fiber owned by IXCs and local telephone companies, the amount of CAP-owned fiber has been growing rapidly. Our survey excludes CAPs that were in the process of constructing fiber plant but that did not have operational owned fiber at year's end. We have also excluded CAPs whose operations exclusively employ microwave technology. Due to variations in the amount and interpretation of data available from different CAPs, this report in some cases only highlights selected areas of service, typically larger or more widely known locations, along with the number of system locations in each state provided by the carrier.

In a typical CAP fiber configuration serving multiple buildings, a cable several miles in length and containing from 20 to 200 fibers is deployed in an existing conduit (or, for example, in subway tunnels) in a ring configuration. The ends of the fiber cable are connected at a hub location. At least one fiber pair in the ring typically is dedicated to a single building, and capacity can be subdivided electronically in order to provide service for individual customers within the building. CAPs have employed both shared and dedicated fiber configurations. Fiber rings provide effective redundancy because traffic can reach the hub by travelling in either direction around the loop.

Initially, CAPs tended to offer non-switched service, although many are now offering switched services. CAP systems also have grown in capacity and sophistication.[21] Several years ago, for example, MFS (now part of WorldCom) reported that it had installed its first 100 megabit per second network, deploying equipment based on SONET standards. Moreover, in an effort to better serve customers who demand switched services, a number of CAPs are establishing collocation interfaces with local telephone companies. Such arrangements may indirectly lead to construction of new operating company facilities by requiring the availability of local company facilities from customer locations that cannot directly access a competitive access system. In some cases, CAPs appear to have motivated local telephone companies to price special access closer to cost and to serve larger customers by constructing their own redundant facilities and fiber rings. In this latter regard, we note that the Bell operating companies reported construction of fiber rings or fiber redundancy arrangements in many of the very same cities where CAP systems currently compete with them for large business customers. CAPs traditionally have been viewed as carriers who compete with monopoly carriers. However, they are also significant customers of monopoly carrier services.

[21] In recent years collocation of facilities with local telephone companies has greatly increased the number of available customers without construction of new facilities. In some cases the building counts may reflect access to buildings not directly served.

As explained in the introductory sections of this report, merger and acquisition activity involving CAPs has complicated reliable data collection. We requested that CAPs supply data only about owned fiber in order to help prevent double counting of facilities. Nevertheless, it is predictable that some double counting has occurred.[22] Merger and acquisition -- as well as partnership -- activity also reflects other changes in the nature of the CAP business, *e.g.*, the increased provision of switched services. Some of these changes are described in the notes to Tables 14 and 15. We direct readers interested in these changes to consult historical information contained in earlier Fiber Deployment Reports.

[22] For example, some merger and acquisition activity has involved CAPs with cable television companies that also use fiber. Further, some cable television companies appear to own facilities through partnership and joint venture arrangements with CAPs, or to have entered into sharing arrangements directly with CAPs. Although we asked surveyed entities to separate cable TV facilities from competitive access facilities, not all entities providing data were able to do so.

Table 14:

Competitive Access Fiber Systems -- 1997

Company Name	Route Miles								Thousands of Fiber Miles							
	1990	1991	1992	1993	1994	1995	1996	1997	1990	1991	1992	1993	1994	1995	1996	1997
ACSI (e.spire)	NA	NA	NA	NA	NA	NA	697	1,061	NA	NA	NA	NA	NA	NA	48.8	92.5
Brooks Fiber	109	141	193	264	264	480	1,059	2,494	2.6	3.8	4.3	6.2	18.0	24.3	71.3	215.2
Eastern Telelogic	140	140	140	194	233	395	438	NA	3.7	3.7	3.7	4.4	4.4	13.8	18.8	NA
Electric Lightwave	NA	6	104	126	225	466	516	952	NA	0.5	6.8	11.7	20.5	NA	61.5	108.4
GST Telecom	NA	NA	NA	NA	NA	NA	305	415	NA	NA	NA	NA	NA	NA	21.5	38.4
Hyperion	NA	NA	NA	NA	NA	NA	2,887	4,761	NA	NA	NA	NA	NA	NA	138.6	220.0
ICG	NA	105	132	151	424	637	2,073	2,872	NA	4.8	6.5	8.6	19.0	28.8	69.6	108.1
Intermedia (ICI)	159	165	213	335	372	561	605	605	2.9	3.0	5.2	10.2	11.3	20.5	24.1	35.0
Kansas City Fib. Net	91	94	97	200	200	200	NA	NA	2.5	2.6	2.9	0.0	3.7	3.8	NA	NA
MCImetro	NA	NA	NA	NA	NA	2,338	2,948	2,948	NA	NA	NA	NA	NA	NA	NA	NA
MFS (WorldCom)	309	546	1,133	1,530	2,387	3,112	3,523	3,858	17.2	29.8	41.4	67.0	106.9	188.0	229.9	283.7
McLeod USA	65	75	95	121	116	NA	2,352	NA	1.6	1.8	3.7	5.0	3.0	NA	123.9	NA
Phoenix FiberLink	NA	NA	NA	NA	NA	32	76	NA	NA	NA	NA	NA	NA	3.1	7.2	NA
Teleport (TCG)	328	507	1,018	2,082	3,902	5,428	6,744	9,474	18.5	24.7	40.0	96.1	167.3	253.3	346.0	491.1
Time Warner	59	86	88	96	348	3,312	4,232	5,911	0.5	1.2	1.2	1.4	10.4	107.9	151.7	233.5
US Signal	67	115	144	367	554	NA	NA	NA	5.6	6.3	7.3	20.2	31.6	NA	NA	NA
Total Reported:	1,326	1,980	3,357	5,466	9,025	16,961	28,454	35,351	55	82	123	231	396	643	1,313	1,826

* See accompanying notes to the tables and discussion in text.

Table 15:

Competitive Access Fiber Systems -- Other Available Data -- 1997*

Company Name	Sheath Miles	Average Fibers per Route	Investment Millions $	Buildings Served	States Served
ACSI (e.spire)	NA	87.2	250.5	1,604	NA
Brooks Fiber	3,100	86.3	269.2	4,546	20
Eastern Telelogic	NA	NA	NA	NA	NA
Electric Lightwave	1,262	113.9	141.5	482	6
GST Telecom	448	92.5	92.0	529	NA
Hyperion	4,761	46.2	NA	1,926	12
ICG	3,043	37.7	NA	2,321	7
Intermedia (ICI)	757	57.9	NA	679	6
Kansas City Fiber Net	NA	NA	NA	276	2
MCImetro	NA	NA	498.0	NA	19
MFS (WorldCom)	4,376	73.5	NA	20,435	23
McLeod USA (formerly MWR)	NA	NA	NA	452	2
Phoenix FiberLink	NA	NA	NA	NA	NA
Teleport (TCG)	NA	51.8	NA	13,514	22
Time Warner	NA	39.5	NA	NA	10
US Signal	NA	NA	NA	NA	4

* See accompanying notes to the tables and discussion in text.

<u>Notes to Tables 14 and 15:</u> *(NA indicates unavailable data)*

Statistics for backbone system and associated data were requested for owned facilities. Due to numerous mergers and acquisitions, it has been difficult to adjust prior data properly. In many cases data for merged entities have been combined retroactively and the merged entities are no longer included in the tables. Some discrepancies from earlier totals have resulted from partial acquisitions and from common facilities of merged entities. Entities identified but not providing data for this year's report are mentioned in these notes.

Some CAPs are owned by cable TV companies and share cable capacity with cable TV services. Where such arrangements were known to exist, we requested the CAPs involved to report fiber mileage associated with the separate operations. Route mileage reflects the reported route mileage of each competitive access system. In some cases, parent companies have partial and overlapping ownership interests in multiple entities.

American Communication Services, Inc. (ACSI), was first identified in 1996. Its name was changed to e.spire Communications, Inc. in April 1998.

Bay Area Teleport, which was acquired by ICG and is not listed in the tables, had previously indicated that it operated 58.9 route miles and 78 sheath miles of leased facilities that are included in the ICG totals.

Brooks Fiber Properties acquired Phoenix Fiberlink and PSO MetroLink in 1994. Data for these entities have been merged retroactively into the Brooks Fiber entry. In 1995 Brooks Fiber acquired a portion of Fibernet USA facilities in Cincinnati, Ohio, Huntsville, Alabama; Raleigh-Durham, North Carolina; and St. Louis, Missouri. These are included in the Brooks total. Brooks Fiber Properties partially acquired US Signal facilities in Lansing, Ann Arbor, and Grand Rapids, Michigan and Toledo, Ohio, in early 1996; data for these facilities in 1995 are incorporated in the Brooks Fiber total. Prior to 1995, total US Signal data are shown separately. Brooks Fiber merged with WorldCom on January 29, 1998.

Cox Communications Services reported a total of 7,711 route miles of fiber cable facilities in 1997 and 6,564 route miles in 1996, but is not included in the tables because it was unable to separate facilities used for telecommunications from its cable TV services for this year's survey.

Digital Direct facilities in Chicago, Dallas, Seattle, and Pittsburgh have been acquired by Teleport Communications Group and this entity is no longer shown in the tables.

Eastern Telelogic 1993 fiber mileage data have been adjusted by the company. Eastern Telelogic has been acquired by Teleport Communications Group (TCG) and its 1997 data is included in the TCG total.

Electric Lightwave previously had included 298 miles of inter-city fiber in its 1995 fiber data. An adjustment had been made to Table 14 to reflect this. Table 14 data for 1996 and 1997 only include its local fiber facilities. Electric Lightwave is a subsidiary of Citizens Utilities Company.

During 1993 new facilities were being constructed by Fibernet in Cincinnati, Ohio, and other facilities were completed in Buffalo and Albany, New York. The purchase of Fibernet's Buffalo, Albany and Rochester facilities by Metropolitan Fiber Systems (MFS) was finalized in 1994. These facilities are now part of the MFS total for 1994 and have been added to previously reported MFS data. The completed Cincinnati facilities and other facilities under construction were not acquired by MFS; they were owned by an entity called Fibernet USA that was acquired by Brooks Fiber Properties. These data have been merged into the Brooks Fiber entry.

Hyperion Telecommunications, Inc. was first identified in 1996.

ICG, originally called Teleport Denver, initiated construction of new facilities in Colorado Springs and Phoenix, Arizona in 1993. The name of the company was changed to IntelCom Group and later to ICG Communications. ICG acquired the facilities of Ohio Lynx in Dayton and Cleveland, Ohio, as well as the facilities of Privacom in Charlotte, North Carolina and Nashville, Tennessee. ICG also had acquired Bay Area Teleport facilities in California. All acquired facilities, including those of Ohio Lynx and Bay Area Teleport, were retroactively included in the IntelCom total. ICG reports 171 route miles of leased facilities that are not included in the route mileage of Table 14, but have been added to the total sheath mileage in Table 15.

Intermedia Communications, Inc., is listed in the tables as Intermedia (ICI). Intermedia reported the acquisition completed in early 1995 of Fibernet USA facilities in Cincinnati, Ohio, and additional Fibernet USA facilities that were constructed in Huntsville, Alabama; Raleigh-Durham, North Carolina; and St. Louis, Missouri. The tables reflect the acquisition of Fibernet USA facilities.

Jones Lightwave was acquired by MFS and is no longer shown in the tables. Its data have been combined retroactively with that of MFS.

Kansas City Fiber Net was formerly part of American Cablevision and partially owned by Time Warner. It was acquired by TCG in July 1998 just prior to TCG's acquisition by AT&T. Because its ownership had been split and its status has changed, it is shown as a separate entity in the attached tables.

MCI has reported limited data on MCImetro, its wholly owned subsidiary created in early 1994 to provide access services.

MFS was acquired by WorldCom, a long distance carrier on December 31, 1996. The associated WorldCom facilities are still referred to as MFS in the tables. MFS had previously acquired New England Digital Distribution and the Atlanta facilities of Metrex during 1992. Totals for MFS include those acquired facilities, as well as facilities of I. C. C., which it acquired in 1991. Historical MFS data were increased to include the fiber associated with these facilities. The company adjusted its totals for 1992 and 1991 to account for these acquisitions as well as to reflect the results of a facilities audit which revealed an overcount in fiber miles and an undercount in route miles. In addition, early reports did not include fiber associated with building access which the company has included starting with the 1992 data. Fibernet facilities are also included in the 1994 MFS data and the MFS data were adjusted retroactively. MFS *acquired Virginia Metrotel in January 1995. Of the 20,435 total buildings accessed 2,813 are directly accessed by fiber, 177 represent telco collocation buildings, and 17,445 buildings are indirectly accessed through local telephone company facilities.*

MWR had partnered with MFS in St. Louis, Missouri, to form MFS-St. Louis (with minority ownership). MWR data for 1994 do not include the St. Louis operation. MWR has been acquired by McLeod, Inc. and is now listed in the tables under that name.

Penn Access, which obtained much of its fiber in conjunction with the local electric utility, was acquired by Teleport Communications Group (TCG) in 1994 and its data are now included with TCG data.

Phoenix Fiberlink and PSO Metrolink were acquired in 1994 by Brooks Fiber Communications (Brooks Fiber Properties). Brooks also acquired 6 route miles of FiveCom's system in Springfield, Mass., whose facilities were not previously listed in this report. The statistics for Phoenix Fiberlink and PSO have been merged with minor adjustment into the Brooks Fiber entry. Subsequently, new facilities under the name Phoenix Fiberlink were constructed in Salt Lake City, Utah, and are listed as a separate entry in the accompanying tables.

During 1992, TCI, the parent company of Digital Direct acquired an interest of slightly under 50% in Teleport Communications. As of the end of 1992, the planned consolidation of facilities of Digital Direct and Teleport Communications had not been completed. During 1993, the acquisition of Digital Direct facilities in Chicago, Dallas and Seattle was completed, and the data filed by Teleport Communications Group (TCG) for 1993 include those facilities. Possible overlapping of routes associated with the consolidation should have been accounted for in 1993 Teleport Communications Group data, since Digital Direct and Teleport Communications Group both operated facilities in Dallas and Chicago. TCI Telephony was identified in 1996 but has declined to provide data for this survey.

During 1993 Teleport Communications Group (TCG) acquired Diginet. Data for Diginet is included in the aggregate for TCG. Diginet fiber connecting Milwaukee and Chicago is shown separately in Table 1 under the name TCG. In 1994, TCG acquired Penn Access whose data have been retroactively merged with the TCG data. TCG merged with AT&T in July 1998.

The Time Warner Communications entry in the tables includes facilities of Indiana Digital Access and Metro Com that were listed in prior deployment reports, as well as other facilities not previously reported. Time Warner has either acquired or gained a financial interest in the facilities of Indiana Digital Access and Metro Com. Data for Kansas City Fibernet, in which Time Warner also has an interest, are shown separately. Facilities for Buffalo, New York were included in 1995 as a Time Warner partnership with another undisclosed entity. Time Warner is no longer part of the partnership and the Buffalo facilities were not included in the Time-Warner total for 1996. Indiana Digital Access and MetroCom were also acquired by Time Warner in 1995. At about the same time Time Warner had also acquired Newhouse Broadcasting, a cable TV operation. Time Warner originally planned to provide business and residential telephony services along with its cable television services. It is now appears to be focusing almost exclusively on its business services and only maintains a small number of residential customers.

Facilities of US Signal, formerly known as City Signal, were acquired by Brooks Fiber Properties, Teleport Communications Group, and at least one other entity, but its data prior to 1995 are shown separately.

Several entities owning fiber facilities at the local level were identified beginning in 1996. These include Cablevision Lightpath, TCI Telephony, Cox Fiber Net, GST Telecom, Hyperion Telecommunications Inc., American Communication Services, Inc., FirstWorld Communications (formerly Spectranet International), USN Communication, RCN Corp., Metromedia Fiber Network, Level 3 and Five Com. Some of the entities have only recently begun to construct facilities. While data for a few of these are included in the tables, telecommunications data for the others were unavailable or not applicable to 1997, could not be provided in time for inclusion in this report, or could not be separated from cable TV facilities. Another entity, Harron Communications had reported that it only operates cable TV facilities.

General Definitions and Descriptions of Items in Tables 14 and 15:

Average fiber count or cross section -- Average number of fibers in a cable sheath or route usually calculated as the number of fiber miles divided by the number of sheath miles or route miles.

Route miles of fiber -- The total number of miles of fiber routes. Each route may contain one or more cable sheaths.

Total fiber miles of fiber -- The number of miles of fiber strand used in all routes including both lit and unlit fiber -- the sum of the number of miles of each cable weighted by the number of fiber strands.

Sheath miles of fiber -- The total number of miles of fiber cable used. The sheath mileage is greater than or equal to the route mileage. A given cable sheath may contain widely varying numbers of fibers depending on the application and associated requirements.

Fiber miles of lit fiber -- The number of miles of fiber strand activated or equipped with optoelectronic equipment at terminal and repeater sites and capable of providing at least one voice-grade circuit .

Investment - Approximate investment in fiber cable, deployment, and repeater sites.
Buildings served -- The total number of buildings accessed by fiber where the carrier is capable of providing service.

States served -- The number of states served by fiber facilities.

Appendix: Summary List of Selected Cities and Localities Served by CAPs

American Communication Services, Inc (ACSI) (recently renamed e.spire)
Alabama: Birmingham, Mobile, Montgomery
Arizona: Tucson, Phoenix
Arkansas: Little Rock
California: Santa Clara, San Jose
Colorado: Colorado Springs
Maryland: Central Maryland, Annapolis
Florida: Jacksonville, Tampa, Miami, Ft. Myers, Ft. Lauderdale, Talahassee
Georgia: Columbus, Atlanta, Savannah
Kansas: Overland Park
Kentucky: Lexington, Louisville
Louisiana: Shreveport, Baton Rouge, New Orleans
Mississippi: Jackson
Missouri: Kansas City
Nevada: Las Vegas
New Mexico: Albuquerque
New York: New York City
North Carolina: Charlotte, Raleigh
Oklahoma: Tulsa
South Carolina: Charleston, Greenville, Columbia, Spartanburg
Tennessee: Chattanooga, Memphis, Nashville
Texas: Amarillo, El Paso, Fort Worth, Irving. Amarillo, Dallas, Houston, Austin, San Antonio, Corpus Christi
Virginia: Richmond, McLean

Bay Area Teleport (acquired by IntelCom Group)

Brooks Fiber Properties, Inc. (Locations shown reflect facilities acquired from Phoenix Fiberlink and PSO Metrolink, Fibernet USA, and US Signal.)
(Brooks merged with WorldCom in early 1998)
Arizona: Tucson
Arkansas: Little Rock
California: Sacramento, San Jose, Santa Clara, Sunnyvale, Stockton, Fresno, Bakersfield, Milpitas, Palo Alto, San Francisco, San Mateo
Connecticut: Hartford, Stamford
Maine: Portland
Massachusetts: Springfield
Michigan: Grand Rapids, Lansing, Traverse City
Minnesota: Minneapolis/St. Paul
Mississippi: Jackson
Missouri: Kansas City, Springfield
Nevada: Reno
New Hampshire: Manchester, Nashua
New Mexico: Albuquerque
New York: Long Island, White Plains

Ohio: Toledo
Oklahoma: Oklahoma City, Tulsa
Rhode Island: Providence
Tennessee: Knoxville
Texas: Austin, Fort Worth, Dallas, Houston, San Antonio, Waco
Utah: Ogden, Provo, Salt Lake City

Cablevision Lightpath (no data)

Cox Communications Services: (telecommunications services not separated from Cable TV services)
Operations in: California, Ohio, Georgia, Louisiana, Rhode Island, Arizona, Virginia, Connecticut, Florida, North Carolina Louisiana, Texas

Digital Direct (facilities acquired by TCG)

Eastern Telelogic (acquired by TCG in March 1998)
Pennsylvania: Philadelphia
New Jersey: Camden
Delaware: Wilmington

Electric Lightwave (subsidiary of Citizens Utilities Company)
Arizona: Phoenix metro area
California: Sacramento metro area (Folsom)
Nevada: Las Vegas metro area
Oregon: Portland metro area (Beaverton, Hillsboro, Milwaukie, Gresham, Tualatin, Tigard, Wilsonville)
Utah: Salt Lake City metro area (West Valley City, Murray, Lehi, Highland)
Washington: Seattle metro area (Bellevue, Kent, Renton, Tukwila, Kirkland, Redmond)

Fibernet USA (acquired by Intermedia Communications in February 1995)

GST Telecom
Arizona: Tucson, Phoenix
California: Fresno, Pleasanton, Los Angeles, Rialto, San Bernadino
Riverside, Loma Linda, Ontario, City of Industry, Monterrey Park, Anaheim, Oakland, San Ramon, Livermore
Hawaii: Honolulu / Islands of Ohahu, Kauai, Motokai, Lanai, Maui, Hawaii
Idaho: Boise
New Mexico: Albuquerque
Texas: Houston, Abilene
Washington: Vancouver, Spokane

Hyperion Telecommunications, Inc.
Florida: Jacksonville
Kansas: Wichita
Kentucky: Lexington, Louisville

New York: Buffalo, Syracuse, Albany, Binghamton, Vermont, Morristown
New Jersey: New Brunswick
Pennsylvania: Harrisburg, Philadelphia, York
Tennessee: Nashville
Virginia: Richmond, Charlottesville

Indiana Digital Access (acquired by Time Warner Communications)

ICG Communications (ICG Telecom Group) (formerly Teleport Denver)
Alabama: Birmingham
California: Los Angeles, San Francisco, Sacramento, and San Diego metro areas
Colorado: Denver, Colorado Springs, Boulder
Kentucky: Louisville
North Carolina: Charlotte
Ohio: Cleveland, Cincinnati, Columbus, Dayton, Akron, Columbus
Tennessee: Nashville

Intermedia Communications, Inc (ICI) (Acquisition of Fibernet USA facilities completed in February 1995.)
Alabama: Huntsville
Florida: Tampa, Miami, Jacksonville, Orlando, St. Petersburg, W. Palm Beach
Missouri: St. Louis under construction
North Carolina: Raleigh/Durham (Research Triangle Park in Durham County)
Ohio: Cincinnati

Jones Lightwave (acquired by MFS)

Kansas City Fiber Net (see notes to tables)
facilities in Missouri and Kansas

Linkatel Communications, Inc. (no data)

McLeod, USA -- (acquired MWR Telecom)

MCImetro (see notes to tables)
Alabama: Mobile
California: Los Angeles, Oakland, San Diego, San Francisco, Sunnyvale
Delaware: Wilmington
Florida: Tampa
Georgia: Atlanta
Illinois: Chicago
Maryland: Baltimore
Massachusetts: Boston
Michigan: Detroit
New Jersey: Northern part of state
New York: New York City
Ohio: Cleveland

Oregon: Portland
Pennsylvania: Philadelphia, Pittsburgh
Texas: Houston, El Paso
Washington: Seattle
Washington, D.C.
Wisconsin: Milwaukee
Texas: Dallas

Metrex Corp. of Alabama (no data)

Metro Com (acquired by Time Warner Communications)

Metropolitan Fiber Systems (MFS) (Selected major metro areas are shown.)
(acquired by WorldCom)
Arizona: Phoenix
California: San Francisco, San Jose, San Diego, Oakland, Los Angeles
Colorado: Denver
Connecticut: Hartford, Stamford
Delaware: Wilmington
Florida: Miami, Tampa, Orlando
Georgia: Atlanta
Illinois: Chicago
Indiana: Indianapolis
Maryland: Baltimore
Massachusetts: Boston
Michigan: Detroit
Minnesota: Minneapolis
Missouri: St. Louis
New Jersey: Newark, Jersey City, Morristown, Parsippany, Middlesex-Sommerset
New York: New York City (and surrounding areas), Albany, Buffalo, Rochester, White Plains (Westchester County)
Ohio: Cleveland
Oregon: Portland
Pennsylvania: Philadelphia, Pittsburgh
Texas: Dallas, Houston
Virginia: Richmond
Washington: Seattle
Washington, D.C.: District of Columbia (and surrounding Virginia and Maryland suburbs)

MWR Telecom (formerly IOR Telecom -- acquired by McLeod USA)
Iowa: Council Bluffs, Des Moines, Carroll
Missouri: St. Louis

Penn Access (acquired by TCG)

Phoenix Fiberlink (California facilities acquired by Brooks Fiber Properties)

Utah: Salt Lake City
Nevada: Reno

PSO Metro Link (acquired by Brooks Fiber Properties)

TCI Telephony (no data)

Teleport Communications Group (TCG) (acquired portion of US Signal)
(selected metro areas shown)
(merged with AT&T in July 1998)
Arizona : Phoenix, Peoria, Tempe, Scottsdale
California : Los Angeles, San Diego, San Francisco, Oakland, San Jose
Colorado: Boulder, Denver
Connecticut : Hartford, New Haven, New London
Florida : Ft. Lauderdale, Miami, West Palm Beach, Pompano, Boca Raton
Illinois : Chicago, Gary, Skokie
Indiana: Indianapolis, Lawrence
Maryland : Baltimore
Massachusetts: Boston, Brockton, Attleboro, Lawrence
Michigan : Detroit, Pontiac, Plymouth, Dearborn
Missouri : St. Louis
Nebraska: Omaha
New Jersey: Princeton, Newark, Jersey City
New York : New York City metropolitan area
Ohio: Cleveland
Oregon : Beaverton, Portland, Tigearard
Pennsylvania: Pittsburgh
Rhode Island: Providence, West Warwick
Texas: Dallas, Houston, Fort Worth, Plano, Irving, Richardson
Utah: Salt Lake City, West Valley, Murray
Washington: Seattle, Bellevue, Tacoma, Everett, Redmond
Wisconsin: Milwaukee, Waukesha

Time Warner Communications
California: San Diego
Florida: Orlando, Tampa
Indiana: Indianapolis
Hawaii: Honolulu
New York: Albany, Binghamton, New York City, Rochester
North Carolina: Charlotte, Greensboro, Raleigh
Ohio: Cincinnati, Columbus
Tennessee: Memphis
Texas: Austin, Houston, San Antonio
Wisconsin: Milwaukee

US Signal (formerly City Signal)
(Facilities that were completed or under construction in the following states were acquired by Brooks Fiber, TCG and at least one other entity.)
Michigan: Grand Rapids, Lansing, Ann Arbor
Indiana: Indianapolis
Nevada: Las Vegas
Tennessee: Memphis, Nashville