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September 9, 1999

FCC RELEASES FIBER DEPLOYMENT UPDATE

The FCC has released a report entitled Fiber Deployment Update - End of Year 1998. This report presents fiber deployment data and associated information for interexchange carriers, incumbent local telephone companies, and competitive providers of exchange access or local exchange service who have constructed their own fiber facilities.

Current estimates indicate that interexchange carrier fiber miles of fiber in place increased by more than 30% in 1998. For entities providing long haul fiber mileage data over 3.6 million fiber miles were constructed at year's end. Incumbent local telephone companies reported more than 16 million fiber miles in place at the end of 1998. Of that amount, the Bell companies reported about 13.8 million fiber miles -- an increase of about 13% during 1998. Competitive providers of local telephone services who are included in this year's study had in place about 3 million fiber miles by the end of 1998.

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

This report is available for reference in the FCC's Information Center at 445 12th Street, S.W., Courtyard Level. Copies may be purchased by calling International Transcription Services, Inc. at (202) 857-3800. The report can also be downloaded from the **FCC-State Link** internet site maintained by the Common Carrier Bureau (<http://www.fcc.gov/ccb/stats> --Infrastructure web page, file names: FIBER98.ZIP and FIBER98.PDF). For additional information, contact Jonathan Kraushaar of the Common Carrier Bureau's Industry Analysis Division (202) 418-0940, or for users of TTY equipment, call (202) 418-0484.

FIBER DEPLOYMENT UPDATE END OF YEAR 1998

By Jonathan M. Kraushaar

Industry Analysis Division
Common Carrier Bureau
Federal Communications Commission



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FIBER DEPLOYMENT UPDATE

End of Year 1998

To Our Readers

We have published this report, to generally favorable reviews, for more than a decade. In the interest of minimizing burdens on participating carriers, we have limited data collection to that submitted on a voluntary basis. This approach, however, has certain shortcomings. First, any voluntary survey necessarily omits those that choose not to participate. Second, the voluntary data varies in terms of accuracy and consistency. Third, as noted below, a great deal of fiber-related activity is now undertaken by non-carrier entities like electric utilities and cable television companies. The increasingly important activities of non-carriers are not adequately reflected in this report. As a result, we are evaluating whether to continue this report in its present form, discontinue it, or modify it substantially. We solicit your thoughts and suggestions. The report's author, Jonathan Kraushaar, can be reached by using e-mail (jkrausha@fcc.gov) or by using the Customer Response information contained at the end of this report. We would appreciate hearing from you no later than November 1, 1999.

Introduction and Overview

This report, which presents data about fiber optic facilities and capacity constructed for use by certain telecommunications carriers, has been issued annually since 1986. In the first part of the report, we provide an overview of the data and discuss the methods and procedures 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 parts of the report that follow the discussion present selected statistical data that may illustrate trends in fiber deployment by surveyed carriers.

Earlier reports -- as well as this update -- are available on the FCC-State Link website, which can be accessed via the World Wide Web at <http://www.fcc.gov/ccb/stats> (infrastructure section). The web site also contains other related infrastructure information,¹ such as the Automated Reporting and Management Information System (ARMIS) 43-07 reports for the mandatory price-cap local exchange carriers and other Commission publications, including the *Preliminary Statistics of Communications Common Carriers*.

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

Because not all the companies listed in the tables provided fiber mileage data for both 1997 and 1998, it was not possible to make a simple growth calculation for this year based on the sum of supplied data. We have therefore estimated a lower bound overall growth figure by using 1997 data in the fiber totals where 1998 data were not available. This would tend to underestimate growth, since those entities with no current data more than likely experienced growth in 1998 which is assumed to be zero by this methodology. Using this approach we estimate that IXCs and CLECs included in this report experienced fiber mileage growth of at least 30 percent in 1998. Long haul fiber growth is significantly higher than last year's reported growth. Fiber mileage of all incumbent local telephone companies included in this report increased about 15 percent.² The actual amounts of fiber deployed in competitive local systems is still significantly smaller than the amounts

¹ See *Comprehensive Monitoring Report on Universal Service (Report No. CC 99-27)*, Section 10, released July 12, 1999 and *Infrastructure of the Local Operating Companies*, released July 21, 1999, which appear on the FCC-State Link Internet site under the names mr99-10.zip and INFRA98.ZIP and the domestic information from *Preliminary Statistics of Communication Common Carriers*, released May 28, 1999, which appears under the file name 98PSOCC.ZIP.

² The Bell company growth figures were somewhat lower than the overall figure.

deployed by major local telephone companies to date. Nevertheless, the rate of overall fiber growth for CAPs is quite dynamic and has often approached or exceeded 50 percent annually in recent years.

Data for interexchange carriers are shown in Tables 1-4, data for incumbent local carriers are shown in Tables 5-13 and data for CAPs are shown in Tables 14-15. It should be noted that much of the data in the tables are shown in thousands. Because the least significant digits are not shown for these data, calculated sums may not necessarily appear as the exact sums of displayed entries. The reader should also note that in this year's report, blank entries are used to denote years in which data were not collected for a given entity. Typically data are shown when an entity began to construct its own fiber facilities. The use of "NA" in the tables typically indicates that the entity elected not to provide data.

New Service Providers

Finally, although this report focuses on fiber deployment by local telephone companies, IXCs and CAPS, we take passing note of fiber deployment by other entities. Recent technological advances that increase the capacity of fiber systems, or that facilitate provision of broadband services over existing facilities, have encouraged fiber deployment by entities as diverse as cable TV companies and electrical utilities. Regarding broadband, including broadband provided by cable TV companies, the Commission is only just beginning to survey its deployment pursuant to the mandate set out in Section 706 of the Telecommunications Act of 1996.³ Certain fiber activities by selected cable TV companies are discussed in the notes following the presentation of data about CAP-provided fiber. We do not, in any case, provide in this report anything at all approaching a complete picture of fiber-related activities by cable TV companies.

Based on the limited information available to us it appears that a number of electric utilities are constructing fiber facilities in order to market broadband (SONET) capacity to interexchange carriers or other customers. In this report we have, for the most part, only noted electric utility fiber capacity from the perspective of the IXCs that lease or obtain fiber through long-term use arrangements with these entities. (See Table 4 of this report.) Neon, a new long-haul provider that was identified in last year's report, apparently is partially owned

³ 47 U.S.C. § 706nt. *See* Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996 Act).

by two electrical utilities (Central Maine Power Co. and Northeast Utilities) and appears in the charts with other IXCs. The United Telecommunications Council (UTC), based in Washington, D.C., publishes resource material about electric utility-provided fiber deployment. Readers who wish further information about such deployment should consult their reports.⁴

Data Collection Techniques

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

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

For example, carriers have upgraded capacity on existing fiber systems by employing equipment that offers, on the same fiber, multiple optical channels using different wavelengths or optical frequencies (also called "rails"), each operating at

⁴ See Report on Utility and Pipeline Fiber Optic Applications and Developments, United Telecommunications Council (1997).

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

Although we requested several basic data items from all surveyed carriers, we requested certain other data items that are specific to the category of carriers surveyed. Thus, we requested data from IXC's about their total number of points of presence -- or points of interconnection -- with 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 these data. AT&T provided point-of-presence data only for its switched services.

As noted previously, we also requested information from IXC's about sharing of electric utility fiber. These data are summarized in Table 4. To avoid double counting of such facilities, we have not generally requested similar information from electric utility companies but include at the end of this report a listing of such entities that have been granted exempt status to operate markets in telecommunications facilities and services under the terms of the 1996 Act. Given the limited responses by interexchange carriers to our survey on this question, this information should be assumed to reflect only a portion of these shared fiber systems.

From local telephone companies we sought specific information about the application of certain technologies associated with 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 and total T1 customer terminations in order to gain some insight into the overall customer demand for T1 data rates and the utilization of fiber facilities at the local level, where carriers have less opportunity to take advantage of economies of scale.

From CAPs we sought information about the number of buildings served since this continues to be a useful index in evaluating the extent of CAP-deployed fiber. Most CAPs provided this information and it is reported in Table 15. We also contacted several cable TV companies that are converting their plant for two-way operation using a customer return channel. We note that some of the entities either chose not to provide data or were unable to provide data in time for this publication.⁵ For further information, we direct the reader to the notes to Tables 14 and 15, *infra*.

Source Methods and Data Limitations

The purpose of the 1996 Act is to open all telecommunications markets (including both the local and long distance markets) to competition. While the information in this report was gathered only from entities currently deploying their own fiber transmission facilities, the current and historical data may have usefulness in forecasting future fiber deployment by newer CLECs.⁶

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

⁵ These entities, including Comcast, Cox, and TCI were informally contacted and provided information about their total route mileage, fiber route mileage and fiber mileage along with the amount of plant that is equipped for two-way operation either in terms of mileage or homes passed and the number of schools and libraries served by fiber or broadband capability. One entity, Media One, chose not to provide data while its merger with AT&T is pending.

⁶ Carriers commonly referred to as competitive local exchange carriers (or CLECs) that do not own fiber facilities are not included in this report. Such excluded CLECs primarily use incumbent local telephone company unbundled network elements or resold services, as provided for in section 251 of the 1996 Act, to deliver switched local service to consumers. To the extent that use of unbundled network elements or resold services is a CLEC entry strategy to build a customer base of sufficient size to justify investment in transmission facilities, such CLECs may choose to deploy their own fiber facilities in the future. In some instances, newer entities have chosen not to provide data. Many of these entities, however, do not own fiber.

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 or all 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.

Many entities provided nearly all requested data. In some instances certain data have been excluded from this report where we detected apparent inconsistencies or where too few of the reporting entities provided the requested information. We have attempted to correct certain previously identified reporting problems and to improve the survey by modifying and augmenting some of the surveyed items, while deleting others. For example, we requested both route mileage and cable sheath mileage data from IXC's and CAP's in order to help ensure that carriers with multiple cables in a route properly distinguish these data items. Also, as noted previously, we have attempted to confine our data requests to owned fiber in order to minimize the possibility of double counting; and in the notes to the tables, we identify known exceptions to this.⁷ 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 IXC's 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. Growth-rate distortions caused by potential double counting of these kinds of facilities has in the past been limited by exclusion of electric utility data from the tables. We caution, however, that the number of new entities constructing fiber and the increasing use of right-to-use contracts between some of the entities included in the tables may be blurring the distinction between leased and owned fiber and may lead to some double counting

⁷ For example, we note that the tables include expanded facilities of Frontier that were at least partially associated with right-to-use (IRU) agreements.

of fiber capacity. We expect that as more joint ventures and right-to-use contracts proliferate the industry it will be increasingly difficult to assure that no double counting of fiber has occurred.⁸

This report primarily focuses on nonmovable and nonfungible backbone cable transmission plant elements of the plant infrastructure that are owned by each reporting carrier. The inherent ability that fiber had from the outset to support data rates that could not yet be achieved in practice, and the steady improvement in terminal and repeater technologies over the years, have increasingly made the variable costs of large fiber networks more a function of the number of terminal elements than a function of distance.⁹ Furthermore, terminal elements are movable and their cost is primarily a function of the number of links on which they are used rather than the length of the link over which they provide service. In addition, significant capacity increases made possible by state-of-the-art terminal facilities - -whose cost should decline over time -- will tend to make the incremental costs of adding network capacity even lower. Nonetheless, there may be significant differences among carriers in the structure of their underlying network, their embedded investment for a given-size network and the robustness of their networks in responding to changes in demand. There are also both embedded capacity and investment differences that are a function of the mix and capability of the various types of terminal and repeater equipment currently installed.

Another problem in evaluating the data is the widespread use by carriers of redundant paths or routes. Redundancy, in general, makes it more difficult to interpret data on activated or lit fiber, since all carriers do not deploy redundant facilities in the same manner or to the same extent. As mergers and overbuilds occur, there is also increased likelihood of ambiguity in connection with data on route mileage. To some extent, we guarded against this problem by requesting that carriers provide sheath mileage data in addition to route mileage data. Fiber cross-section data, calculated by dividing the fiber mileage by the sheath mileage or route mileage, provides a check for data errors or misinterpretations, since erratic fluctuation of fiber cross section would not generally occur. Nevertheless, the

⁸ Although we have requested data on owned fiber, not all entities track fiber built or obtained in connection with long-term right-to-use contracts the same way. We have included available information on this issue in the notes to the tables.

⁹ The cost of the underlying fiber network is mileage sensitive. Once constructed, the cost of adding terminals is less a function of mileage than the number of network links. It should of course be noted that the number of terminal elements required in providing service is partially a function of the structure of the underlying fiber network.

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 these 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.

We express one more general caveat about methodology and data quality: 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 and not all carriers track their owned fiber the same way, the reader should exercise care when interpreting growth-rate data.

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

Interexchange Carriers

We present IXC data in Tables 1 through 4. By year-end 1998, IXCs had deployed fiber networks exceeding 150,000 route miles, and we estimate their fiber mileage increased by more than 30% over previous levels.¹⁰ At the same time, the increasing use of leveraged builds and right-to-use agreements by entities such as Williams and Qwest is making it more difficult to assure that double counting has not occurred. Total 1998 IXC fiber mileage from entities providing data is

¹⁰ A few entities, including WorldCom, provided us with route mileage data but were unable to provide fiber mileage data this year. We calculated an expected minimum overall fiber mileage growth by conservatively assuming that data for these entities were unchanged from last year.

estimated at more than 3.6 million miles, as shown in Table 2. We expect that total long-haul fiber is considerably larger if we take into consideration electric utility entities marketing SONET capacity (not included in the tables) and entities that did not provide data. We note that a significant amount of long-haul interexchange fiber utilizes railroad rights-of-way, abandoned pipelines, or is simply buried. While some of the IXC's operate a significant number of microwave routes, these data are not reflected in the tables.

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

As noted above, newer technologies using wavelength division multiplexing boost capacity significantly. Moreover, in some cases this technology can be overlaid on existing systems without requiring total replacement of terminal equipment. For example, IXC's have deployed synchronous optical network (SONET) multiplexing systems at the OC-192 (10 Gbit/second) rate¹¹ that provide the capacity equivalent of 192 DS-3's per fiber pair. Even newer systems able to handle aggregate transmission at 40 Gbit/second and higher also have been developed. MCI, for example, reported the construction of such systems for trials and new deployments.¹² While most newer systems increase capacity by employing wavelength division multiplexing and so-called "dense" wavelength division multiplexing (which multiplies existing data throughput by using separate optical frequencies), it is also possible to provide two-way transmission (full duplex) over the same fiber. Of course, a portion of the capacity available using these new

¹¹ SONET systems provide advanced protocols for multiplexing or interleaving of data channels or streams and are becoming an increasingly attractive means for subdividing fiber capacity into manageable chunks. SONET system rates are prefixed by the letters "OC". The DS-3 used widely in backbone transmission systems is roughly equivalent in capacity to the OC-1 SONET physical interface rate of 51.84 Mbit/sec. An OC-3 SONET system is therefore capable of handling the equivalent of approximately 3 DS-3's. Each DS-3 in turn can support up to 672 voice-grade equivalent circuits encoded at the 64 kb/second rate.

¹² See *Lightwave*, Mar. 1997, at 1.

systems is typically allocated to facility redundancy and failure restoration. Many IXC's (as well as local telephone companies) have been using SONET rings for redundancy; when failures occur, transmissions can be rerouted in the reverse direction around the ring.

Overall increased fiber system capacity made possible by greater use of optical amplification and wavelength division multiplexing have reduced the need of existing carriers to construct new fiber. As a result, the cost of long-haul transmission is becoming less a function of distance than of the number of terminations, since a greater portion of the cost of adding capacity is being directed toward fixed terminal capabilities that are required on each link, regardless of length. This, along with a desire to use existing fiber transmission facilities more effectively for varying bandwidth requirements, appears to be encouraging new networking strategies like so-called distributed switching. In distributed switching, switching functionality and components are spread over a network rather than being concentrated in specific locations. Changes in the relative costs of distance-sensitive and non-distance-sensitive network components, and new advances in router technology (used for internet and packet services), appear to be major factors promoting such developments.¹³

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 fiber investment data by carrier. In recent years, not enough entities have provided such data so as to allow inclusion in the tables. The reader may refer to the notes to the tables in order to estimate investment based upon past reports.

¹³ For example, Sprint plans to evolve towards an integrated network using asynchronous transfer mode (ATM) links in a configuration of distributed switching that would facilitate the simultaneous transmission of services requiring different data rates, such as voice, internet, packetized data, and broadband services over the same backbone network. In such a configuration, the entire network begins to look very much like the components of a single switch. What is now termed "internet voice" would become a seamless component of this kind of network.

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

Year:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AT&T	5,677	10,893	18,000	23,324	28,900	32,398	32,500	33,500	35,000	36,022	37,419	38,704	38,704	39,576
Caprock														800
Elec. Lightwv.											298	733	1,054	1,665
Frontier (RCI)	580	580	796	413	414	415	417	417	417	414	516		3,341	12,261
GST Telecom												106	769	5,666
IXC	382	382	803	803	803	914	914	914	1,257	1,357	1,365	2,025	4,647	6,028
MCI	3,025	6,752	10,267	12,467	13,839	16,000	16,700	17,040	19,793	21,460	21,049	23,096	25,234	25,882
McLeod USA	310	310	332	332	332	332	332	332	332	519	NA	621	621	4,252
Metromedia														300
NEON INC														505
Norlight			670	670	844	844	844	850	850	850	850	935	935	935
Qwest	881	950	1,210	1,210	1,210	1,210	1,406	1,406	1,406	1,408	1,408	3,977	7,101	12,496
Sprint	5,300	11,915	17,476	21,938	22,002	22,093	22,725	22,799	22,996	22,996	22,996	23,432	23,574	23,574
Williams														4,192
WorldCom	3,884	8,886	9,169	10,262	10,888	11,056	11,093	11,093	11,104	11,104	11,127	12,060	19,619	21,647
Tot. Reported:	20,039	40,668	58,723	71,419	79,232	85,262	86,931	88,351	93,156	96,130	97,028	106,205	125,599	159,779

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

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

Calendar Year:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AT&T	136	261	432	705	838	936	1,011	1,019	1,056	1,142	1,179	1,259	1,282	1,296
Caprock														77
Elec. Lightwv.											15	31	31	53
Frontier (RCI)	7	7	7	3	3	3	3	3	3	3	3	3	71	285
GST Telecom												4	37	390
IXC	10	10	14	14	14	14	14	15	21	22	22	70	125	NA
MCI	84	179	259	279	304	388	414	430	450	525	597	655	663	NA
McLeod USA	4	4	4	4	4	4	4	4	4	7	NA	16	16	NA
Metromedia														80
NEON INC														33
Norlight			8	8	10	10	10	10	10	10	10	18	18	18
Qwest	14	17	22	22	22	22	25	25	25	25	25	138	234	567
Sprint	122	249	343	449	451	453	467	467	467	467	467	469	471	471
Williams														410
WorldCom	79	191	203	238	245	255	256	256	256	256	266	277	471	NA
Total Reported:	456	918	1,293	1,722	1,892	2,085	2,203	2,227	2,291	2,456	2,585	2,940	3,419	3,681

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

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

Calendar Year:	Percent Fiber Miles Lit							Estimated DS-3 Mileage in Thousands of Miles							
	1991	1992	1993	1995	1996	1997	1998	1991	1992	1993	1994	1995	1996	1997	1998
AT&T	45%	50%	51%	55%	53%	52%	50%	4,384	5,189	5,203	5,243	5,864	6,865	10,354	11,453
Caprock															NA
Elec. Lightwv.				NA	NA	NA	NA					NA	NA	NA	NA
Frontier (RCI)	56%	57%	57%	46%	46%	18%	8%	16	18	4	4	4	4	26	631
GST Telecom							2%						5	NA	NA
IXC	58%	66%	56%	NA	NA	NA	NA	35	38	39	NA	NA	NA	NA	NA
MCI	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
McLeod USA	53%	53%	58%	NA	NA	NA	NA	NA	NA	NA	30	30	30	NA	NA
Metromedia															NA
NEON INC							5%								19
Norlight (was MRC)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Qwest					6%	7%	2%								NA
Sprint	55%	55%	NA	77%	80%	85%	85%	1,706	1,741	NA	NA	1,841	2,386	3,930	5,556
Williams							1%								457
WorldCom	90%	90%	NA	69%	69%	67%	NA	NA	NA	NA	NA	NA	NA	NA	NA

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

Table 4: Other 1998 or Latest Available Data -- Interexchange Carriers *

	Above Ground		Avg. Fiber Cross Section	Fiber in Electric Utility Facilities	
	Points of Presence	Sheath Miles		Sheath Miles	Fiber Miles
AT&T	1,074	1,376	32.7	1,194	28,656
Caprock	NA	NA	96.0	NA	NA
Elec. Lightwv.	NA	NA	31.9	NA	NA
Frontier (RCI)	59	0	23.3	2	NA
GST Telecom	689	63	68.9	NA	NA
IXC Communications	110	1,001	NA	NA	NA
MCI	NA	NA	NA	NA	NA
McLeod USA	NA	NA	NA	94	NA
Metromedia	NA	NA	266.7	NA	NA
NEON INC	5	NA	65.7	NA	NA
Norlight (was MRC)	20	599	19.3	599	7,157
Qwest	65	NA	45.4	NA	NA
Sprint	NA	140	20.0	0	0
Williams	52	0	97.7	432	NA
WorldCom	245	NA	NA	NA	NA

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

Notes to Tables 1-4: Blank entries are used to denote years in which data were not collected for a given entity. Typically data are shown when an entity began to construct its own fiber facilities. The use of "NA" in the tables typically indicates that the entity elected not to provide data.

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

AT&T 1990 data included the effect of a downward adjustment of its 1990 fiber mileage and a proportional adjustment to its 1989 fiber mileage to correct for what had been characterized as rounding errors on components making up the total. Data shown in the tables include domestic fiber only. AT&T's points-of-presence data item is based only on its switched services. AT&T's 1996 fiber mileage and route mileage data have been adjusted to more closely correspond to survey definitions provided and to account for procedural errors in which testbed and other unspecified fiber had been previously included in the total. In accordance with these changes, AT&T has provided adjustments to its historical data starting with 1991 that are reflected in the attached tables. AT&T is one of the few interexchange carriers whose reported sheath mileage has generally been greater than its route mileage. AT&T reported its sheath mileage as 39,576 miles in 1998 and 39,316 miles in 1997. It had previously revised its sheath mileage data to 39,689 miles in 1996, 38,042 miles in 1995, and 36,511 miles in 1994. AT&T's revisions may also affect the amount of lit fiber as presented in Table 3.

Caprock Communications Corp. is constructing regional facilities in Texas, Louisiana, Arkansas, Oklahoma, New Mexico and Arizona. An 800-mile portion of its planned build was completed by the end of 1998 and its facilities as of that time are included in the tables. Construction in 1999 include joint venture facilities with Enron, an electric power company.

Consolidated Communication, formerly included in this report, has merged with McLeod USA.

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

Frontier Corporation began to construct fiber facilities in a SONET network during 1997 which are now reflected in the aggregate data shown in the tables. These facilities expand Frontier's original non-SONET network of 516 route miles and 3,216 fiber miles as reported for 1997 and 1998. Frontier reportedly has an interest or agreements for long-term use of fiber in Qwest and Williams systems associated with this SONET network.

GTE did not provide data on its interexchange facilities.

GST Telecom has an installed base of both interexchange and local facilities west of the Rocky Mountains and in Hawaii. It has included fiber obtained through long-term right-to-use agreements in the data it provided.

IXC Communications, Inc. was previously known as Communications Transmission Group, Inc. IXC reports 96,575 OC-48 miles in a SONET network which could support up to 4.6 million equivalent DS-3 miles.

LCI International was formerly Litel. LCI was acquired by Qwest during 1998. Data for the two entities have been merged retroactively in the tables.

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

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

Because MCI's historical data prior to 1995 could not be reconstructed, MCI's 1995 and 1996 data reported in Tables 1 and 2 include leased facilities to maintain consistency with earlier data. It appears that leased facilities had been included in submitted data since 1993. As of the end of 1996, MCI reported a total of 23,096 route miles of fiber facilities including 3,501 miles of leased facilities. Correspondingly, its reported figure of 655,410 fiber miles includes 135,494 fiber miles of leased fiber facilities. It also reported an additional 16,300 route miles of owned digital radio facilities. MCI had also revised its 1995 data and reported that it includes 2,281 route miles and 127,241 fiber miles of leased facilities. MCI did not provide any adjustments for data prior to 1995. MCI reported 13,690 route miles of digital radio at the end of 1997. Previously it had reported 16,350 route miles as of the end of 1995 and 13,815 route miles as of the end of 1994. The company had also reported development of a program to construct an improved system for fiber restoration including the use of multistate fiber rings.

Prior to 1991, MCI based its DS-3 mileage on its circuit mileage data and an assumption of 672 circuits per DS-3. MCI's DS-3 mileage was reported as 2.8 million miles in 1991. This was consistent with previously provided total DS-3 mileage including DS-3's on digital microwave

radio facilities. The company reported 2.9 million miles of DS-3 facilities on fiber for 1992. In 1993, the company reported 5.29 million DS-3 miles including spare and restoration facilities.

MCI estimated 6.8 million DS-3 miles for 1994. It appears that these data were not reported in a consistent manner. There are possible inconsistencies relating to the inclusion of DS-3's on MCI's microwave facilities, the way spare facilities are accounted for, and the reporting of capacity on leased facilities. (The reader should refer to prior fiber deployment reports for further details.)

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. Subsequent data has not been provided. 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.

McLeod USA reported that its total reported fiber route mileage shown in Table 1 includes 138 route miles associated with facilities obtained through right-to-use agreements.

Metromedia Fiber Network data added to the tables include fiber provided to other entities in connection with right-to-use agreements.

NEON, Inc. has been added to the tables. It was originally set up as a joint venture of Central Maine Power Co. and Northeast Utilities, which have maintained a partial ownership stake in the company.

Norlight was acquired in December 1991 by Midwestern Relay Co., was known as MRC Telecommunications, and previously listed in the tables as MRC. It is now called Norlight Telecommunications. The tables reflect adjustments to 1996 and 1997 data.

Qwest Communications has begun to construct interexchange fiber facilities in a joint venture with Frontier Corporation and other partners and is shown in the tables. If completed as planned, the network would eventually serve up to 80% of the nation's population centers. Qwest indicates that its reported fiber mileage does not include fiber used by other joint venture entities. Its status, however may increase the likelihood of some double counting of fiber mileage. Qwest's route mileages can be expected to overlap with other joint venture entities. In mid-1998 Qwest acquired LCI. LCI data have been merged retroactively that of Qwest.

Sprint's facility base reflects facilities obtained through the merger of US Telecom and GTE toll facilities in 1986. In a press release dated March 14, 1994 discussing its deployment of SONET equipment in its network, Sprint reported that the new equipment would more than double capacity on its existing system without adding new cable, as well as provide for improved network restoration capabilities. Sprint had also reported (in a press release) that, as of March 1994, the company had 338 points of presence throughout the country. These data have not been provided since that time. Sprint has a significant Internet backbone capability.

The original facility base of Williams Telecommunications Group (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). Most of these original fiber facilities were acquired by LDDS in 1995. The entity was subsequently called LDDS-WorldCom but is now known as WorldCom. The WorldCom entry in the tables reflect these acquired facilities. A small amount of fiber, typically 1 or 2 strands in Wiltel's original 11,000 route mile network, was not acquired by WorldCom, and this fiber was then used to support the operations of VYVX, a video service provider that is part of the Williams Telecommunications Group.

Williams has more recently embarked on a construction program to build an entirely new base of fiber. Its reported base of owned fiber is shown in the tables and includes all owned fiber including fiber associated with 20-year indefeasible right-to-use (IRU) agreements. In press releases Williams has reported right-to-use agreements and dark fiber swaps with FTV Communications GST Telecommunications, Pacific Fiber Link, Hyperion Communications, Frontier Communications and others. The extent and variety of these agreements is making it increasingly difficult to assure that no double counting of fiber presented in the tables has occurred. Through these leveraging agreements, Williams expects to have constructed a 32,000 mile fiber-optic system by the end of 2001, which would represent a substantial portion of the current total base long-haul fiber route miles.

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

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

Tables 1 and 2 are typically intended to represent owned facilities; however, specific information relating to ownership that was provided by some of the carriers is included in the notes. Fiber used in long-term arrangements with electric utilities may be reported as owned fiber by some of the carriers and may not be so noted. New long-haul entities identified recently include Level 3, Five Com, Metromedia Fiber Network and Worldwide Fiber. Five Com, now known as Northeast Optical Network (NEON, Inc.) is primarily a regional long-haul entity; it operates facilities in the northeast and owns long-haul facilities with 505 route miles and 33,176 fiber miles as shown in the tables. Level 3 had earlier been expected to have approximately 230 route miles and about 33,000 fiber miles of its planned network completed by the end of 1998, but indicates that it was not completed in the projected time frame -- its construction only began at the end of 1997. Level 3 had indicated that it eventually expects to construct as much as 16,000 long-haul route miles. Worldwide Fiber, a recently identified entity, operates North American facilities in both the United States and Canada, but was unable to separate its owned United States facilities. Pathnet, another new entity, is constructing facilities between Chicago and Denver in a joint venture with Pacific Fiber Link, which is owned by Worldwide Fiber. These facilities were not completed as of the end of 1998.

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

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

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

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

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

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

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

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

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

Local Telephone Companies

Tables 5 through 13 present data for local telephone companies including the Bell operating companies, companies affiliated with GTE, and Sprint. We also include a limited amount of information about fiber deployment by rural, independent telephone companies.¹⁴ Fiber growth rates for these entities have been maintained at fairly consistent levels over the past few years with fiber mileage typically growing at annual rates roughly between 12 and 15 percent and sheath mileage growing at rates between 7 and 10 percent.

Our survey focused on a number of aspects of the infrastructure owned by local telephone companies including a comparison of the relative amount of owned fiber versus copper. The surveyed infrastructure generally falls into several categories: (1) interoffice, (2) interexchange access, (3) feeder, and (4) distribution.¹⁵ The total sheath miles, fiber miles, and average cable size of fiber facilities for local operating companies appear in Tables 5-7, respectively. By and large, the companies did not distinguish feeder from distribution plant, except that specific data on loop length and on deployments of feeder fiber in arrangements called "fiber-to-the-pedestal" or "fiber-to-the-curb" are shown in Table 8, along with data on bandwidth enhancing terminals. In this report we use the term "subscriber" fiber or plant to refer to the combination of feeder and distribution plant associated with subscriber loops. As a general matter, the data suggest that fiber deployment in the subscriber loop has been concentrated in feeder plant.

¹⁴ A number of independent operating companies which together comprise about 5% of the total fiber have not been included in the accompanying tables. Fiber data for rural carriers in 1995, 1996, and 1997 reported by the Rural Utilities Service (RUS) are included in Table 5. *See Rural Utility Service, 1997 Statistical Report -- Rural Telecommunications Borrowers*, Informational Publication 300-4. Data for prior years were not available from this source.

¹⁵ 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.

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

Tables 12 and 13 provide useful comparisons of fiber and copper deployment, both for total plant and for subscriber plant. These tables indicate that, typically, fiber cable constitutes less than 10% of total cable deployed to date. Table 13 also highlights the use of pair-gain systems (used as part of subscriber or loop plant to increase the number of loops where not enough copper pairs are available). Based on data submitted on loops not supported by pair-gain equipment, we estimate that more than two-thirds of copper loops do not use pair-gain systems and, instead, employ copper wire pairs from customers to the central office.

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

The expense associated with installation of loop plant perhaps helps to explain why competition has developed where it has and why CAPs have grown rapidly. CAPs have tended to target large customers whose total circuit requirements allow for test marketing of new goods and services, prior to more general introduction to customers with more modest requirements.¹⁶ Further, the

¹⁶ 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

expense of loop plant installation also helps to explain interest in lower-cost technology alternatives, such as wireless access, enhancements to copper facilities, and use of hybrid technologies employing more efficient architectures. Despite the risks associated with construction of cable-based loop plant, there can also be significant rewards.

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

We note that aggregate fiber mileage data may not necessarily denote actual 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

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.

interoffice data, but with less than complete success.¹⁷ Several of the companies stated that they have had difficulty providing interoffice data separately from subscriber fiber and copper data. Typically, they claim that many facilities are jointly used for interoffice and subscriber applications and that, in some cases, there are no readily available data sources for these separate categories. Further, regulatory bodies historically established exchange and toll classifications of local plant. U S WEST has, therefore, used exchange and toll categories as a substitute for the interoffice and subscriber categories where such data have been provided. This would tend to result in an overestimate of the amount of subscriber fiber and copper. Ameritech, on the other hand, originally used engineering estimates to separate interoffice and subscriber fiber and copper, but no longer provides subscriber fiber information at all. Other companies either do not provide certain subscriber data or do not indicate where they have used estimates. Tables 10, 11, and 13 set out currently available subscriber loop data.

As new technologies are introduced and existing technologies mature, the significance of the data presented in this report may change.¹⁸ For example, again this year we requested information about fiber-to-the-curb systems and technologies that expand the capability of existing copper pairs, such as HDSL (high-bit-rate digital subscriber loop) and ADSL (asymmetric digital subscriber loop). Because HDSL and ADSL (often termed xDSL technologies) enhance the capabilities of existing copper outside plant by using movable equipment rather than deploying new fixed plant, they may be used in conjunction with hybrid fiber/copper architectures and elsewhere to provide interim applications at lower risk. This allows customer demand to develop before the company commits to more extensive construction of fiber facilities.¹⁹ It appears that the flexibility and ease of deploying

¹⁷ 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.

¹⁸ 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.

¹⁹ 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

such technologies may have contributed to research and development in this area, as well as implementation of technical standards.²⁰

Moreover, although copper facilities generally support lower data rates than fiber facilities, surprising advances in copper technology 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.

Once again, we asked companies to provide general information about their ADSL/HDSL deployments, as well as data about numbers of bandwidth enhancing terminals. Table 8 shows the results. While most surveyed companies apparently have been using HDSL equipment for some time to provide T1 service, ADSL technologies were initially deployed as trials.²¹ Because ADSL and HDSL technologies and ISDN services all require use of selected copper pairs in the loop

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.

²⁰ See Philip Kyees, *et al.*, *ADSL: A New Twisted-Pair Access to the Information Highway*, IEEE Communications Magazine, Vol. 33, No. 4, Apr. 1995, at 52-60; Russell Hsing, *et al.*, *HDSL and ADSL: Giving New Life to Copper*, Bellcore Exchange, March/April 1992, at 3-7. Present and future Integrated Services Digital Network (ISDN) type offerings using HDSL or ADSL technology coupled with video compression technologies can provide video as well as an expanding list of computer applications, some of which have been used in local area networks of businesses. See, e.g., Borko Furht, *et al.*, *Design Issues for Interactive Television Systems*, Computer (IEEE Computer Society Magazine), Vol. 28, No.5, May 1995, at 31-32.

²¹ Availability of off-the-shelf equipment may tend to accelerate applications of ADSL technology. Other variations of this technology are also becoming available. Bell Atlantic and Pacific Telesis reported the first trials of ADSL.

plant, effective management of pairs suitable for use with these systems coupled with new fiber loop deployment may become increasingly important. As usable copper pairs are exhausted, fiber predictably will become an increasingly important element in the local loop.²²

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

Fiber architectures that promote the efficient provision of 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.²³

²² Presently it does not appear that there is much investment directed toward fiber facilities associated with access to smaller customers. In the absence of other alternatives, investment in fiber facilities to customers and to pedestal or curb locations will become increasingly important, since ADSL-type technologies for enhancing copper facilities, or even ISDN for that matter, cannot be used in many situations where loop quality is not acceptable or where pair-gain equipment is currently installed on copper pairs. Greater area specific public availability of data on relevant characteristics of existing copper loops maintained by the incumbent local exchange carriers could help to stimulate investment where it is needed most.

²³ In the area of optoelectronic equipment, further cost reductions are expected. Such cost reductions will facilitate the development of optical networks and may affect design considerations used in fiber-to-the-curb systems. Fiber to the home applications, for example, will become more attractive as the cost of optoelectronic equipment continues to decline. *See Lightwave*, Mar. 1997, at 1.

Following its merger with NYNEX, Bell Atlantic reports the most significant deployment of fiber-to-the-curb technology. (Bell Atlantic also has begun to develop facilities to provide switched digital video capabilities in New Jersey and other states.²⁴) U S WEST and BellSouth also report significant early fiber-to-the-curb deployments, while SBC initially reported the use of fiber-to-the-curb arrangements in Texas. Ameritech continues to report no use of this configuration. As demand for copper pairs suitable to support ISDN and ADSL/HDSL technologies increases -- and the number of available high-quality copper access pairs declines -- fiber-to-the-curb and fiber-to-the-pedestal systems should become more attractive.

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

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

²⁴ See *Lightwave*, Sept. 1996, at 1.

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

Company	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Ameritech	3.2	5.2	6.7	8.7	10.8	12.1	15.2	18.3	21.5	23.8	26.4	29.6	32.6	35.3
Bell Atlantic **	1.2	4.4	6.7	9.2	11.9	15.0	18.4	23.7	28.2	32.3	35.7	39.0	73.9	81.4
BellSouth	3.8	8.7	11.7	15.6	19.8	24.2	29.7	35.2	40.5	45.6	51.0	56.0	60.2	65.5
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	14.6	15.7
SBC	1.9	4.4	6.0	7.3	9.1	11.7	15.0	17.7	22.1	25.4	29.5	34.4	36.9	41.1
U S WEST	3.5	5.0	6.9	10.0	13.4	17.6	22.2	27.4	31.3	34.7	38.5	38.7	39.6	40.4
Bell Totals:	17.6	33.6	46.0	61.9	78.0	97.6	121.7	148.4	173.9	195.9	218.7	238.9	257.8	279.4
GTE	NA	NA	NA	10.1	20.9	28.6	31.6	34.0	39.8	45.4	41.8	43.7	49.2	54.0
Sprint	NA	NA	NA	2.9	5.0	5.9	7.4	9.9	12.0	14.2	16.5	18.8	18.7	21.7
Rural	NA	0.5	2.6	4.7	6.4	8.7	NA	NA	NA	NA	51.3	59.3	66.6	NA
Total Reported:	17.6	34.1	48.6	79.5	110.3	140.8	160.8	192.3	225.6	255.5	328.3	360.7	392.4	355.0

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

** Starting in 1997, Bell Atlantic data include NYNEX.

Table 6: Fiber Miles Deployed by Local Operating Companies *
Fiber Miles in Thousands

Company	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Ameritech	78	111	147	178	228	286	401	586	802	919	1,096	1,339	1,556	1,774
Bell Atlantic **	83	151	228	311	373	523	810	1,193	1,569	1,919	2,169	2,403	4,374	5,019
BellSouth	51	170	218	319	445	609	769	939	1,121	1,381	1,685	2,012	2,293	2,630
NYNEX **	83	130	207	291	358	473	637	807	964	1,112	1,265	1,423		
Pacific Telesis	84	98	101	110	127	185	246	312	375	424	482	540	605	661
SBC	70	151	183	215	270	352	478	576	775	971	1,235	1,504	1,724	2,004
U S WEST	47	70	108	164	235	352	542	798	1,043	1,239	1,483	1,615	1,668	1,710
Bell Totals:	497	881	1,192	1,588	2,037	2,780	3,882	5,210	6,649	7,965	9,414	10,837	12,219	13,799
GTE	NA	NA	NA	135	163	317	391	514	672	795	930	1,065	1,262	1,418
Sprint	NA	NA	NA	32	55	84	116	140	187	257	353	441	536	860
Rural	NA	2	14	29	42	68	NA	NA	NA	NA	NA	NA	NA	NA
Total Reported:	497	883	1,206	1,783	2,297	3,249	4,389	5,863	7,508	9,018	10,698	12,343	14,017	16,077

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

** Starting in 1997, Bell Atlantic data include NYNEX.

Table 7: Average Fiber Cable Cross Section *

Company	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Ameritech	24.3	21.4	22.0	20.4	21.1	23.6	26.4	32.0	37.3	38.6	41.5	45.2	47.7	50.3
Bell Atlantic **	67.0	34.5	33.8	33.7	31.3	35.0	42.2	47.0	56.4	59.4	60.8	61.7	59.2	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	38.1	40.2
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	41.5	42.0
SBC	36.8	34.5	30.6	29.2	29.7	30.1	31.7	32.5	35.1	38.2	41.8	43.7	46.7	48.8
U S WEST	13.4	14.0	15.5	16.3	17.5	20.0	24.5	29.1	33.3	35.7	38.5	41.8	42.2	42.3
Bell Companies	28.2	26.2	25.9	25.7	26.1	28.5	31.7	34.4	38.3	40.7	43.0	45.4	47.4	49.4
GTE	NA	NA	NA	13.3	7.8	11.1	12.4	15.1	16.9	17.5	22.3	24.4	25.6	26.3
Sprint	NA	NA	NA	11.1	10.9	14.2	15.5	14.2	15.6	18.1	21.4	23.5	28.7	39.6
Rural	NA	4.0	5.5	6.2	6.6	7.9	NA	NA	NA	NA	NA	NA	NA	NA
Total Reported	28.2	25.9	24.8	22.4	20.8	23.1	27.2	29.9	33.3	35.3	32.6	34.2	35.7	45.3

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

** Starting in 1997, Bell Atlantic data include NYNEX.

Table 8: Data on Fiber to the Pedestal of Local Operating Companies -- 1998 *

	Number of Pedestal** Locations	Fibers Serving Pedestals *	Fiber Miles Serving Pedestals	Customers Accessible to Pedestal Locations	Bandwidth Enhancing Terminals	All Access Lines Loop Length (miles)		
						Average	Median	Maximum
Ameritech	0	0	0	0	189,600	1.4	1.9	5.7
Bell Atlantic	10,582	21,165	63,495	211,649	94,413	3.0	1.9	25.9
BellSouth	34,161	40,993	NA	220,857	137,747	3.4	2.5	26.9
Pacific Telesis	80	288	159	937	42,062	2.3	2.0	19.4
SBC	1,248	2,496	1,256	19,304	0	NA	2.7	24.6
U S WEST	8,919	9,509	29,128	53,583	51,373	2.7	NA	NA
Total Reported:	54,990	74,451	94,038	506,330	515,195			

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

** The term "pedestal" includes curb locations.

Table 9: Other 1998 Fiber Data for Local Operating Companies *

Company	Percent Lit	DS-3 Miles on Fiber	T1 Miles on Copper	Customer Terminated T1 Lines	Aggregate Fiber Investment (\$ Million)	
					Subscriber Plant	Total Plant
Ameritech	15.6%	1,127,100	141,300	79,800	NA	1,169.2
Bell Atlantic	52.8%	313,953	4,241,399	90,060	NA	3,021.6
BellSouth	28.2%	690,154	28,137	323,936	NA	1,962.4
Pacific Telesis	31.2%	319,268	511,300	207,724	NA	632.0
SBC	18.7%	749,191	431,990	NA	927.1	1,354.3
U S WEST	34.0%	1,792,933	725,029	170,592	NA	1,173.0
GTE	50.6%	199,024	600,683	109,901	NA	1,259.0
Sprint	NA	NA	NA	NA	NA	567.2
Total Reported		5,191,622	6,679,837	982,013	927.1	11,138.6

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

Table 10 -- Fiber Subscriber Plant of Local Operating Companies *

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Company	Sheath Miles										
Ameritech	2,800	2,600	3,300	3,700	4,300	NA	NA	NA	NA	NA	NA
Bell Atlantic **	NA	4,872	6,543	NA	NA	NA	NA	NA	NA	NA	NA
BellSouth	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NYNEX **	1,935	2,656	3,995	5,388	7,095	8,976	10,398	12,799	14,442		
Pacific Telesis	537	722	1,451	2,210	2,874	3,426	3,938	4,636	5,332	5,920	6,608
SBC	NA	2,500	2,800	4,498	5,409	8,008	9,866	16,479	NA	NA	NA
U S WEST	2,816	3,484	4,714	6,595	8,706	10,879	13,047	16,340	NA	NA	NA
GTE	NA	NA	NA	NA	NA	NA	NA	NA	20,420	22,998	25,216
Company	Thousands of Fiber Miles										
Ameritech	56.6	69.2	84.6	153.0	234.4	NA	NA	NA	NA	NA	NA
Bell Atlantic **	116.9	152.3	226.0	NA	NA	NA	NA	NA	NA	NA	NA
BellSouth	185.8	267.3	355.2	440.4	NA	NA	NA	648.7	748.7	802.2	871.2
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	239.9	264.5
SBC	NA	95.4	135.6	185.3	221.8	365.4	514.6	878.2	NA	NA	NA
U S WEST	84.8	112.4	113.8	295.2	452.6	618.2	761.9	968.6	NA	NA	NA
GTE	NA	NA	NA	NA	NA	NA	NA	NA	563.8	668.8	751.7

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

** Starting in 1997, Bell Atlantic data include NYNEX.

Table 11: Copper Subscriber Plant of Local Operating Companies *

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Company	Thousands of Sheath Miles										
Ameritech	242.7	245.2	244.4	242.7	243.5	NA	NA	NA	NA	NA	NA
Bell Atlantic **	280.3	290.8	291.3	288.9	NA	NA	NA	NA	NA	NA	NA
BellSouth	560.0	564.2	566.1	570.4	NA	NA	NA	NA	NA	NA	NA
NYNEX **	225.5	229.5	232.7	232.9	233.2	233.9	234.5	235.5	236.7		
Pacific Telesis	170.3	167.5	184.1	185.2	192.7	207.9	187.9	189.0	190.3	191.7	193.6
SBC	NA	338.1	343.3	345.1	347.4	350.1	354.4	357.4	NA	NA	NA
U S WEST	384.3	389.4	395.8	401.7	407.9	413.2	403.0	408.4	NA	NA	NA
GTE	NA	NA	NA	NA	NA	NA	NA	NA	721.0	727.5	736.6
Company	Millions of Wire Miles										
Ameritech	139.6	140.4	141.9	142.4	143.2	NA	NA	NA	NA	NA	NA
Bell Atlantic **	187.4	191.7	194.4	194.4	NA	NA	NA	NA	NA	NA	NA
BellSouth	238.8	241.2	243.5	243.6	NA	NA	NA	NA	NA	NA	NA
NYNEX **	130.9	134.2	137.9	140.0	141.6	143.2	144.3	145.2	146.4		
Pacific Telesis	128.8	127.5	134.3	136.3	140.6	158.1	156.4	141.4	139.4	140.6	145.8
SBC	NA	156.9	159.3	160.1	160.9	162.3	169.5	170.3	NA	NA	NA
U S WEST	154.2	156.2	158.7	161.1	163.6	165.7	169.5	170.2	NA	NA	NA
GTE	NA	NA	NA	NA	NA	NA	NA	NA	164.8	168.7	174.3

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

** Starting in 1997, Bell Atlantic data include NYNEX.

Table 12: Fiber and Copper in Total Plant in Relation to Access Lines -- End-of-Year 1998 *

Company	Access Lines (thousands)**	Total Plant				Per Thousand Access Lines				
		Strand Miles (thousands)		Sheath Miles		Miles Copper Wire	Miles Fiber Strand	Miles Copper Sheath	Miles Fiber Sheath	Percent Fiber Sheath
		Copper	Fiber	Copper	Fiber					
Ameritech	25,449	199,759	1,774	336,300	35,300	7,849	69.7	13.2	1.4	9.5%
Bell Atlantic	48,978	361,538	5,019	545,332	81,374	7,382	102.5	11.1	1.7	13.0%
BellSouth	28,406	262,352	2,630	599,689	65,452	9,236	92.6	21.1	2.3	9.8%
Pacific Telesis	23,843	159,669	661	205,948	15,737	6,697	27.7	8.6	0.7	7.1%
SBC	20,343	180,856	2,004	394,330	41,058	8,890	98.5	19.4	2.0	9.4%
U S WEST	23,356	178,594	1,710	403,556	40,444	7,647	73.2	17.3	1.7	9.1%
GTE	21,252	174,324	1,418	747,076	53,995	8,203	66.7	35.2	2.5	6.7%
Total reported:	191,626	1,517,092	15,217	3,232,231	333,360	7,917	79.4	16.9	1.7	9.3%

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

** Total switched and special access lines from ARMIS 43-08 data.

Table 13: Fiber and Copper in Subscriber Plant in Relation to Access Lines -- End-of-Year 1998 *

Company	Subscriber Plant						Per Thousand Access Lines				
	Access Lines (000)		Strand Miles (000)		Cable Sheath Miles		Miles Copper Wire	Miles Fiber Strand	Miles Copper Sheath	Miles Fiber Sheath	% Fiber Sheath Miles
	Total**	% Without Pair Gain	Copper	Fiber	Copper	Fiber					
Ameritech	25,449	69%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bell Atlantic	48,978	72%	NA	NA	NA	NA	NA	NA	NA	NA	NA
BellSouth	28,406	58%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pacific Telesis	23,843	75%	145,753	264	193,583	6,608	6,113	11.1	8.1	0.28	3.3%
SBC	20,343	68%	NA	NA	NA	NA	NA	NA	NA	NA	NA
U S WEST	23,356	58%	NA	NA	NA	NA	NA	NA	NA	NA	NA
GTE	21,252	74%	172,232	752	736,617	25,216	8,104	35.4	34.7	1.19	3.3%
Total reported:	191,626	68%									

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

** : Total switched and special access lines from ARMIS 43-08 data.

Notes to Tables 5-13: Blank entries are used to denote years in which data were not collected for a given entity. Typically data are shown when an entity began to construct its own fiber facilities. The use of "NA" in the tables typically indicates that the entity elected not to provide data.

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

Ameritech has not provided data on subscriber plant since 1992. Data prior to 1993 are based on engineering judgment. Ameritech's HDSL terminals are shown in the tables. An additional 208,000 UDC terminals in 1997 and 200,500 in 1998 used for pair gain were reported by the company.

BellSouth subscriber fiber mileage for 1989, 1990, and 1991, as shown in Table 10, was estimated as 60% of the total fiber mileage based upon data provided by the company for 1987 and 1988. Other companies currently separating subscriber and interoffice fiber on average show close to half of the total fiber sheath mileage as subscriber and more than 90% of the copper wire as subscriber. As fiber penetration in the local loop increases, this ratio should increase as well. BellSouth fiber investment does not include electronics at terminal or repeater sites. BellSouth data for 1990 fiber mileage reflect an earlier correction. BellSouth subscriber loop fiber mileage was reported as 182,627 lit subscriber miles in 1995, 204,142 in 1996, 225,416 in 1997 and 246,013 in 1998. Total (lit plus dark) subscriber fiber mileage data shown in the Table 10 for BellSouth were estimated by dividing lit subscriber mileage by overall lit fiber percentages. BellSouth bandwidth enhancing terminals shown in Table 8 consist of HDSL installed central office circuit packs. According to the company, not all circuit packs are necessarily in current use.

Bell Atlantic data include data for NYNEX except for T1 miles on copper and DS-3 miles on fiber, which only reflect the pre-merger Bell Atlantic entity. Bell Atlantic had indicated last year that its average loop length was 2.4 miles, its median length was 2.3 miles, and its maximum length was 9.9 miles. This year it reported an average loop length of 3.0 miles, a median length of 1.9 miles and a maximum length of 25.9 miles. Bell Atlantic indicated that this year's loop length data are drawn from a more reliable data source.

Data in the tables reflect the fact that prior to 1989 Southwestern Bell (now SBC Communications) used interexchange and toll rather than interoffice and loop subcategories. Southwestern Bell's nonfinancial data for 1989 to the present properly reflect loop and interoffice subcategories which were originally requested. However, investment data under the subscriber heading actually represent exchange facilities, which also includes some interoffice plant.

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

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

Total access line counts (switched and special access combined) shown in Tables 12 and 13 were taken from the annual ARMIS 43-08 submissions of the carriers covering the 1998 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 are shared to a pedestal or curb location.

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

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

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

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

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

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

Competitive Access Providers

CAP fiber data appear in Tables 14 and 15. Although there is evidence that access providers are expanding their operations in order to compete more widely with local telephone companies, we primarily focus on fiber deployment in metropolitan areas by CAPs that own fiber and have typically provided access services to large business customers, for example, IXCs and financial institutions. The amount of CAP-owned fiber is still growing rapidly. Our survey excludes entities that were in the process of constructing fiber plant that was not operational fiber at year's end. We have also excluded companies whose operations exclusively employ microwave technology. In addition we note that, while most newer CAP entities still appear to be leasing facilities, some of the entities that are in the process of merging or constructing new facilities have chosen not to provide data for competitive reasons. This list of entities shown in Tables 14 and 15 should thus be viewed as a partial list generally limited to the more established CAP entities. Due to variations in the amount and interpretation of data available from different CAPs, this report highlights selected areas of service, typically larger or more widely known locations.

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.

CAPs traditionally have been viewed as carriers who compete with incumbent local exchange carriers. However, they are also significant customers of the incumbent local exchange carriers. Initially, CAPs tended to offer non-switched service, although many are now offering switched services. CAP systems also have grown in capacity and sophistication.²⁵ Several years ago, for

²⁵ In recent years, collocation of facilities with local telephone companies has greatly increased the number of available customers without construction of new facilities. In some cases, the building counts may reflect access to buildings not directly served.

example, MFS (now part of MCI WorldCom) reported that it had installed its first 100-megabit-per-second network, deploying equipment based on SONET standards. Moreover, in an effort to better serve customers who demand switched services, a number of CAPs are establishing collocation interfaces with local telephone companies. Such arrangements may indirectly lead to construction of new operating company facilities by requiring the availability of local company facilities from customer locations that cannot directly access a competitive access system. In some cases, CAPs appear to have motivated local telephone companies to price special access closer to cost and to serve larger customers by constructing their own redundant facilities and fiber rings. In this latter regard, we note that the Bell operating companies had previously reported construction of fiber rings or fiber redundancy arrangements in many of the very same cities where CAP systems currently compete with them for large business customers.

As explained in the introductory sections of this report, merger and acquisition activity involving CAPs has complicated reliable data collection. We requested that CAPs supply data only about owned fiber in order to help prevent double counting of facilities. Nevertheless, some double counting doubtless has occurred.²⁶ Merger and acquisition -- as well as partnership -- activity also reflects other changes in the nature of the CAP business, for example the increased provision of switched services. Some of these changes are described in the notes to Tables 14 and 15. We direct readers interested in these changes to consult historical information contained in earlier Fiber Deployment reports.

²⁶ 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 -- 1990 to 1998 *

Company Name	1990	1991	1992	1993	1994	1995	1996	1997	1998
	Route Miles								
Brooks Fiber	109	141	193	264	264	480	1,059	2,494	2,494
Electric Lightwave		6	104	126	225	466	516	952	1,426
e.spire (ACSI)							697	1,061	1,781
GST Telecom							305	415	849
Hyperion							2,887	4,761	5,666
ICG		105	132	151	424	637	2,073	2,872	4,208
Intermedia (ICI)	159	165	213	335	372	561	605	605	1,016
Kansas City Fib. Net	91	94	97	200	200	200			
MCImetro						2,338	2,948	2,948	NA
McLeod USA	65	75	95	121	116	NA	2,352	NA	6,436
Metromedia									380
MFS (WorldCom)	309	546	1,133	1,530	2,387	3,112	3,523	3,858	4,203
MHLightnet									148
NEXTLINK									2,477
RCN									1,700
Teleport (TCG)	468	647	1,158	2,276	4,135	5,823	7,182	9,474	11,417
Time Warner Telecom	59	86	88	96	348	3,312	4,232	5,911	6,968
Total Reported:	1,259	1,865	3,213	5,099	8,471	16,929	28,379	35,351	51,169
	Thousands of Fiber Miles								
Brooks Fiber	2.6	3.8	4.3	6.2	18.0	24.3	71.3	215.2	232.0
Electric Lightwave		0.5	6.8	11.7	20.5	NA	61.5	108.4	128.3
e.spire (ACSI)							48.8	92.5	157.2
GST Telecom							21.5	38.4	64.3
Hyperion							138.6	220.0	272.0
ICG		4.8	6.5	8.6	19.0	28.8	69.6	108.1	132.3
Intermedia (ICI)	2.9	3.0	5.2	10.2	11.3	20.5	24.1	35.0	40.4
Kansas City Fib. Net	2.5	2.6	2.9	NA	3.7	3.8			
MCImetro	NA	NA	NA	NA	NA	NA	NA	NA	NA
McLeod USA	1.6	1.8	3.7	5.0	3.0	NA	123.9	NA	382.9
Metromedia									160.0
MFS (WorldCom)	17.2	29.8	41.4	67.0	106.9	188.0	229.9	283.7	359.6
MHLightnet									4.7
NEXTLINK									195.5
RCN									86.6
Teleport (TCG)	22.2	28.4	43.7	100.5	171.7	267.1	364.8	491.1	549.7
Time Warner Telecom	0.5	1.2	1.2	1.4	10.4	107.9	151.7	233.5	272.4
Total Reported	50	76	116	211	365	640	1,306	1,826	3,038

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

Table 15: Competitive Access Fiber Systems -- Other Latest Available Data -- 1998 *

Company Name	Sheath Miles	Average Fibers per Route	Investment Millions \$	Buildings Served	States Served
Brooks Fiber	2,494	93.0	NA	NA	20
Electric Lightwave	1,426	90.0	NA	2,686	7
e.spire (formerly ACSI)	1,781	88.3	NA	3,231	22
GST Telecom	917	75.7	170.6	689	8
Hyperion	NA	48.0	300.0	6,721	12
ICG	NA	31.4	NA	5,397	7
Intermedia (ICI)	1,016	39.7	NA	4,342	12
Kansas City Fiber Net	NA	NA	NA	276	2
MCImetro	NA	NA	NA	NA	33
McLeod USA (formerly MWR)	NA	59.5	193.9	1,028	2
Metromedia	NA	NA	NA	NA	NA
MFS (WorldCom)	4,376	85.6	NA	20,435	23
MHLightnet	148	32.0	NA	8	1
NEXTLINK	NA	NA	NA	NA	NA
RCN	NA	50.9	NA	NA	7
Teleport (TCG)	NA	48.1	NA	20,005	22
Time Warner Telecom	NA	39.1	NA	NA	10

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

Notes to Tables 14 and 15: Blank entries are used to denote years in which data were not collected for a given entity. Typically data are shown when an entity began to construct its own fiber facilities. The use of "NA" in the tables typically indicates that the entity elected not to provide data. Statistics for backbone system and associated data were requested for owned facilities. Due to numerous mergers and acquisitions, it has been difficult to adjust prior data properly. In many cases, data for merged entities have been combined retroactively and the merged entities are no longer included in the tables. In other cases, particularly where acquisitions are operated as a separate subsidiary or division, the original entity name has been retained in the tables. In these cases, the reader should refer to the notes below for the name of the acquiring entity. Some discrepancies from earlier totals have resulted from partial acquisitions and from common facilities of merged entities. Entities identified but not providing data for this year's report are mentioned in these notes.

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

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

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

Comcast reported 23,500 route miles and 756,000 fiber miles of fiber facilities in its cable TV plant as of the end of 1998. Approximately 60% of its facilities are equipped for two-way operation. These two-way facilities pass a total of 4.35 million homes out of 7.25 million homes passed. The company reports that it has "wired" about 600 schools and 50 libraries. Comcast operates a subsidiary called MH Lightnet which is included in the tables.

Cox Communications Services reported a total of 8,764 route miles of fiber cable facilities in 1998, 7,711 route miles in 1997 and 6,564 route miles in 1996, but was unable to separate facilities that are not used for cable TV services in this year's survey. It did, however, report that it operates a total of 58,460 miles of plant, of which 25,191 miles or 43.1% are equipped for two-way operation.

Digital Direct facilities in Chicago, Dallas, Seattle, and Pittsburgh had been acquired by Teleport Communications Group which has since merged with AT&T.

Eastern Telelogic has been acquired by Teleport Communications Group (TCG) and its historical data have been merged with the TCG totals.

Electric Lightwave previously had included 298 miles of intercity fiber in its 1995 fiber data. An adjustment had been made to Table 14 to reflect this. Table 14 data for 1996, 1997 and 1998 only include its local fiber facilities. Electric Lightwave is a subsidiary of Citizens Utilities Company.

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

Hyperion Telecommunications, Inc. was first identified in 1996.

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

Intermedia Communications, Inc., is listed in the tables as Intermedia (ICI). Intermedia reported the acquisition completed in early 1995 of Fibernet USA facilities in Cincinnati, Ohio, and additional Fibernet USA facilities that were constructed in Huntsville, Alabama; Raleigh-Durham, North Carolina; and St. Louis, Missouri. The tables reflect the acquisition of Fibernet USA facilities. Jones Lightwave was acquired by MFS and is no longer shown in the tables. Its data have been combined retroactively with that of MFS.

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

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

MFS was acquired by WorldCom, a long distance carrier, on December 31, 1996. The associated WorldCom facilities are still referred to as MFS in the tables. MFS had previously acquired New

England Digital Distribution and the Atlanta facilities of Metrex during 1992. Totals for MFS include those acquired facilities, as well as facilities of I. C. C., which it acquired in 1991. Historical MFS data were increased to include the fiber associated with these facilities. The company adjusted its totals for 1992 and 1991 to account for these acquisitions as well as to reflect the results of a facilities audit which revealed an overcount in fiber miles and an undercount in route miles. In addition, early reports did not include fiber associated with building access which the company has included starting with the 1992 data. Fibernet facilities are also included in the 1994 MFS data and the MFS data were adjusted retroactively. MFS acquired Virginia Metrotel in January 1995. Of the 20,435 total buildings accessed in 1997 2,813 are directly accessed by fiber, 177 represent telco collocation buildings, and 17,445 buildings are indirectly accessed through local telephone company facilities. Comparable 1998 data were not provided.

MHLightnet with 148 route miles and 4,700 fiber miles is owned by Comcast, a cable TV company.

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

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

Phoenix Fiberlink and PSO Metrolink were acquired in 1994 by Brooks Fiber Communications (Brooks Fiber Properties). Brooks also acquired 6 route miles of FiveCom's system in Springfield, Mass., whose facilities were not previously listed in this report. The statistics for Phoenix Fiberlink and PSO have been merged with minor adjustment into the Brooks Fiber entry. Brooks is now part of WorldCom.

During 1992, TCI, the parent company of Digital Direct acquired an interest of slightly under 50% in Teleport Communications. As of the end of 1992, the planned consolidation of facilities of Digital Direct and Teleport Communications had not been completed. During 1993, the acquisition of Digital Direct facilities in Chicago, Dallas and Seattle was completed, and the data filed by Teleport Communications Group (TCG) for 1993 include those facilities. Possible overlapping of routes associated with the consolidation should have been accounted for in 1993 Teleport Communications Group data, since Digital Direct and Teleport Communications Group both operated facilities in Dallas and Chicago. TCI Telephony was identified in 1996 but has not provided data. TCI reports a total of 16,600 route miles of fiber in its plant infrastructure. A total of 12% of its total plant provides two-way operation, and an unspecified additional amount is equipped for two-way capability but is not yet operational. The company reports that approximately 16,000 schools and libraries or about 80-85% of the number in its service area are "wired". TCI was recently acquired by AT&T on February 18, 1999.

During 1993 Teleport Communications Group (TCG) acquired Diginet. Data for Diginet is included in the aggregate for TCG. Diginet fiber connecting Milwaukee and Chicago is shown

separately in Table 1 under the name TCG. In 1994, TCG acquired Penn Access, whose data have been retroactively merged with the TCG data. TCG merged with AT&T in July 1998.

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

Facilities of US Signal, formerly known as City Signal, were acquired by Brooks Fiber Properties, Teleport Communications Group, and at least one other entity. Its data are no longer included in the tables but can be obtained from prior reports.

Several entities owning fiber facilities at the local level were identified beginning in 1996. These include Cablevision Lightpath, TCI/TCI Telephony, Cox/Cox Fiber Net, GST Telecom, Hyperion Telecommunications Inc., e.spire (formerly American Communication Services, Inc.), FirstWorld Communications (formerly Spectranet International), USN Communication, RCN Corp., Metromedia Fiber Network, Interpath Communications Inc., NEXTLINK, Inc., Harron Communications, MHLightnet, Comcast, and MediaOne. Some of the entities have only recently begun to construct fiber facilities. While data for some of these are now included in the tables, telecommunications data for the others were unavailable or not applicable to 1998, could not be provided in time for inclusion in this report, or could not be separated from other categories of facilities. Some of the above entities primarily operate cable TV facilities but have been installing fiber in the backbone plant and have been upgrading their facilities for two-way operation. Metromedia Fiber Network is also constructing local facilities but only limited information on this entity was available. Interpath Communications, a subsidiary of Carolina Power and Light, owns fiber facilities in Raleigh-Durham, Greensboro, Charlotte, and Wilmington, North Carolina. It was unable to provide data for this year's report. Other entities owning fiber facilities and wishing to be included in publicly available reports such as this one should contact the author.

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

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

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

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

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

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

Investment - Approximate investment in fiber cable, deployment, and repeater sites.

Buildings served -- The total number of buildings accessed by fiber where the carrier is capable of providing service.

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

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

Bay Area Teleport (acquired by IntelCom Group)

Brooks Fiber Properties, Inc. (Locations shown reflect facilities acquired from Phoenix Fiberlink and PSO Metrolink, Fibernet USA, and US Signal.)

(Brooks merged with WorldCom in early 1998)

Arizona: Tucson

Arkansas: Little Rock

California: Sacramento, San Jose, Santa Clara, Sunnyvale, Stockton, Fresno, Bakersfield, Milpitas, Palo Alto, San Francisco, San Mateo

Connecticut: Hartford, Stamford

Maine: Portland

Massachusetts: Springfield

Michigan: Grand Rapids, Lansing, Traverse City

Minnesota: Minneapolis/St. Paul

Mississippi: Jackson

Missouri: Kansas City, Springfield

Nevada: Reno

New Hampshire: Manchester, Nashua

New Mexico: Albuquerque

New York: Long Island, White Plains

Ohio: Toledo

Oklahoma: Oklahoma City, Tulsa

Rhode Island: Providence

Tennessee: Knoxville

Texas: Austin, Fort Worth, Dallas, Houston, San Antonio, Waco

Utah: Ogden, Provo, Salt Lake City

Cablevision Lightpath (no data)

Comcast (operates cable TV facilities and owns MH Lightnet)

Cox Communications Services (telecommunications services not separated from cable TV services)

Operations in: California, Ohio, Georgia, Louisiana, Rhode Island, Arizona, Virginia, Connecticut, Florida, North Carolina Louisiana, Texas

Digital Direct (facilities acquired by TCG)

Eastern Telelogic (acquired by TCG in March 1998)

Pennsylvania: Philadelphia

New Jersey: Camden

Delaware: Wilmington

Electric Lightwave (subsidiary of Citizens Utilities Company)

Arizona: Phoenix metro area

California: Sacramento metro area (Folsom)

Nevada: Las Vegas metro area

Oregon: Portland metro area (Beaverton, Hillsboro, Milwaukie, Gresham, Tualatin, Tigard, Wilsonville)

Utah: Salt Lake City metro area (West Valley City, Murray, Lehi, Highland)

Washington: Seattle metro area (Bellevue, Kent, Renton, Tukwila, Kirkland, Redmond)

e.spire (name changed from ACSI)

Alabama: Birmingham, Mobile, Montgomery

Arizona: Tucson, Phoenix

Arkansas: Little Rock

California: Santa Clara, San Jose

Colorado: Colorado Springs

Maryland: Central Maryland, Annapolis

Florida: Jacksonville, Tampa, Miami, Ft. Myers, Ft. Lauderdale, Tallahassee

Georgia: Columbus, Atlanta, Savannah

Kansas: Overland Park

Kentucky: Lexington, Louisville

Louisiana: Shreveport, Baton Rouge, New Orleans

Mississippi: Jackson

Missouri: Kansas City

Nevada: Las Vegas

New Mexico: Albuquerque

New York: New York City

North Carolina: Charlotte, Raleigh

Oklahoma: Tulsa

South Carolina: Charleston, Greenville, Columbia, Spartanburg

Tennessee: Chattanooga, Memphis, Nashville

Texas: Amarillo, El Paso, Fort Worth, Irving, Amarillo, Dallas, Houston, Austin, San Antonio, Corpus Christi

Virginia: Richmond, McLean

Fibernet USA (acquired by Intermedia Communications in February 1995)

GST Telecom

Arizona: Tucson, Phoenix

California: Fresno, Pleasanton, Los Angeles, Rialto, San Bernadino

Riverside, Loma Linda, Ontario, City of Industry, Monterrey Park, Anaheim,
Oakland, San Ramon, Livermore

Hawaii: Honolulu / Islands of Ohahu, Kauai, Motokai, Lanai, Maui, Hawaii

Idaho: Boise

New Mexico: Albuquerque

Texas: Houston, Abilene

Washington: Vancouver, Spokane

Hyperion Telecommunications, Inc.

Arkansas: Little Rock

Florida: Jacksonville

Kansas: Wichita

Kentucky: Lexington, Louisville

Louisiana: Baton Rouge

Mississippi: Jacksonville

New York: Buffalo, Syracuse, Albany, Chektowaga, Tonawanda, West Seneca

New Jersey: New Brunswick, Piscataway, Freehold, Morristown

Pennsylvania: Harrisburg, Philadelphia, York

Tennessee: Nashville

Vermont: Burlington, Rutland, Montpelier

Virginia: Richmond, Charlottesville

Indiana Digital Access (acquired by Time Warner Communications)

ICG Communications (ICG Telecom Group) (formerly Teleport Denver)

Alabama: Birmingham

California: Los Angeles, San Francisco, Sacramento, and San Diego metro areas

Colorado: Denver, Colorado Springs, Boulder

Kentucky: Louisville

North Carolina: Charlotte

Ohio: Cleveland, Cincinnati, Columbus, Dayton, Akron, Columbus

Tennessee: Nashville

Intermedia Communications, Inc (ICI) (Acquisition of Fibernet USA facilities completed in February 1995.)

Alabama: Huntsville, Birmingham

Florida: Tampa, Miami, Jacksonville, Orlando, St. Petersburg, W. Palm Beach,
Gainesville, Pensacola, Tallahassee

Illinois: Chicago
Maryland: Baltimore
Massachusetts: Boston
Missouri: St. Louis
New York: Albany, Buffalo
North Carolina: Raleigh/Durham (Research Triangle Park in Durham County)
Ohio: Cincinnati
Pennsylvania: Philadelphia
Texas: Dallas
Washington, D.C.

Jones Lightwave (acquired by MFS)

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

Linkatel Communications, Inc. (no data)

McLeod, USA (acquired MWR Telecom)

MCImetro (see notes to tables)

Alabama: Mobile
California: Los Angeles, Oakland, San Diego, San Francisco, Sunnyvale
Delaware: Wilmington
Florida: Tampa
Georgia: Atlanta
Illinois: Chicago
Maryland: Baltimore
Massachusetts: Boston
Michigan: Detroit
New Jersey: Northern part of state
New York: New York City
Ohio: Cleveland
Oregon: Portland
Pennsylvania: Philadelphia, Pittsburgh
Texas: Houston, El Paso
Washington: Seattle
Washington, D.C.
Wisconsin: Milwaukee
Texas: Dallas

Metrex Corp. of Alabama (no data)

Metro Com (acquired by Time Warner Communications)

Metromedia Fiber Network (added to tables)

Illinois: Chicago

New York: New York City

Pennsylvania: Philadelphia

Washington, D. C.: District of Columbia

Metropolitan Fiber Systems (MFS) (acquired by WorldCom-- selected metro areas are shown.)

(acquired by WorldCom)

Arizona: Phoenix

California: San Francisco, San Jose, San Diego, Oakland, Los Angeles

Colorado: Denver

Connecticut: Hartford, Stamford

Delaware: Wilmington

Florida: Miami, Tampa, Orlando

Georgia: Atlanta

Illinois: Chicago

Indiana: Indianapolis

Maryland: Baltimore

Massachusetts: Boston

Michigan: Detroit

Minnesota: Minneapolis

Missouri: St. Louis

New Jersey: Newark, Jersey City, Morristown, Parsippany, Middlesex-Sommerset

New York: New York City (and surrounding areas), Albany, Buffalo, Rochester, White Plains (Westchester County)

Ohio: Cleveland

Oregon: Portland

Pennsylvania: Philadelphia, Pittsburgh

Texas: Dallas, Houston

Virginia: Richmond

Washington: Seattle

Washington, D.C.: District of Columbia (and surrounding Virginia and Maryland suburbs)

MH Lightnet (subsidiary of Comcast)
New Jersey: Newark, Jersey City

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

NEXTLINK, Inc. (no city data)

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 (no city data)

Teleport Communications Group (TCG) (merged with AT&T)
(selected metro areas shown)

(merged with AT&T in July 1998)

Arizona : Phoenix, Peoria, Tempe, Scottsdale

California : Los Angeles, San Diego, San Francisco, Oakland, San Jose

Colorado: Boulder, Denver

Connecticut : Hartford, New Haven, New London

Florida : Ft. Lauderdale, Miami, West Palm Beach, Pompano, Boca Raton

Illinois : Chicago, Gary, Skokie

Indiana: Indianapolis, Lawrence

Maryland : Baltimore

Massachusetts: Boston, Brockton, Attleboro, Lawrence

Michigan : Detroit, Pontiac, Plymouth, Dearborn

Missouri : St. Louis

Nebraska: Omaha

New Jersey: Princeton, Newark, Jersey City

New York : New York City metropolitan area

Ohio: Cleveland

Oregon : Beaverton, Portland, Tigearard

Pennsylvania: Pittsburgh

Rhode Island: Providence, West Warwick

Texas: Dallas, Houston, Fort Worth, Plano, Irving, Richardson

Utah: Salt Lake City, West Valley, Murray
Washington: Seattle, Bellevue, Tacoma, Everett, Redmond
Wisconsin: Milwaukee, Waukesha

Time Warner Communications

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

US Signal (formerly City Signal)

(Facilities that were completed or under construction in the following states were acquired by Brooks Fiber, TCG and at least one other entity.)

Michigan: Grand Rapids, Lansing, Ann Arbor
Indiana: Indianapolis
Nevada: Las Vegas
Tennessee: Memphis, Nashville

Exempt Telecommunications Companies as of June 1999

The following are companies subject to the Public Utilities Holding Company Act that have requested and been granted exemptions to operate telecommunications facilities in accordance with the provisions of the Telecommunications Act of 1996. These entities requiring FCC exemptions are typically owned by multistate holding companies and may either be constructing long haul fiber optic telecommunications facilities to be leased to other entities, marketing DS-3 or SONET capacity, or providing CLEC services. Other companies operating telecommunications facilities in accordance with the provisions in the Public Utilities Holding Company Act that are implemented by the Securities and Exchange Commission may not be required to apply to the FCC for exempt status under the terms of the Telecommunications Act of 1996.

APPLICANT	FCC APPROVAL DATE
1. CSW COMMUNICATIONS	04/08/96
2. ENTERGY TECH. CO.	04/16/96
3. ENTERGY TECH HOLDING CO	04/16/96
4. NU/MODE 1 COMMUNICATIONS	06/03/96
5. SOUTHERN INFO. HOLD. CO.	06/14/96
6. SOUTHERN INFORMATION 1	06/14/96
7. SOUTHERN INFORMATION 2	06/14/96
8. SOUTHERN TELECOM HOLD CO	06/14/96
9. SOUTHERN TELECOM 1	06/14/96
10. SOUTHERN TELECOM 2	06/14/96
11. ALLEGHENY COMM. CONNECT	06/17/96
12. AEP COMMUNICATIONS	08/02/96
13. COLUMBIA NET SERVICES	08/26/96
14. 280 SECURITY HOLDING	09/24/96
15. NEES COMMUNICATION	10/04/96
16. GPU TELCOM SERVICES	11/12/96
17. SENTRY MANAGEMENT CORP	11/26/96
18. CINERGY COMMUNICATIONS	11/26/96
19. CNG TELECOM	02/07/96
20. WEBCEL COMMUNICATIONS	03/10/97
21. CSWC SW HOLDINGS, ET AL	03/14/97
22. e prime TELECOM	05/09/97
23. ACCESS COMMUNICATIONS	05/09/97
24. DAKOTA COOP TELECOM ET AL	07/21/97
25. EUA TELECOM CORP	07/22/97
26. ENTERGY ETHC MERGER CO	07/22/97
27. SONITROL SOUTHEAST, INC	07/22/97
28. SENTRY ALARMS SYSTEMS	08/05/97
29. BECOM/RCN-BETG	08/19/97
30. CNS MICROWAVE	08/19/97
31. AEP COMMUNICATIONS	08/29/97
32. VA PCS ALLIANCE & WV PCS	10/03/97
33. VANGUARD COMMUNICATIONS	10/07/97
34. CONECTIV COMMUNICATIONS	10/07/97
35. DIGITAL BROADCASTING OVS	01/09/98
36. ENERGY.COM CORPORATION	03/13/98
37. MCLEOD USA	03/17/98
38. TOTAL MEDIA TECHNOLOGIES	06/05/98
39. CO-LOCATE, INC.	06/15/98
40. COLUMBIA ENERGY TELCOM CO	07/28/98
41. AMEREN ENERGY COMM	08/28/98
42. LATTICE COMM, LLC (CINERGY)	12/01/98
43. N. AMERICAN POWER BROKERS	05/19/98
44. ALAMOS PSC LLC	05/19/99
45. ROSEWOOD TELECOMMUNICATIONS LLC	05/24/99
46. AMERICAN STERLING COMM, LLC	06/03/99

Customer Response

Publication: Fiber Deployment Update -- End of Year 1998
 --- September 1999 ---

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.

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- 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	()	()	()	()	()
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Completeness of data	()	()	()	()	()
Text clarity	()	()	()	()	()
Completeness of text	()	()	()	()	()

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				Poor	No opinion
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