FIBER DEPLOYMENT UPDATE
END OF YEAR 1996

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Introduction and Overview

This report, which presents data about fiber optic facilities and capacity built or used 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.

This report updates information presented in previous Fiber Deployment Reports, but does not include the list of references and certain technical and other background information contained in those earlier reports. We direct the reader to the Fiber Deployment Report released March 20, 1992, for this information. That earlier report -- as well as this updated report -- is 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, 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 *Statistics of Communication Common Carriers (SOCC)*, released June 30, 1997, which appears under the file name 96PSOCC.ZIP.

This Fiber Deployment Report surveys fiber deployment by three types of carriers: interexchange carriers (IXCs), local telephone companies, and certain competitive access providers (CAPs), i.e., entities that provide access service using their own fiber facilities. In some cases, these CAPs also provide competitive local service or are preparing to provide such service. Overall, IXCs experienced fiber route growth of about 10 percent in 1996, while local telephone companies experienced fiber mileage growth of about 15 percent (down from over 18 percent in 1995). CAPs also significantly expanded their fiber deployment in 1996. 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, exceeding 50 percent annually. 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 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, 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. These kinds of changes may well continue, for example, as capacity limits are broken and average repeater spacings are increased using inline optical amplification. Our tables show the total remaining "dark" (i.e., non-equipped) fiber and "lit" fiber capable of supporting telecommunications services.

Although we requested some 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 also asked for data about IXC deployment of backbone facilities and traffic in connection with Internet use, measured in terms of DS-3 or OC-1 equivalent miles, or terabytes (trillions of bytes) per year handled. Not all entities operate Internet backbone facilities using facilities that they own. Further, too few IXCs provided adequate data for such information to be included in the tables. Based on available information, we (very roughly) estimate 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 the past year.[2] We hope to gather more reliable Internet related data in the future from major backbone providers owning fiber facilities.[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 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 in order to gain some insight into 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 Tables 14 and 15. We note that we surveyed several CAPs for the first time for this report and that some of these entities, particularly those owned by cable TV companies, either chose not to provide data or were unable to separate telecommunication fiber from their total figures of deployed fiber. For further information we direct the reader to the notes to Tables 14 and 15, infra.

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[2] During 1996 there were a total of about 439 billion billed minutes of interstate traffic handled based on data for billed access minutes. Assuming standard digital encoding of voice calls at the 64,000 bits/sec rate, (8,000 bytes per second) this is the equivalent of 210,720 terabytes. Internet packet switches capable of handling aggregated traffic of 1 billion bits per second can handle as much as 2,000 to 4,000 terabytes of packetized traffic annually.

[3] The following Internet backbone providers were 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.

Source Methods and Data Limitations

The purpose of the Telecommunications Act of 1996[4] is to open all telecommunications markets (including both the local and long distance markets) to competition. Because the information in this report was gathered only from entities currently deploying their own fiber transmission facilities,[5] the data may have limited usefulness for projecting fiber deployment by emerging competitive local exchange carriers (CLECs).

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.

Most entities provided nearly all requested data. In a few instances certain data have been excluded from this report where we detected inconsistences or where too few of the reporting entities provided information on data items not previously requested. 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

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[4] See Pub. L. No. 104-104. 110 Stat. 56.

[5] The larger entities including MFS, Time Warner Communications, Brooks Fiber, and Teleport Communications have expressed an interest in offering switched services as competitive local exchange carriers. In addition several newly identified entities that are constructing fiber facilities, including GST Telecom and American Communication Services, Inc., also appear to be focusing on the provision of switched services. Several other entities constructing local fiber facilities have been identified and are either mentioned in Tables 14 and 15 or in the associated notes. Some of the entities either were unable to separate telecommunications facilities from their cable TV operations or chose not to provide data.

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 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.

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 carriers do not all 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 threat 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.

Interexchange Carriers

We present IXC data in Tables 1 through 4. By year-end 1996, IXCs had deployed fiber networks exceeding 106,000 route miles, even after accounting for certain downward historical adjustments for AT&T. Growth in IXC fiber route mileage -- following data adjustments described in the notes to the tables -- was nearly 10 percent in 1996. Total adjusted 1996 IXC fiber mileage is estimated at more than 2.9 million miles, as shown in Table 2. We note that a significant amount of long-haul interexchange fiber utilizes railroad rights-of-way or abandoned pipelines; in other cases, fiber 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 data rate. For example, assuming 28 DS-3's or 18,816 circuits per fiber pair, using the older existing 1.2 Gbit/second terminal and repeater technology, on the order of at least 30 to 40 million DS-3 equivalent miles are available using IXC fiber networks.

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, some IXCs are deploying Synchronous Optical Network (SONET) multiplexing systems at the OC-192 (10 Gbit/second) rate[6] that provide the

[6] 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

capacity equivalent of 192 DS-3's per fiber pair. Even newer systems able to handle aggregate transmission rates up to 40 Gbit/Second also have been developed. MCI, for example, apparently constructed such systems for trials and plans to deploy them for regular service as early as the end of 1997.[7] While most newer systems primarily increase capacity by employing wavelength division multiplexing (which multiplies existing data rates by using separate optical frequencies), other systems at higher data rates allow 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) are using SONET rings for redundancy; when failures occur, transmissions can be rerouted in the reverse direction around the ring.

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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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.

[7] See *Lightwave*, March 1997, p.1

Table 1: Route Miles -- Interexchange Carriers *

	Fiber System Route Miles											
Calendar Year:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AT&T	5,677	10,893	18,000	23,324	28,900	32,398	32,500	33,500	35,000	36,022	37,419	39,057
Consolidated	310	310	332	332	332	332	332	332	332	519	NA	621
Electric Lightwave	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	298	733
Frontier (RCI)	580	580	796	413	414	415	417	417	417	414	516	516
GST Telecom	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	106
IXC Communications	382	382	803	803	803	914	914	914	1,257	1,357	1,365	2,025
LCI	881	950	1,210	1,210	1,210	1,210	1,406	1,406	1,406	1,408	1,408	1,408
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
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
MRC	NA	NA	670	670	844	844	844	850	850	850	850	1,100
Qwest Commun.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,569
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
TCG	NA	NA	NA	84	84	84	84	84	84	84	84	84
Valley Net	NA	NA	NA	NA	520	570	581	581	581	NA	NA	NA
Total Reported:	20,039	40,668	58,723	71,503	79,836	85,916	87,596	89,016	93,821	96,214	97,112	106,807

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

Table 2: Fiber Miles -- Interexchange Carriers *

Thousands of Fiber Miles

Calendar Year:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
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
Consolidated	3.5	3.5	3.7	3.7	3.7	3.7	3.7	3.7	3.7	6.5	NA	15.6
Elec. Lightwave	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	14.9	37.7
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
GST Telecom	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.6
IXC Commun.	10.0	10.0	14.0	14.0	14.0	14.2	14.2	14.6	20.8	22.2	22.2	70.5
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
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
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
MRC	NA	NA	8.0	8.0	10.1	10.1	10.1	10.2	10.2	10.3	10.2	19.2
Qwest Comm.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	113.3
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
TCG	NA	NA	NA	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Valley Net	NA	NA	NA	NA	6.1	6.8	7.2	7.2	7.2	NA	NA	NA
Total Reported:	455.7	918.4	1,293.3	1,723.3	1,899.5	2,093.2	2,211.5	2,235.9	2,300.0	2,458.1	2,587.0	2,949.6

* 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 Miles					
Calendar Year:	1991	1992	1993	1994	1995	1996	1991	1992	1993	1994	1995	1996
AT&T	44.6%	49.5%	50.9%	52.6%	54.7%	53.1%	4,383,896	5,188,927	5,203,272	5,243,472	5,864,031	6,864,536
Consolidated	53.4%	53.4%	57.8%	53.7%	NA	NA	29,890	31,616	NA	29,702	NA	29,813
Electric Lightwave	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Frontier (RCI)	56.1%	57.0%	57.0%	57.1%	46.0%	46.0%	15,535	17,735	4,135	4,326	4,329	4,329
GST Telecom	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5,088
IXC Commun.	58.3%	65.9%	55.8%	NA	NA	NA	34,569	38,195	39,227	NA	NA	NA
LCI	60.1%	60.1%	60.1%	68.8%	71.1%	76.5%	42,081	47,058	69,285	94,485	131,955	163,356
Worldcom	90.0%	90.0%	NA	NA	69.0%	68.8%	NA	NA	NA	NA	NA	NA
MCI	NA	NA	NA	NA	NA	NA	NA	NA	NA	* NA	NA	NA
MRC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Qwest Commun.	NA	NA	NA	NA	NA	5.5%	NA	NA	NA	NA	NA	NA
Sprint	55.1%	55.1%	NA	55.8%	77.2%	80.0%	1,705,542	1,740,555	NA	NA	1,840,695	2,386,200
TCG	NA	80.0%	80.0%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Valley Net	40.0%	40.0%	NA	NA	NA	NA	11,600	NA	NA	NA	NA	NA

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

Table 4: Other 1996 Fiber Data -- Interexchange Carriers *

	Points of Presence	Avg. Fiber Cross Section	Fiber in Electric Utility Facilities Sheath Miles	Fiber Miles
AT&T	835	32.2	1,194	28,656
Consolidated	11	25.2	94	NA
Electric Lightwave	NA	51.5	NA	NA
Frontier (RCI)	5	6.4	2	39
GST Telecom	6	33.8	0	0
IXC Communications	NA	34.8	0	0
LCI	46	17.6	220	NA
Worldcom	110	23.0	NA	NA
MCI	NA	28.4	NA	NA
MRC	15	17.5	596	7,157
Qwest Communications	16	44.1	NA	NA
Sprint	NA	20.0	0	0
TCG	NA	20.0	NA	NA
Valley Net	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)

Investment data, as noted above, is not included in the tables but can usually be estimated by multiplying the route mileage by $65,000 based upon data presented in prior reports. Carriers using only above ground fiber facilities or ground-wire fiber built in conjunction with electric utilities should incur much lower investment, as little as half the above value. 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. Also, historical data for merged entities have been typically combined. Carriers were requested to report owned facilities to avoid double counting of fiber; however, in some cases leased fiber may have been included, particularly in connection with long term arrangements. The reader may wish to refer to prior fiber deployment reports for previously reported data.

AT&T's 11.6% increase in fiber mileage in 1990 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 point-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. Accordingly, this information is not included in the tables. AT&T revised its sheath mileage 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.

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

GST Telecom was not previously included in this report but now 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. The entity is now called Worldcom. MFS, a competitive access provider listed in Tables 14 and 15, has since merged with Worldcom.

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 therefore made the minimal adjustments possible to earlier historical data to minimize inconsistencies by using the company's revised route mileage data for 1991 and adjusting the 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 that includes 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 has revised its 1995 data and now reports a total of 21,049 route miles of owned facilities that includes 2,281 route miles of leased facilities. It has also revised its 1995 fiber mileage and reports a revised figure of 597,363 fiber miles that includes 127,241 miles of leased facilities. MCI did not provide any adjustments for data prior to 1995. MCI reported 16,350 route miles of digital microwave radio facilities 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. These data appear to be affected by inconsistencies as to whether DS-3's on MCI's microwave facilities are included, inconsistencies in the way spare facilities are accounted for, or inconsistencies in the reporting of capacity on leased facilities. (The reader may 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., now known as MRC Telecommunications, and listed in the tables as MRC.

Qwest Communications has recently begun to construct interexchange fiber facilities in a joint venture with Frontier Corporation and other partners and has been added to the tables. If completed as planned, the network would eventually serve up to 80% of the nation's population centers.

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. (The reader may refer to prior fiber deployment reports.) In a press release dated March 14, 1994 discussing its deployment of SONET equipment in its network, Sprint reported that the new equipment could more than double capacity on its existing system without adding new cable, as well as provide for improved network restoration capabilities. Sprint had 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 a competitive access provider that 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 fibers lit may be distorted by route redundancy and the method used to report these data. Considerations affecting when a fiber pair is lit or equipped may vary from company to company; whether fiber is lit or not does not indicate how many circuits are presently operating. In a number of instances, prior data for percent lit fiber have been recalculated.

DS-3 mileage reflects actual equivalent DS-3s in use on fiber facilities only.

Except for Valley Net, which is a long-haul network formed using facilities of several local telephone companies, Tables 1 and 2 reflect owned facilities. Fiber used in long-term arrangements with electric utilities may be reported as owned fiber by some of the carriers.

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. (See also text of report.)

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 usually 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 fiber and copper data for local telephone companies, including the Bell operating companies, companies affiliated with GTE, and the United telephone companies (now owned by Sprint). We also include a limited amount of information about fiber deployment by rural, independent telephone companies.[8]

Our survey focused on a number of aspects of fiber and copper 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.[9] The total sheath miles, fiber miles, and average cable size of fiber facilities for these categories 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. As a general matter, the data suggest that fiber deployment in the subscriber loop has been concentrated in feeder plant.

Table 9 presents investment data for both subscriber plant and total plant, which also includes information about the amount of "lit" (activated) fiber as well as the equipped capacities of fiber and copper facilities. Other information about the amount of subscriber fiber and copper 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, while the per strand costs -- including initial investment and maintenance costs -- will differ.

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

[9] 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.

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, overall, 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 enough copper pairs are available). Roughly 80% of copper loops do not use pair gain systems and, instead, employ a copper wire pair from the customer 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 tend 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.[10] 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, however, there can also be significant rewards.

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[10] 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.

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 for interoffice plant cable containing more than 40 fibers for the reasons just described. (See Table 7.)

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.[11] Several of the companies stated that they have had difficulty providing interoffice data separate 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. US West, for example, has 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

[11] 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.

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. Tables 10, 11, and 13 set out available subscriber data.

As new technologies are introduced, and existing technologies mature, the significance of the data presented in this report may change.[12] In the preparation of this report, therefore, we have considered the use of several new technologies by the local telephone companies. For example, this year we requested information about fiber-to-the-curb systems and HDSL (High-bit-rate Digital Subscriber Loop) and ADSL (Asymmetric Digital Subscriber Loop) technologies that expand the capability of existing copper pairs. Because HDSL and ADSL 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 construction of fiber facilities.[13] 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.[14]

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[12] 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.

[13] 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.

[14] See "ADSL: A New Twisted-Pair Access to the Information Highway," IEEE Communications Magazine, Vol. 33, No. 4, April 1995, pp. 52-60, (Philip Kyees, et al.) and "HDSL and ADSL: Giving New Life to Copper," Bellcore Exchange, March/April 1992, pp. 3-7, (Russell Hsing, et al.). 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., "Design Issues for Interactive Television Systems," Computer (IEEE Computer Society Magazine), Vol. 28, No.5, May 1995, pp. 31-32, (Borko Furht, *et al.*).

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 last year to provide general information about their ADSL and HDSL deployments. This year we specifically requested data about numbers of bandwidth enhancing terminals. Table 8 shows the results. While most surveyed companies apparently are using HDSL equipment to provide T1 service, ADSL technologies are typically deployed only in the trial stage.[15] (Bell Atlantic, NYNEX and Pacific Telesis note trials of ADSL.) SBC Communications (Southwestern) does not report the use of such technology, and had previously suggested that it has only limited plans for its use. 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 will become increasingly important. As usable copper pairs are exhausted, fiber will become an increasingly important element in the local loop.

We also note the continued growth of fiber ring deployment. 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. (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.) We have noticed distinguishing aspects of fiber rings as deployed by specific companies. Some of the BOC-deployed fiber redundancy arrangements differ from

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[15] Availability of off-the-shelf equipment may tend to accelerate applications of ADSL technology.

CAP-deployed fiber rings by using the existing plant structure to provide two separate access paths to the customer. US West, for example, has tariffed such redundant arrangements.

Fiber architectures that could reduce the 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.[16]

NYNEX reports the most significant deployment of fiber-to-the-curb technology, with as many as 100,000 subscribers. Bell Atlantic is also actively planning for fiber-to-the-curb deployment; it plans to provide switched digital video capabilities in New Jersey and other states.[17] US West and BellSouth also report significant early fiber-to-the-curb deployments, while SBC reports the use of fiber-to-the-curb arrangements in Texas only. Ameritech continues to report no use of this 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 may become more attractive.

Companies have used fiber technology trials to test various fiber-to-residence arrangements and architectures, including (as already noted) systems with limited switched video capability. Other types of fiber technology trials have also been conducted. In past years, for example, BellSouth reported trials of its interoffice synchronous optical network (SONET) 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 have reported trials involving subscriber systems. In particular, Pacific Telesis reported trials of

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[16] In the area of optoelectronic equipment further significant cost reductions are possible. Such cost reductions will facilitate the development of optical networks and may affect design considerations used in fiber-to-the-curb systems. See Lightwave, March 1997, p. 1.

[17] See *Lightwave,* Sept. 1996, p.1.

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. In past years, the cost per fiber of a significant number of the trial systems were in the upper end of that range. More recent trial investment data reflect costs that fall in the lower end of the above range. 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. Nevertheless, the local telephone companies are continuing to deploy new fiber to modernize their plant and at the same time bring fiber closer to the customer.

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

Company			Sheath Miles in Thousands									
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
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
Bell Atlantic	1.2	4.4	6.7	9.2	11.9	15.0	19.2	21.9	27.8	32.3	35.7	39.0
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
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
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
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
US 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
Bell Totals:	17.6	33.6	46.0	61.9	78.0	97.6	122.5	146.5	173.5	195.9	218.7	238.9
GTE Companies	NA	NA	NA	10.1	20.9	28.6	31.6	34.0	39.8	45.4	41.8	43.7
Sprint Companies	NA	NA	NA	2.9	5.0	5.9	7.4	9.9	12.0	14.2	16.5	18.8
Rural Companies	NA	0.5	2.6	4.7	6.4	8.7	NA	NA	NA	NA	51.3	59.3
Total Reported:	17.6	34.1	48.6	79.5	110.3	140.8	161.6	190.4	225.3	255.5	328.3	360.7

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

Table 6: Fiber Miles of Fiber Deployed by Local Operating Companies

	Fiber Miles in Thousands											
Company	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Ameritech	77.7	111.1	147.1	177.5	228.4	285.5	400.7	585.6	802.1	918.9	1,095.9	1,339.3
Bell Atlantic	83.1	150.8	227.5	311.0	373.4	523.0	809.7	1,026.6	1,568.7	1,919.4	2,169.2	2,403.5
BellSouth	50.8	170.1	218.5	319.2	445.5	609.2	768.6	938.7	1,121.0	1,380.9	1,685.0	2,012.0
NYNEX	83.4	129.7	207.1	290.6	357.8	473.3	637.0	806.7	964.4	1,112.0	1,264.7	1,422.5
Pacific Telesis	84.3	97.8	101.1	110.3	126.9	185.2	246.4	311.7	374.9	424.2	481.5	540.4
SBC	70.5	151.0	182.9	214.9	270.3	352.3	477.7	576.4	775.0	970.8	1,234.8	1,504.4
US West	47.3	70.1	107.8	164.0	234.9	351.6	542.3	797.6	1,042.5	1,238.8	1,483.3	1,615.3
Bell Totals:	497.1	880.7	1,192.0	1,587.6	2,037.1	2,780.0	3,882.4	5,043.3	6,648.6	7,965.0	9,414.4	10,837.3
GTE Companies	NA	NA	NA	134.7	163.4	317.5	390.5	513.7	672.4	795.2	930.4	1,064.9
Sprint	NA	NA	NA	32.3	54.6	83.5	115.6	139.7	187.0	257.4	353.0	440.9
Rural Companies	NA	2.0	14.2	28.7	42.3	68.2	NA	NA	NA	NA	NA	NA
Total Reported:	497.1	882.7	1,206.2	1,783.2	2,297.3	3,249.3	4,388.5	5,696.8	7,508.0	9,017.6	10,697.8	12,343.1

* 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
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
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
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
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
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
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
US 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
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
GTE Companies	NA	NA	NA	13.3	7.8	11.1	12.4	15.1	16.9	17.5	22.3	24.4
Sprint Companies	NA	NA	NA	11.1	10.9	14.2	15.5	14.2	15.6	18.1	21.4	23.5
Rural Companies	NA	4.0	5.5	6.2	6.6	7.9	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

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

Table 8:
Data on Fiber to the Pedestal of Local Operating Companies -- 1996 *

	Number of Pedestal** Locations	Fibers Serving Pedestals *	Fiber Miles Serving Pedestals	Customers Accessible to Pedestal Lo(	Bandwidth Enhancing Terminals	All Access Lines Loop Length (miles) Average	Median	Maximum
Ameritech	0	0	0	0	69,800	1.4	1.9	5.7
Bell Atlantic	805	1,700	NA	4,885	23,638	2.3	2.9	9.6
BellSouth	8,160	9,792	NA	44,140	26,721	3.4	2.5	26.9
NYNEX	6,200	NA	NA	103,700	5,482	2.4	1.8	10.2
Pacific Telesis	80	288	159	310	20,010	2.0	12.0	19.4
SBC	145	237	259	1,751	0	2.7	NA	24.6
US West	8,900	9,490	24,680	53,510	18,560	2.8	NA	NA
Total Reported:	24,290	21,507	25,098	208,296	164,211			

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

** The term "pedestal" includes curb locations.

Table 9: Other 1996 Fiber Data for Local Operating Companies

Company	Percent Lit	DS-3 Miles on Fiber	T1 Miles on Copper	Customer Terminated Fiber Lines	Aggregate Fiber Investment (Million $) Sub-scriber	Total
Ameritech	14.5%	596,200	194,300	0	NA	963.5
Bell Atlantic	40.8%	282,596	4,103,962	190,000	NA	1,264.0
BellSouth	27.3%	560,061	64,929	15,547	NA	1,674.9
NYNEX	37.7%	NA	NA	NA	676.6	1,269.3
Pacific Telesis	27.9%	190,833	854,931	0	NA	513.3
SBC	18.8%	501,195	528,593	NA	684.9	1,078.5
US West	35.1%	755,734	918,684	53,510	NA	1,074.6
GTE Companies	52.0%	NA	NA	NA	NA	1,072.7
Sprint Companies	41.6%	NA	NA	NA	NA	373.4
Total Reported		2,886,619	6,665,399	259,057	1,361.4	9,284.2

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

Table 10 -- Fiber Subscriber Plant of Bell Operating Companies

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

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

Table 11: Copper Subscriber Plant of Bell Operating Companies *

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

* 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 1996 *

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 Fiber Fiber Sheath
Ameritech	22,998	193,775	1,339	327,400	29,600	8,426	58.2	14.2	1.3	8.3%
Bell Atlantic	22,017	194,315	2,403	287,092	38,985	8,825	109.2	13.0	1.8	12.0%
BellSouth	24,493	247,482	2,012	586,008	55,981	10,104	82.1	23.9	2.3	8.7%
NYNEX	19,119	160,184	1,423	255,115	27,939	8,378	74.4	13.3	1.5	9.9%
Pacific Telesis	20,521	157,099	540	203,334	13,369	7,656	26.3	9.9	0.7	6.2%
SBC	17,602	174,119	1,504	383,947	34,419	9,892	85.5	21.8	2.0	8.2%
US West	19,386	174,769	1,615	408,714	38,653	9,015	83.3	21.1	2.0	8.6%
Total reported:	146,136	1,301,744	10,837	2,451,610	238,946	8,908	74.2	16.8	1.6	8.9%

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

** From ARMIS 43-08 data.

Table 13: Fiber and Copper in Subscriber Plant in Relation to Access Lines -- End of Year 1996 *

Company	Access Lines (000) Total**	% Without Pair Gain	Subscriber Plant Strand Miles (000) Copper	Subscriber Plant Strand Miles (000) Fiber	Cable Sheath Miles Copper	Cable Sheath Miles Fiber	Per Thousand Access Lines: Miles Copper Wire	Miles Fiber Strand	Miles Copper Sheath	Miles Fiber Sheath	% Fiber Sheath Miles
Ameritech	22,998	79%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bell Atlantic	22,017	80%	NA	NA	NA	NA	NA	NA	NA	NA	NA
BellSouth	24,493	67%	NA	749	NA	NA	NA	30.6	NA	NA	NA
NYNEX	19,119	93%	146,408	712	236,693	14,442	7,658	37.3	12.4	0.76	5.8%
Pacific Telesis	20,521	84%	139,404	216	190,290	5,332	6,793	10.5	9.3	0.26	2.7%
SBC	17,602	76%	NA	458	NA	NA	NA	NA	NA	NA	NA
US West	19,386	73%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total reported:	146,136	79%	285,812	1,677	426,983	19,774	7,210	26.1	10.8	0.5	4.4%

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

** From ARMIS 43-08 data.

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

In some instances, carriers estimate certain data, such as end-of-year data received prior to the end of the year. Accuracy also varies depending on the carrier's method of collecting and assembling its data. Historical data may reflect adjustments made this year. The reader may 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 subscriber data since 1992. Data prior to 1993 is based on engineering judgment. Ameritech adjusted its 1994 fiber investment data previously reported to $749.1 million. It also adjusted its 1994 data for total copper sheath miles to 324,500. Ameritech's HDSL terminals are shown in the tables. An additional 160,200 UDC terminals used for pair gain are 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. Fiber investment of BellSouth 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 or activated subscriber miles in 1995 and 204,142 lit miles in 1996. Data shown in the Tables 10 and 13 for total BellSouth subscriber fiber was estimated by the author dividing the lit mileage by the overall lit fiber percentages for 1995 and 1996. 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.

NYNEX and Bell Atlantic reported bandwidth enhancing terminals as the number of reported HDSL systems used for T1 service. For consistency the data for these companies in Table 8 is twice the number reported, since two terminals are typically used in each system.

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 for 1995 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 provided revised 1992-1995 data along with its 1996 submission. The revisions are reflected in the attached tables.

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 1996 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.

Investment in fiber backbone facilities -- 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.

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. Although there is evidence that CAPs are expanding their operations in order to compete more widely with local telephone companies, we focus in this report 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 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 services, although several have begun offering switched services as well. CAP systems also have grown in capacity and sophistication. Several years ago, for example, MFS 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 report 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.

As explained in the introductory sections of this report, merger and acquisition activity involving CAPs has made reliable data collection difficult. 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.[18] 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 attachments to Tables 14 and 15. We direct readers who wish to further study such changes to consult historical information that is contained in earlier Fiber Deployment Reports.

[18] 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 -- 1996

Company Name	Route Miles							Thousands of Fiber Miles							
	1990	1991	1992	1993	1994	1995	1996	1990	1991	1992	1993	1994	1995	1996
American (ACS)	NA	NA	NA	NA	NA	NA	697	NA	NA	NA	NA	NA	NA	48.8
Brooks Fiber	109	141	193	264	264	480	1,059	2.6	3.8	4.3	6.2	18.0	24.3	71.3
Eastern Telelogic	140	140	140	194	233	395	438	3.7	3.7	3.7	4.4	4.4	13.8	18.8
Electric Lightwave	NA	6	104	126	225	466	516	NA	0.5	6.8	11.7	20.5	NA	61.5
GST Telecom	NA	NA	NA	NA	NA	NA	305	NA	NA	NA	NA	NA	NA	21.5
Hyperion	NA	NA	NA	NA	NA	NA	2,887	NA	NA	NA	NA	NA	NA	138.6
IntelCom Group	NA	105	132	151	424	637	2,073	NA	4.8	6.5	8.6	19.0	28.8	69.6
Intermedia (ICI)	159	165	213	335	372	561	654	2.9	3.0	5.2	10.2	11.3	20.5	24.1
Kansas City Fiber Net	91	94	97	200	200	200	NA	2.5	2.6	2.9	0.0	3.7	3.8	NA
MCImetro	NA	NA	NA	NA	NA	2,338	2,948	NA	NA	NA	NA	NA	NA	NA
MFS	309	546	1,133	1,530	2,387	3,112	3,523	17.2	29.8	41.4	67.0	106.9	188.0	229.9
McLeod USA, Inc.	65	75	95	121	116	NA	2,352	1.6	1.8	3.7	5.0	3.0	NA	123.9
Phoenix FiberLink, Inc.	NA	NA	NA	NA	NA	32	76	NA	NA	NA	NA	NA	3.1	7.2
Teleport (TCG)	328	507	1,018	2,082	3,902	5,428	6,744	18.5	24.7	40.0	96.1	167.3	253.3	346.0
Time Warner	59	86	88	96	348	3,312	4,232	0.5	1.2	1.2	1.4	10.4	107.9	151.7
US Signal	67	115	144	367	554	NA	NA	5.6	6.3	7.3	20.2	31.6	NA	NA
Total Reported:	1,326	1,980	3,357	5,466	9,025	16,961	28,503	55.1	82.2	122.9	230.7	396.2	643.4	1,312.9

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

Table 15:

Competitive Access Fiber Systems -- Other Available Data -- 1996*

Company Name	Sheath Miles	Average Fibers per Route	Investment Millions $	Buildings Served	States Served
American Commun. Services, Inc.	697	70.0	NA	595	12
Brooks Fiber Properties	1,059	67.3	85.0	883	11
Eastern Telelogic	581	42.9	7.6	368	3
Electric Lightwave	777	119.1	141.5	405	6
GST Telecom	330	70.7	21.8	153	4
Hyperion Telecommunications, Inc.	NA	48.0	NA	1,101	8
IntelCom Group	2,385	33.6	NA	2,069	9
Intermedia Communications (ICI)	489	36.9	NA	486	5
Kansas City Fiber Net	NA	NA	NA	176	2
MCImetro	NA	NA	498.0	NA	19
MFS	3,994	65.2	NA	13,204	23
McLeod USA, Inc. (formerly MWR)	NA	52.7	NA	452	2
Phoenix FiberLink, Inc.	76	96.0	5.9	41	2
Teleport Communications Group	7,036	51.3	NA	2,965	22
Time Warner Communications	NA	35.9	NA	NA	9
US Signal	NA	NA	NA	NA	4

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

Notes to Tables 14 and 15: (NA indicates unavailable data)

Statistics shown are 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 most cases data for merged entities have been combined retroactively; however, 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 identified 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. Ownership of many of these entities is complex. In some cases, parent companies have partial and overlapping ownership interests in multiple entities.

American Communication Services, Inc., shown in the tables, was first identified in 1996.

Bay Area Teleport, which was acquired by IntelCom Group, had previously indicated that it operated 58.9 route miles and 78 sheath miles of leased facilities that are included in the IntelCom group 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 the tables. In 1995 Brooks Fiber acquired a portion of Fibernet USA facilities in Cincinnati, Ohio, Huntsville, Alabama, Raleigh-Durham, North Carolina, and St. Louis, Missouri, which are included in the Brooks total shown. 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 therefore incorporated in the Brooks Fiber total. Prior to 1995, total US Signal data are shown separately.

Cox Communications Services reports a total of 6,564 route miles of fiber cable facilities 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.

Eastern Telelogic 1993 fiber mileage data have been adjusted by the company.

Electric Lightwave previously had included 298 miles of inter-city fiber in its 1995 fiber data. An adjustment has been made to table 14 to reflect this. Table 14 data for 1996 only includes its local fiber facilities.

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, Inc., shown in the tables was first identified in 1996.

Intermedia Communications of Florida, Inc., is listed in the tables as Intermedia Communications. 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 include the effect of the acquisition of Fibernet USA facilities.

Jones Lightwave was acquired by MFS. Its data have been combined retroactively with that of MFS.

Kansas City Fiber Net, formerly part of American Cablevision, is partially owned by Time Warner. Because its ownership is split and its management status has changed, it is shown as a separate entity in the attached tables. Indiana Digital Access and MetroCom were also acquired by Time Warner in 1995. Time Warner also acquired Newhouse Broadcasting, a cable TV operation.

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

MFS has recently been acquired by LDDS-Worldcom, a long distance carrier. MFS Communications Company, Inc., referred to as MFS in the tables, 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.

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 is now included with the 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 company initially was funded in November 1993 with $41 million of equity capital. 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 had both operated facilities in Dallas and Chicago. TCI Telephony was identified in 1996 but declined to provide data for this year's survey.

During 1993, Teleport Communications Group (TCG) also 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.

During 1993, Teleport Denver initiated construction of new facilities in Colorado Springs and Phoenix, Arizona, and the name of the company was changed to IntelCom Group. In addition, IntelCom Group 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. IntelCom Group also acquired Bay Area Teleport facilities in California. All acquired facilities, including those of Ohio Lynx and Bay Area Teleport, have been retroactively included in the IntelCom total.

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 are not included in the Time-Warner total for 1996.

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 new entities were identified in 1996. These include Cablevision Lightpath, TCI Telephony, Cox Fiber Net, GST Telecom, Hyperion Inc., American Communication Services, Inc., and USN Communications. While data for a few of these are included in the tables, telecommunications data for the others were unavailable or could not be separated from cable TV facilities. Another entity, Harron Communications reported that it presently 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. Often economic and environmental considerations lead to deployment of cables containing more fibers than needed to meet current demand.

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 Served by CAPs

American Communication Services, Inc (ACSI)
Alabama: Birmingham, Mobile, Montgomery
Arizona: Tucson
Arkansas: Little Rock
Maryland: Central Maryland
Georgia: Columbus
Kentucky: Lexington, Louisville
Mississippi: Jackson
Nevada: Las Vegas
New Mexico: Albuquerque
South Carolina: Charleston, Greenville, Columbia, Spartanburg
Tennessee: Chattanooga
Texas: Amarillo, El Paso, Fort Worth, Irving
Facilities under contruction in Colorado, Florida, Georgia, Louisiana, Missouri, New Mexico, Oklahoma, Tennessee, Texas, and Virginia

Bay Area Teleport (acquired by IntelCom Group)

Brooks Fiber (Locations shown were operational in 1996 and reflect facilities acquired from Phoenix Fiberlink and PSO Metrolink, Fibernet USA, and US Signal. Additional facilities under construction in California, Ohio, Minnesota, Missouri, New York, and New Hampshire)
Arizona: Tucson
Arkansas: Little Rock
California: Sacramento, San Jose, Santa Clark, Sunnyvale, Stockton, Fresno, Bakersfield, Milpitas, Palo Alto
Connecticut: Hartford
Massachusetts: Springfield
Mississippi: Jackson
Michigan: Grand Rapids, Lansing, Traverse City
New Mexico: Albuquerque
Oklahoma: Oklahoma City, Tulsa
Rhode Island: Providence
Tennessee: Knoxville

Cablevision Lightpath (no data)

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

Digital Direct (facilities acquired by TCG)

Eastern Telelogic
Pennsylvania: Philadelphia
New Jersey: Camden
Delaware: Wilmington

Electric Lightwave
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
California: Fresno, Pleasanton, Los Angeles, Rialto, San Bernadino, Riverside, Loma Linda, Ontario, City of Industry, Monterrey Park
New Mexico: Albuquerque
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)

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

Intermedia Communications of Florida (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 -- (no new data: see MWR Telecom)

MCImetro
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.)
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)
(total number of reported areas served with selected metro areas shown)
Arizona (11): Phoenix, Peoria, Tempe, Scottsdale
California (49): Los Angeles, San Diego, San Francisco, Oakland, San Jose
Colorado (10): Boulder, Denver
Connecticut (49): Hartford, New Haven, New London
Florida (5): Ft. Lauderdale, Miami, West Palm Beach, Pompano, Boca Raton
Illinois (81): Chicago, Gary, Skokie
Indiana (4): Indianapolis, Lawrence
Maryland (3): Baltimore
Massachusetts (25): Boston, Brockton, Attleboro, Lawrence
Michigan (15): Detroit, Pontiac, Plymouth, Dearborn
Missouri (13): St. Louis
Nebraska (1): Omaha
New Jersey (21): Princeton, Newark, Jersey City
New York (28): New York City metropolitan area
Ohio(1) : Cleveland
Oregon (3): Beaverton, Portland, Tigearard
Pennsylvania (33): Pittsburgh

Rhode Island (2): Providence, West Warwick
Texas (9): Dallas, Houston, Fort Worth, Plano, Irving, Richardson
Utah (3): Salt Lake City, West Valley, Murray
Washington (23): Seattle, Bellevue, Tacoma, Everett, Redmond
Wisconsin (23): Milwaukee, Waukesha

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

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

Customer Response Survey
Publication: Fiber Deployment Update - End of Year 1996

You can help us provide the best possible information to the public by completing this form and returning it to the Industry Analysis Division of the FCC's Common Carrier Bureau.

1. Please check the category that best describes you:

____ press
____ current telecommunications carrier
____ potential telecommunications carrier
____ business customer evaluating vendors/service options
____ consultant, law firm, lobbyist
____ other business customer
____ academic/student
____ residential customer
____ FCC employee
____ other federal government employee
____ state or local government employee
____ Other (please specify)

2. Please rate the report:

	Excellent	Good	Satisfactory	Poor	No opinion
Data accuracy	(_)	(_)	(_)	(_)	(_)
Data presentation	(_)	(_)	(_)	(_)	(_)
Timeliness of data	(_)	(_)	(_)	(_)	(_)
Completeness of data	(_)	(_)	(_)	(_)	(_)
Text clarity	(_)	(_)	(_)	(_)	(_)
Completeness of text	(_)	(_)	(_)	(_)	(_)

3. Overall, how do you rate this report?

	Excellent	Good	Satisfactory	Poor	No opinion
	(_)	(_)	(_)	(_)	(_)

4. How can this report be improved?

5. May we contact you to discuss possible improvements?
Name:

Telephone #:

To discuss the information in this report, contact:
Jonathan Kraushaar at 202-418-0940

Fax this response to: (202) 418-0520

OR

Mail this response to:

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Washington, DC 20554