

**FIBER DEPLOYMENT UPDATE**

**End of Year 1992**

**By Jonathan M. Kraushaar**

**Industry Analysis Division - Common Carrier Bureau**

**Federal Communications Commission**

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### Introduction and Overview

This report was first released in December 1986; since then it has been updated annually. Its primary purpose is to document fiber capacity built or used by communications common carriers. The first part reviews the statistical data being collected and discusses the methods, procedures and shortcomings associated with the data and the data collection process. The following parts highlight selected statistical data illustrating key fiber trends and developments.

The report updates the statistical tables contained in prior reports but does not include the list of references and much of the technical and other background information contained in the earlier reports. This information is contained in last year's update which was released March 20, 1992. That report, along with this update, are available on an electronic bulletin board operated by the Industry Analysis Division. The bulletin board can be reached by dialing (202) 632-1361 and is available 24 hours daily, except between 9:30 and 10:30 A. M. and between 1:00 and 1:30 P. M. Other usage restrictions between 8 A. M. and 1:30 P. M. are applicable to unofficial users only. The bulletin board also contains other related infrastructure data such as the Automated Reporting and Management Information System (ARMIS) 43-07 infrastructure reports for the local operating companies, and selected data from a publication entitled, "Statistics of Communications Common Carriers." These reports are also available by calling International Transcription Service, Inc. (ITS) at (202) 857-3800.

The statistical data in tables 1-15 cover three categories of carriers: interexchange carriers, local operating telephone companies, and metropolitan or urban fiber carriers. Fiber growth for the interexchange carriers was about 12 percent during 1991 and 2.7 percent during 1992. The local operating companies have increased their fiber in plant by about 25.4 percent this year compared to a revised growth figure of about 35.1 percent last year. There has also been expansion in the urban or metropolitan fiber systems. While the amount of fiber in these systems continues to be small in relation to the fiber deployed by the local operating companies, this continues to be a dynamic sector of the industry. Other entities such as electric utilities and cable TV companies have also been deploying fiber. A discussion of these entities is contained in prior reports.

### Items of Data Collected

Carriers were contacted by telephone and a written description of the requested data items was made available to them. These descriptions are summarized in the notes to the accompanying tables and have led, in some cases, to data adjustments for prior years. Five elements of the request are common to all carriers surveyed. These

are route-miles of fiber system, fiber miles of fiber deployed, sheath miles of fiber cable deployed, fiber miles of "lit" or equipped fiber, and investment in backbone fiber facilities (i.e., underlying fiber, repeater, and deployment cost). It may be useful to note that two fiber cables extending 100 miles along the same route and each containing 10 fibers would result in 100 route miles of fiber, 200 sheath miles, and 2,000 fiber miles in the statistics collected.

These statistics are useful as an indication of the potential capacity of each carrier's system because the number of circuits that can be multiplexed onto the same fiber can change as terminal and repeater technologies improve. Therefore, the same underlying fiber data can be used in conjunction with updated estimates of available terminal technology to arrive at updated estimates of maximum available capacity. For example, 1.76 gigabit terminal technology supports up to about 25,000 2-way circuits on a single fiber pair and more than tripled the capacity of earlier systems. Many carriers are acutely aware that although up-front costs for fiber deployment in absolute terms are high, a significant portion of the total investment can be deferred until actual demand materializes, thus allowing the use of the most up-to-date equipment available for equipping the fiber.

A number of other items of data have been requested that are tailored to the category of carriers to which the request was made. For the interexchange carriers the total number of points of presence or points of interconnection to local or metropolitan carriers was requested, which was to include interconnection locations which may not be owned by the interexchange carrier. A number of carriers did not provide this data this year. AT&T provided point of presence data only for its switched services. The number of points of presence like fiber route mileage provides a very basic measure of network coverage.

To provide some estimate of the cost of equipping terminal and repeater electronic and optoelectronic equipment on fibers in relation to the underlying fiber investment, data on both backbone fiber investment and DS-3 investment was requested along with DS-3 mileage. Actual DS-3 mileage divided by the potential DS-3 mileage (i.e., assuming all fibers were equipped with the highest capacity systems) would provide an indication of the application of the latest available terminal and repeater technology and would provide a measure of current fiber utilization. Investment per DS-3 mile was calculated based on the limited available data and is listed in Table 4.

Information on fiber facilities leased from other entities was requested to insure that leased fiber capacity would not be included with owned fiber. This should have minimized the chance of double counting of fiber. In at least one instance fiber statistics have been revised to remove leased fiber, which had erroneously been included in prior data submissions. Information on leasing has not been updated by all carriers. Therefore, information on leasing in Table 4 is provided as a rough guide, as it represents the latest information provided and does not necessarily reflect current status. Finally, information on sharing of fiber facilities with electric utilities was requested this year and is also summarized in Table 4. Although it is expected that this report has only identified a portion of the total leased and shared capacity, the information on the amount of leased fiber capacity also provides some indication of the amount of interaction among those entities deploying fiber.

Information on the application of fiber technology in several areas was included in the survey of the local operating companies. First, information on fiber-to-the-curb systems allowing residential fiber to be shared to the pedestal or drop wire by several residences was requested. Second, information on fiber technology trials including, but not limited to fiber-to-the-home trials, was requested. Third, information on fiber rings or redundancy arrangements (either dedicated or using a bus structure) was requested. These systems appear to compete with metropolitan or urban fiber systems. Information on the use of pair gain systems was also requested. The data indicates that presently most local loops utilize dedicated copper facilities from the customer all the way to the central office. Finally, DS-3 mileage on fiber facilities and T1 mileage on copper facilities was requested to provide an indication of the utilization of fiber facilities at the local level where there is less opportunity to take advantage of economies of scale.

For metropolitan fiber carriers, information on the number of customer locations and buildings served was requested in addition to the information on the extent of deployed fiber. The information on buildings and customer locations served was provided by nearly all entities and is reported in Table 15.

## Source Methods and Data Limitations

This report primarily focuses on domestic common carrier use of fiber and is based on survey work conducted since the fall of 1985. A significant amount of the data has been collected through telephone interviews with key representatives of the carriers. This approach is now supplemented with a written description of the survey items which is made available to each participating carrier. The items of data collected are described with the tables. It was hoped that this procedure would make the reported data somewhat more uniform.

Telephone interviews and a survey item description sheet have been used, and follow-up discussions focused on clarification and questions about the responses as well as more general questions on current developments and trends. A number of trade associations including the Utilities Telecommunications Council representing electric utilities, the National Cable Television Association and the Association for Local Telecommunications Services (ALTS) representing urban fiber carriers have also provided input and have been very cooperative and helpful. The Bell Operating Companies were initially contacted by letter. The report has benefitted from the opportunity to talk directly with a variety of industry and industry association contacts. The author greatly appreciates the support and cooperation of all those individuals who made this report possible, especially in view of the fact that the survey is conducted informally and the responses are voluntary.

Most entities provided nearly all of the requested data. In a few instances, provided data may have been excluded from this report where inconsistencies were detected or where data items not heretofore requested were not provided by enough of the reporting entities. Several reporting problems have been identified in the past and an attempt has been made to correct these by modifying and augmenting the surveyed items. First, both route and cable sheath mileage were requested of interexchange and urban carriers to insure that carriers with multiple cables in a route make a proper distinction in these data items. Second, the fact that fiber data requested is for owned fiber was reiterated and was further highlighted by separately requesting data on leased fiber. Third, more detailed information on fiber technology trials, fiber-to-the-curb systems and fiber terminations has been requested of the Bell operating companies. Urban carriers were asked to supply counts of buildings and customer locations served by fiber. Local operating companies, which in many cases do not track buildings served, were asked to provide data on customer locations served by fiber rings or other forms of redundant access. In some instances their responses were incomplete or limited. Finally, the interexchange carriers were asked to separate backbone investment from the investment associated with DS-3 additions.

With continuing merger and acquisition activity as well as joint ventures, capacity sharing arrangements, leases, etc., it has become increasingly difficult to be sure that no double counting of capacity has occurred. Of particular note is the fact that the interexchange carriers typically have categorized fiber constructed with electric utilities as owned cable even though long-term leases or right to use arrangements may have been used. Since the terms of such shared-use agreements with the electric utilities are confidential and may vary, there was no way of assuring that all such agreements were handled in the same way as they impact the amount of owned fiber. Nonetheless, fiber capacity obtained through long-term agreements with entities which themselves are not interexchange carriers would not lead to double counting insofar as the primary scope of this report is concerned. Thus, inclusion of such fiber as owned capacity of the interexchange carriers was permitted.

Another problem in evaluating the data is the widespread use of redundant paths or routes. Redundancy, in general, makes it more difficult to benchmark utilization levels. Also, mergers compound this problem and may result in situations, due to overlapping of routes, where combined route mileages are less than the sum of the parts. In general, as mergers and overbuilds occur, the likelihood of ambiguity on route mileage data increases. For this reason, all carriers were requested to provide sheath mileage supplementing any route mileage data which was also provided.

Fiber cross section data, calculated by dividing the fiber mileage by the sheath mileage or route mileage, could be a useful check for data errors or misinterpretations. Nonetheless, a tendency to base fiber mileage on route

mileage data and an estimated fiber count factor may have limited the usefulness of this approach. Similar factors may also have been used in some cases to generate the DS-3 mileages and to provide lit fiber mileages. However, there is indication that such problems have been partially addressed this year by the reporting entities. In particular, Sprint no longer appears to use this approach. Williams Telecommunications had indicated that last year's reported data was not consistent with the previously published data series because it had previously included about 1,000 miles of microwave and an unspecified amount of leased fiber in its data. Downward adjustment of historical data reflects the estimated impact of these factors.

Beginning with last year's report AT&T eliminated a practice of rounding or estimating components of its totals before arriving at an aggregate. Based upon information provided by the company, downward adjustments to previously reported fiber mileage data were made to make the data more consistent. AT&T's 1989 route mileage was similarly adjusted, although the company could not confirm a similar rounding problem in its route mileage data. MCI has revised its 1991 route mileage data and has provided 1992 fiber mileage data which appeared inconsistent with the previously provided 1990 and 1991 data. The inconsistencies seem to relate to MCI's acquisition of Telecom\*USA during 1990 and the way overlapping routes may have been defined and accounted for. Adjustments were therefore made to 1990 and 1991 data consistent with this and other assumptions described in the notes associated with Tables 1-4.

Lit fiber data may have other pitfalls as well. In particular, route redundancy and backhauling may mask underlying usage levels. Most likely such route redundancy would tend to increase lit fiber percentage over the level which would otherwise exist. In general, abrupt changes in the amount of lit fiber on a year-to-year basis should alert the reader to possible problems with this data element. Some corrections to previously provided lit fiber data are reflected in the tables.

In interpreting data and growth rates from the accompanying tables the reader should be aware that in a number of instances the current year's data was prepared prior to the end of the year and therefore may have been estimated. As such, uncertainty concerning project completion dates may have resulted in data and resulting growth distortions. This may tend to be more of a problem with the metropolitan fiber carriers which are a rapidly growing sector of the industry.

#### Interexchange Carriers

Data for interexchange carriers is shown in Tables 1 through 4. By the end of 1992, interexchange carriers had deployed fiber networks totalling about 95,000 route miles. This year, growth in fiber mileage deployed by interexchange carriers was about 2.7 percent, down from last year's growth of about 12 percent. Total 1992 fiber mileage deployed by the interexchange carriers is presently estimated at approximately 2.4 million miles, as shown in Table 2. Much of the long-haul interexchange fiber utilizes railroad rights of way, abandoned pipelines or is simply buried. While some of the interexchange carriers operate a significant number of microwave routes, this data is not reflected in the data shown in the tables. Some of the carriers have been utilizing fiber built in conjunction with electric power company facilities and rights of way. This data is now included in Table 4.

A rough estimate of the capacity of all known fiber facilities used by the interexchange carriers, assuming 28 DS-3's or 18,816 circuits per fiber pair, suggests that on the order of 35 million DS-3 miles could eventually be equipped on the existing fiber using 1.2 Gbit/second terminal and repeater technology. Based on data provided this year or in prior years, the carriers have reported equipping between 8 and 10 million DS-3 miles or roughly a quarter of the available capacity associated with 1.2 gigabit technology, as determined from Tables 2 and 3. Table 4 summarizes the cost per route mile of fiber backbone and the cost per DS-3 mile. The cost per DS-3 mile was calculated by dividing the total DS-3 investment reported by the carrier by the corresponding number of DS-3 miles reported. This cost is affected by network complexity, system loading, and other factors.

**Table 1: Route Miles – Interexchange Carriers \***

Calendar Year:	Fiber System Route-Miles							
	1985	1986	1987	1988	1989	1990	1991	1992
AT&T	5,677	10,893	18,000	23,324	28,900	32,398	36,871	39,288
ATC	800	950	967	1,127	1,163	1,163	1,163	1,163
Consolidated Network	310	310	352	352	352	352	352	352
CTI (Electra + Mutual)	382	382	803	803	803	914	914	914
Diglnet	NA	NA	NA	84	84	84	84	84
LCI International (Litel)	881	950	1,210	1,210	1,210	1,210	1,406	1,406
MCI	3,025	6,752	10,267	12,467	13,839	16,000	16,700	17,040
MRC Telecommunications	NA	NA	670	670	844	844	844	850
RCI	580	580	796	413	414	415	417	417
US Sprint	5,300	11,915	17,476	21,938	22,002	22,093	22,725	22,799
Valley Net	NA	NA	NA	NA	520	570	581	581
Williams Telecom.	3,084	7,936	8,202	9,135	9,725	9,893	9,930	9,930
<b>Total Reported:</b>	<b>20,039</b>	<b>40,668</b>	<b>58,743</b>	<b>71,523</b>	<b>79,856</b>	<b>85,936</b>	<b>91,987</b>	<b>94,824</b>

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

**Table 2: Fiber-Miles and Average Route Cross Section -- Interexchange Carriers \***

Calendar Year:	Thousands of Fiber Miles								Average Cross Section				
	1985	1986	1987	1988	1989	1990	1991	1992	1988	1989	1990	1991	1992
AT&T	136.2	261.4	432.0	704.7	838.4	935.7	1,146.9	1,194.5	30.2	29.0	28.9	31.1	30.4
ATC	8.0	9.5	9.7	17.2	18.1	18.3	18.3	18.3	15.2	15.6	15.7	15.7	15.7
Consolidated Network	3.5	3.5	3.9	4.0	4.0	4.0	4.0	4.0	11.2	11.2	11.2	11.2	11.2
CTI (Electra + Mutual)	10.0	10.0	14.0	14.0	14.0	14.2	14.2	14.6	17.4	17.4	15.5	15.5	16.0
Diginet	NA	NA	NA	1.7	1.7	1.7	1.7	1.7	20.0	20.0	20.0	20.0	20.0
LCI International (Litel)	13.7	17.3	22.3	22.3	22.3	22.3	24.7	24.7	18.4	18.4	18.4	17.6	17.6
MCI	83.9	179.1	259.3	278.8	304.2	388.0	413.7	430.0	22.4	22.0	24.3	24.8	25.2
MRC Telecommun.	NA	NA	8.0	8.0	10.1	10.1	10.1	10.2	12.0	12.0	12.0	12.0	12.0
RCI	7.0	7.0	7.2	2.6	2.7	2.7	2.7	2.7	6.3	6.4	6.4	6.4	6.4
US Sprint	122.4	249.3	343.2	449.5	450.8	453.4	466.7	466.7	20.5	20.5	20.5	20.5	20.5
Valley Net	NA	NA	NA	NA	6.1	6.8	7.2	7.2	NA	11.8	12.0	12.4	12.4
Williams Telecommun.	71.0	181.3	193.8	220.8	227.3	236.3	237.6	237.6	24.2	23.4	23.9	23.9	23.9
<b>Total Reported:</b>	<b>455.7</b>	<b>918.4</b>	<b>1,293.4</b>	<b>1,723.5</b>	<b>1,899.7</b>	<b>2,093.4</b>	<b>2,347.7</b>	<b>2,412.1</b>	<b>24.1</b>	<b>23.8</b>	<b>24.4</b>	<b>25.5</b>	<b>25.4</b>

\* 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 Mi. Lit						Estimated DS-3 Miles					
	1987	1988	1989	1990	1991	1992	1987	1988	1989	1990	1991	1992
AT&T	26.5%	41.6%	45.5%	49.6%	44.6%	49.5%	NA	1,294,129	3,024,902	3,656,642	4,383,896	5,188,927
ATC	80.0%	69.0%	75.0%	90.0%	90.0%	90.0%	NA	171,580	NA	NA	NA	NA
Consolidated Network	33.0%	33.0%	50.0%	53.4%	53.4%	53.4%	NA	4,224	7,026	12,672	31,616	31,616
CTI (Electra + Mutual)	52.9%	67.8%	55.1%	56.3%	58.3%	65.9%	NA	NA	NA	23,766	34,569	38,195
Diginet	NA	NA	NA	NA	NA	80.0%	NA	NA	5,400	NA	NA	NA
LCI International	54.2%	54.9%	55.9%	60.6%	60.1%	60.1%	NA	52,293	55,869	43,874	42,081	47,058
MCI	30.0%	40.0%	56.7%	64.3%	NA	NA	449,829	907,802	1,061,143	1,203,458	NA	NA
MRC Telecommun.	33.3%	50.0%	41.7%	65.0%	NA	NA	NA	8,040	25,350	NA	NA	NA
RCI	34.9%	57.4%	56.7%	56.7%	56.1%	57.0%	7,164	5,206	10,446	10,446	15,535	17,735
US Sprint	30.0%	31.0%	50.4%	53.9%	55.1%	55.1%	865,000	987,000	1,431,985	NA	1,705,542	1,740,555
Valley Net	NA	NA	37.3%	50.7%	40.0%	40.0%	NA	NA	12,250	NA	11,600	NA
Williams Telecommun.	42.5%	37.2%	49.0%	58.5%	58.2%	57.9%	201,665	245,869	NA	NA	NA	NA
<b>Total Reported:</b>	<b>31.8%</b>	<b>38.7%</b>	<b>49.3%</b>	<b>54.9%</b>	<b>49.6%</b>	<b>52.5%</b>						

See accompanying notes to the tables and discussion in text.

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

	Estimated Backbone Fiber Investment (Millions \$)	Estimated DS-3 Investment per DS-3 mile	Estimated Backbone Investment per Route ml. (Thousands \$)	Points of Presence	Fiber In Electric Utility Facilities		Previously Identified Leasing of Fiber *		
					Sheath Miles	Fiber Miles	DS-3 Miles	Route Miles	Fiber Miles
AT&T	2,922	242	74	745	1,159	27,816	18,034	NA	12,742
ATC	90	NA	77	44	50	NA	NA	280	2,460
Consolidated Network	16	276	45	10	NA	NA	208	180	6,962
CTI	93	NA	102	26	NA	NA	NA	NA	NA
Diglnet	6	NA	75	NA	NA	NA	NA	NA	NA
LCI International	101	244	72	34	220	NA	7,383	200	2,520
MCI	1,253	NA	75	NA	2,722	65,328	215,000	5,400	NA
MRC Telecommunications	63	NA	75	14	596	7,157	NA	155	NA
RCI	9	425	21	NA	0	0	1,700	130	558
US Sprint	1,064	215	47	241	0	0	NA	NA	500
Valley Net	9	NA	16	21	NA	NA	NA	NA	NA
Williams Telecommun.	454	NA	46	74	NA	NA	NA	275	1,100
<b>Total Reported:</b>	<b>6,080</b>			<b>1,209</b>	<b>4,747</b>	<b>100,301</b>	<b>242,325</b>	<b>6,620</b>	<b>26,842</b>

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

Notes to Tables 1-4: (NA indicates data was not available)

In some instances carriers may have estimated certain data, such as end of year data received prior to the end of the year. Accuracy may also vary depending on the carrier's method of collecting and assembling its data. Historical data may have been changed from prior reports to reflect adjustments made this year. Also, historical data for merged entities has been typically combined. The reader may thus wish to refer to prior fiber deployment reports for previously reported data.

ATC refers to Advanced Telecommunications Corp., which was formerly known as Microtel.

AT&T's 11.6% increase in fiber mileage in 1990 included the effect of a downward adjustment of its 1990 fiber mileage and a proportional adjustment to its 1989 fiber mileage to correct for what has been characterized as rounding errors on components making up the total. Data shown in the tables includes domestic fiber only. Sheath mileage for AT&T was 38,184 as of the end of 1991 and 40,071 miles at the end of 1992. AT&T's point of presence data only includes its switched services.

Diginet reported that its fiber mileage had previously included leased facilities which were removed from its 1992 data. Prior data has been adjusted accordingly.

The Electra Network in Texas and Mutual Signal Corp. were acquired by Communications Transmission, Inc. (CTI). CTI also identified 52 route miles and 14,653 fiber miles of unspecified fiber in its 1989 data which is not reflected in the tables. Investment data for CTI reflects data which was previously provided.

LCI international was formerly Litel. LCI international has corrected its 1991 lit fiber as shown in table 3.

MCI data reflects the acquisition of Telecom\*USA which had previously been formed by the merger of Southland Fibernet, SouthernNet and Teleconnect. Data provided by MCI this year was inconsistent with previously provided data. The company source indicated that the company is upgrading its data collection processes and that last year's reported 19,793 route mileage was incorrect. The company's revised data indicates that this year's route mileage should be 17,040 and that last year's figure should be 16,700. A higher route mileage was expected based on known recent construction, but it is possible that the reported route mileage figures are explained by overbuilds or completion dates extending into 1993. The company reports 17,800 sheath mileage of owned fiber facilities at end of year 1992. The company could not provide any revised historical data at this time. The company source also indicated that its recent deployments have utilized up to 48 strand fiber cable. The 19,793 route miles reported last year may have included some leased capacity and may have improperly reflected the addition of the Telecom\*USA facilities. The author has therefore made the minimal adjustment possible to historical data to account for this by using the company's revised route mileage data for 1991, adjusting the 1990 route mileage and fiber mileage data accordingly, and adjusting the 1991 fiber mileage based on the assumption of 48 fibers per route associated with 1992 additions. Revised figures are reflected in Tables 1 and 2. The reader may also wish to refer to previous fiber deployment reports.

MCI has historically 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 last year. This was consistent with previously provided total DS-3 mileage including DS-3's on 13,946 route miles of digital microwave radio facilities. This year the company reports 2.9 million miles of DS-3 facilities on fiber. The author believes that the 2.8 million and 2.9 million DS-3 miles reported this year and last year either represent a change in the previous procedure of basing DS-3 mileage on circuit mileage with an assumption of full DS-3 utilization or reflect DS-3 miles in total plant including 13,946 miles of microwave facilities rather than DS-3 miles on fiber facilities only. The company source indicates that the historical data could not be reconstructed and that the current figure of 2.9 million DS-3 miles on fiber supersedes earlier data.

Overall fiber investment for MCI shown in Table 4 for 1992 was estimated on the basis of \$75,000 per route mile. DS-3 investment per DS-3 mile could not be reliably calculated from data provided.

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

US Sprint's historical data was revised by the company last year. The reader may wish to refer to prior fiber deployment reports for comparison with previously supplied data. These revisions are reflected in Tables 1 and 2 for the period since the merger of US Telecom and GTE toll facilities in 1986. US Sprint now reports 3,152.88 route miles and 64,755.24 fiber miles for 1985.

The composite historical data for Williams Telecommunication Group was adjusted downward by the author last year to account for such things as previously included leased fiber and about 1,000 miles of microwave system. Historical data for Williams Telecommunications Group reflects the effect of acquisitions of LDX (1,379 route miles and 33,096 fiber-mi. reported by LDX for 1986) and Lightnet (5,300 route miles and 127,200 fiber mi. reported by Lightnet for 1988) and includes the effect of prior historical data supplied by those companies. Investment was adjusted downward by the company last year to include only backbone fiber facilities. Other downward adjustments made last year removed a small amount of previously identified leased fiber from the 1989 to 1991 data. (See prior fiber deployment reports.)

Data on percent of fibers lit may be distorted by route redundancy and method of reporting this data. Considerations affecting when a fiber pair is lit or equipped may vary from company to company and generally does not indicate how many circuits are presently operating. In a number of instances prior data for percent lit fiber has been recalculated.

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

Primary investment data was requested for fiber backbone system only. Additional investment for equipping DS-3's was requested separately. Investment per route mile is calculated from aggregate investment data and route mileage provided. In cases where data was missing, investment was either based on previously provided data and system growth or was estimated on the basis of \$ 75,000 per route mile.

Data on leasing of fibers may be rounded or approximated based on data provided in prior years. In some cases leased capacity is reported as DS-3's rather than entire fibers. Data provided on leased DS-3 miles may not be mutually exclusive with data on leased fiber.

Companies providing data on fiber associated with electric utilities have indicated that these facilities have been included in the owned fiber totals.

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

Definitions and descriptions of the items in Tables 1-4:

Route miles of fiber -- The total mileage of fiber routes as would be seen on a network map.

Total 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. (Also see text of report.)

**Sheath miles of fiber** -- The total number of miles of fiber cable used in the network. (Typically 12 to 36 fibers are contained in a given sheath.)

**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 .

**Investment in backbone fiber facilities** -- The total investment in fiber cable, deployment, and repeater sites but not including electronic or optoelectronic equipment.

**DS-3 miles carried on fiber** -- The number of miles of DS-3 system where each DS-3 system is capable of providing at least one equivalent 2-way voice grade circuit.

**DS-3 investment per DS3 mile** -- Additional investment for optoelectronic and electronic equipment per mile of DS-3 defined above.

**Leased facilities** -- Route miles, fiber miles or DS-3 miles leased from other interexchange carriers or resellers as applicable.

**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 metropolitan fiber carrier for access to its customers.

## Local Telephone Companies

This section summarizes data from the Bell operating companies, rural carriers which provide data to the Rural Electrification Administration (REA), and companies affiliated with Contel, GTE, and United. The data is presented in Tables 5 through 13. A number of independent operating companies which together comprise less than 5% of the total fiber have not been included in the accompanying tables. Data covering the REA companies for 1991 and 1992 was unavailable. Data on fiber trials and fiber applications was included as part of the company submissions. The information on fiber trials summarized in Table 8 and in this section is limited to information provided by the companies in connection with this report.

The plant of the local operating companies can be generally divided into several categories. These are interoffice, interexchange access, feeder, and distribution. Interoffice facilities provide for the interconnection of telephone company central offices. Access facilities provide connection with interexchange carriers which is accomplished through an access tandem switch and through direct links to interexchange carrier points of presence. Usually these facilities handle traffic from many subscribers and can take advantage of economies of scale. 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 companies do not provide data which separates feeder and distribution plant.

The survey of local companies leading to this report focused on a number of aspects of the fiber infrastructure of the local companies. A primary purpose of the survey was to track the amount of fiber in various portions of the operating company plant. While the survey also covered data on the amount of copper in plant which is included in Tables 11 through 13 of this report, the reader should exercise caution when attempting to compare the amount of fiber and copper in plant, since strands of fiber inherently have a much greater information carrying capacity than an equivalent number of copper wires and differing investments and maintenance expenses are associated with activation of comparable capacities on fiber and copper systems.

Several of the companies have had difficulty providing data which separated interoffice from subscriber fiber and copper, claiming that many facilities are jointly used for interoffice and subscriber applications and that in some instances no good sources of data in these categories could be located. US West, for example, has stated that it has used exchange and toll categories as a substitute for the interoffice and subscriber categories that were requested. This would tend to result in an overestimate of the amount of subscriber fiber and copper. Ameritech has reported the use of engineering estimates to separate interoffice and subscriber fiber and copper. Other companies either do not provide certain subscriber data or do not indicate whether estimation procedures were used. Subscriber data is displayed in Tables 10, 11, and 13.

The survey included a request for data on interLATA fiber used exclusively for internal company business. These facilities could not be used by the Bell companies under the MFJ for carrying traffic other than official company traffic, and the data indicates the extent of their interLATA facility base associated with such use. This data is summarized in Table 9.

Of particular interest was a determination of how and to what degree new fiber technology was being deployed by the operating companies. Thus, information on fiber rings, fiber-to-the-curb systems and new technology trials associated with fiber was requested. Under the price cap regime instituted in 1991, cost effective applications of new technology should be an increasingly important means by which the local companies will be able to enhance their profitability. Technology trials are one way the benefits and pitfalls of new technologies can be explored prior to large scale deployment. An important element of such trials is the exploration of more reliable and more efficient plant architectures and electronic configurations.

Perceived competitive pressures and a desire to lower the cost of deploying fiber to business and residential

customers have resulted in deployment of fiber rings. In a number of metropolitan areas, local telephone companies are deploying a redundant fiber structure generically known as a "ring," which provides for fiber redundancy by allowing customer access to be achieved from either of two diverse paths. In other instances rings are used for redundant interconnection of central offices. Often fiber redundancy arrangements established by the Bell operating companies differ from the fiber rings of the urban carriers in that they use the existing plant structure with two separate access paths provided to the customer. US West, for example, has tariffed such redundant arrangements. Nonetheless, it should be noted that available data suggests that significantly more fibers appear to have been deployed to date in these arrangements than the number of current customers.

Fiber architectures which would reduce the cost of serving large numbers of residential customers with some form of wide bandwidth service are also being explored. One such application of technology in an architecture which is designed to make deployment of wideband capabilities to residences more cost effective is the use of what is called "fiber-to-the-curb." This approach involves sharing of fiber and equipment to convert optical to electrical signals by more than one residence. In this arrangement fiber is deployed to an interface point near the customer, which in newer construction sites is often referred to as a "pedestal." Sharing of expensive opto-electronic equipment is then possible, and coaxial or other copper wire systems can be used for the short link to the subscriber. Systems of this type have been deployed by some of the local operating companies, as shown in Table 8.

Data on fiber technology trials is summarized in Table 8. These are primarily being used to test various fiber-to-residence arrangements and architectures, including systems with limited switched video capability. Other types of fiber technology trials are also being conducted. BellSouth, for example, has reported trials of its 2.4 gigabit interoffice synchronous optical network (SONET) as well as SONET 150 megabit loop trials. BellSouth, NYNEX, and GTE have reported trials and research projects involving medical imaging applications. A number of carriers have reported trials involving subscriber systems. In particular, Pacific Bell has reported a technology test of a loop optical carrier system and an associated software support system. Bell Atlantic has reported trials involving bandwidth sharing and voice and video integration capability involving off-the-shelf systems with future broadband upgrading capability.

Bell Atlantic also reports deployment of fiber to residences in addition to its trials. The company has announced that New Jersey Bell will build a video dialtone system during the next two years that will provide telephone service to 11,700 households in three Morris County, New Jersey communities. It will also provide Sammons Communications, Inc. a video transport service to their 8,000 customers. Bell Atlantic has also announced an agreement to provide FutureVision of America Corp. with video dialtone transmission services to approximately 38,000 homes and businesses in Dover Township, New Jersey. NYNEX reports plans for installation of fiber-based optical Digital Loop Carrier (DLC) systems to serve as many as 500,000 telephone lines by 1995. The company has announced it will use Lightspan-2000 equipment based on SONET standards. Southwestern Bell has announced its agreement to purchase two Hauser Communications Cable TV systems in the Washington, D. C. area, Montgomery Cablevision Limited Partnership in Maryland and Arlington Cable Partners in Virginia.

To better enable assessment of the deployment cost per fiber, investment and fiber count data associated with fiber trials is also shown in Table 8. Evaluation of this data appears to suggest that per fiber costs of most systems undergoing trial range from about \$2,000 to an amount in excess of \$6,000 per deployed fiber. The cost per fiber of a significant number of the systems undergoing trial appears to fall in the upper end of the above range. Aside from the fiber trials and fiber redundancy arrangements alluded to above, there is presently little distribution fiber in place. Nonetheless, the operating companies are generally continuing to deploy significant amounts of new fiber to modernize their plant and at the same time bring fiber closer to the customer. The effective management of rapidly developing fiber and related technologies will pose a major challenge to the operating companies in the years to come.

**Table 5: Fiber Deployment by Local Operating Companies**

Company	Sheath-Miles							
	1985	1986	1987	1988	1989	1990	1991	1992
Ameritech	3,200	5,200	6,700	8,700	10,800	12,100	15,200	17,300
Bell Atlantic	1,240	4,374	6,730	9,239	11,943	14,950	19,170	21,300
BellSouth	3,830	8,694	11,727	15,643	19,781	24,181	29,677	35,228
NYNEX	1,606	3,209	4,956	7,413	9,221	11,905	14,680	17,708
Pacific Telesis	2,318	2,779	2,964	3,480	3,767	5,139	6,564	8,334
Southwestern Bell	1,913	4,374	5,970	7,349	9,100	11,700	15,046	17,164
US West	3,527	5,017	6,937	10,030	13,425	17,596	22,152	27,401
<b>Regional Bell Total:</b>	<b>17,634</b>	<b>33,647</b>	<b>45,984</b>	<b>61,854</b>	<b>78,037</b>	<b>97,571</b>	<b>122,489</b>	<b>144,435</b>
Contel Companies				1,100	9,000	12,807	14,424	14,853
GTE Companies				8,999	11,855	15,827	17,196	19,285
United Companies				2,907	5,002	5,877	7,443	9,525
Rural Companies		500	2,584	4,651	6,369	8,689	NA	NA
<b>Total Reported:</b>	<b>17,634</b>	<b>34,147</b>	<b>48,568</b>	<b>79,511</b>	<b>110,263</b>	<b>140,771</b>	<b>161,552</b>	<b>188,098</b>

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

**Table 6: Fiber Deployment by Local Operating Companies**

Company	Fiber-Miles							
	1985	1986	1987	1988	1989	1990	1991	1992
Ameritech	77,700	111,100	147,100	177,500	228,400	285,500	400,700	520,000
Bell Atlantic	83,085	150,847	227,507	311,022	373,398	522,970	809,740	954,900
BellSouth	50,807	170,092	218,489	319,248	445,452	609,201	768,597	938,704
NYNEX	83,384	129,743	207,077	290,600	357,766	473,274	636,954	806,658
Pacific Telesis	84,310	97,800	101,090	110,273	126,944	185,212	246,418	311,668
Southwestern Bell	70,490	151,043	182,911	214,948	270,300	352,300	477,654	551,804
US West	47,341	70,082	107,782	163,968	234,851	351,571	542,309	797,593
<b>Regional Bell Totals:</b>	<b>497,117</b>	<b>880,707</b>	<b>1,191,956</b>	<b>1,587,559</b>	<b>2,037,111</b>	<b>2,780,028</b>	<b>3,882,372</b>	<b>4,881,327</b>
Contel Companies						103,603	114,410	121,383
GTE Companies				134,677	163,396	213,891	276,139	334,638
United Companies				32,287	54,569	83,540	115,590	167,022
Rural Companies		2,000	14,236	28,705	42,260	68,237	NA	NA
<b>Total Reported:</b>	<b>497,117</b>	<b>882,707</b>	<b>1,206,192</b>	<b>1,783,228</b>	<b>2,297,336</b>	<b>3,249,299</b>	<b>4,388,511</b>	<b>5,504,370</b>

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

**Table 7: Average Fiber Cable Cross Section \***

<b>Company</b>	<b>1985</b>	<b>1986</b>	<b>1987</b>	<b>1988</b>	<b>1989</b>	<b>1990</b>	<b>1991</b>	<b>1992</b>
<b>Ameritech</b>	24.3	21.4	22.0	20.4	21.1	23.6	26.4	30.1
<b>Bell Atlantic</b>	67.0	34.5	33.8	33.7	31.3	35.0	42.2	44.8
<b>BellSouth</b>	13.3	19.6	18.6	20.4	22.5	25.2	25.9	26.6
<b>NYNEX</b>	51.9	40.4	41.8	39.2	38.8	39.8	43.4	45.6
<b>Pacific Telesis</b>	36.4	35.2	34.1	31.7	33.7	36.0	37.5	37.4
<b>Southwestern Bell</b>	36.8	34.5	30.6	29.2	29.7	30.1	31.7	32.1
<b>US West</b>	13.4	14.0	15.5	16.3	17.5	20.0	24.5	29.1
<b>Average -- Bell Companies:</b>	28.2	26.2	25.9	25.7	26.1	28.5	31.7	33.8
<b>Contel Companies</b>						8.1	7.9	8.2
<b>GTE Companies</b>				15.0	13.8	13.5	16.1	17.4
<b>United Companies</b>				11.1	10.9	14.2	15.5	17.5
<b>Rural Companies</b>		4.0	5.5	6.2	6.6	7.9	NA	NA
<b>Average -- All Companies:</b>	28.2	25.9	24.8	22.4	20.8	23.1	27.2	29.3

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

**Table 8: Data on Fiber Trials of Local Operating Companies \***

<b>Selected Recent Fiber Trial Data</b>							
	<b>1992 Subscriber Trials/Systems</b>			<b>Other Fiber-to-Curb Systems</b>			<b>Types of Trials</b>
	<b>Systems</b>	<b>Fibers</b>	<b>Investment Million \$</b>	<b>Systems</b>	<b>Fibers</b>	<b>Investment Millions \$</b>	
Ameritech	2	266	2.6				<i>Subscriber POTS, Integ. POTS &amp; CATV transport</i>
Bell Atlantic	2	132	0.8	1	52	NA	<i>Subscriber FTTH</i>
BellSouth	9	2,726	10.0	6	858	4.0	<i>SONET; Subscriber POTS, ISDN, Video</i>
NYNEX	6	554	5.7				<i>Media Broadband Medical Services, FTTC, ODLC</i>
Pacific Telesis	1	288	1.5				<i>Subscriber FTTC</i>
Southwestern Bell	2	637	1.3				<i>Subscriber FTTH and FTTC</i>
US West	2	312	1.9	2	24	0.4	<i>Subscriber FTTC</i>
Contel Companies	NA	NA	NA	1	128	0.3	
GTE Companies	1	2,406	16.1	4	432	1.9	<i>Subscriber FTTC, FTTH; Broadband ISDN</i>
United Companies	2	16	1.6	1	4	0.1	<i>SONET; Subscriber Equipment Trials</i>
<b>Total Reported:</b>	<b>27</b>	<b>7,337</b>	<b>41.5</b>	<b>15</b>	<b>1,498</b>	<b>6.7</b>	

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

**Abbreviations Used Above:**

- CATV-- Cable Television
- FTTC-- Fiber To The Curb
- FTTH-- Fiber To The Home
- ISDN-- Integrated Switched Digital Network
- ODLC-- Optical Digital Loop Carrier
- POTS-- Plain Old Telephone Service
- SONET-- Synchronous Optical Network

**Table 9: Other 1992 Data for Local Operating Companies \***

	Fiber Rings-Cities	Cust. Loc. Served by Rings	Percent Lit Fiber	DS-3 Miles on Fiber	T1 Miles on Copper	Aggregate Fiber Investment (Million \$)		InterLata Fiber for Internal Co. Business	
						Sub-scriber	Total	Route MI.	Fiber MI.
Ameritech	36	718	47.1%	279,000	2,030,000	NA	542	1	7
Bell Atlantic	13	NA	NA	228,055	2,956,882	NA	582	28	4,258
BellSouth	28	NA	28.9%	343,019	198,733	NA	1,058	561	6,713
NYNEX	9	1,454	37.4%	NA	NA	255.1	705	306	4,893
Pacific Telesis	38	497	27.1%	631,948	2,248,977	NA	322	1,151	12,107
Southwestern Bell	8	77	31.6%	347,387	554,143	315.2	544	1,593	8,205
US West	30	373	23.6%	NA	23,407,133	282.0	636	NA	NA
Contel Companies	4	13	56.9%	NA	NA	NA	128	2,622	14,968
GTE Companies	17	754	50.3%	NA	NA	NA	439	8	67
United Companies	5	32	32.3%	414,990	3,738,887	NA	198	103	1,453
<b>Total Reported:</b>	<b>188</b>	<b>3,918</b>	<b>34.5%</b>	<b>2,244,399</b>	<b>35,134,755</b>	<b>NA</b>	<b>5,153</b>	<b>6,373</b>	<b>52,671</b>

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

**Table 10: Fiber Subscriber Plant of Bell Operating Companies \***

	Sheath-Miles					Fiber-Miles					
	1988	1989	1990	1991	1992	1987	1988	1989	1990	1991	1992
Ameritech	2,800	2,600	3,300	3,700	4,300	NA	56,600	69,200	84,600	153,000	234,400
Bell Atlantic	NA	4,872	6,543	NA	NA	79,434	116,873	152,334	226,008	NA	NA
BellSouth	NA	NA	NA	NA	NA	136,807	185,795	267,271	355,163	440,432	NA
NYNEX	1,935	2,656	3,995	5,388	7,095	45,938	66,823	90,027	135,876	209,716	301,989
Pacific Telesis	537	722	1,451	2,210	2,874	15,911	22,104	30,353	64,107	96,914	120,905
Southwestern	NA	2,500	2,800	4,498	5,409	NA	NA	95,400	135,600	185,283	221,846
US West	2,816	3,484	4,714	6,595	8,706	61,616	84,824	112,373	113,795	295,194	452,568

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

**Table 11: Copper Subscriber Plant of Bell Operating Companies \***

	Thousands of Sheath Miles					Thousands of Wire Miles				
	1988	1989	1990	1991	1992	1988	1989	1990	1991	1992
Ameritech	242.7	245.2	244.4	242.7	243.5	139,588	140,420	141,930	142,358	143,166
Bell Atlantic	280.3	290.8	291.3	288.9	NA	187,439	191,674	194,426	194,378	NA
BellSouth	560.0	564.2	566.1	570.4	NA	238,776	241,225	243,458	243,641	NA
NYNEX	225.5	229.5	232.7	232.9	233.2	130,893	134,247	137,882	139,976	141,616
Pacific Telesis	170.3	167.5	184.1	185.2	192.7	128,767	127,456	134,312	136,319	140,557
Southwest.	NA	338.1	343.3	345.1	347.4	NA	156,900	159,300	160,078	160,913
US West	384.3	389.4	395.8	401.7	407.9	154,245	156,229	158,737	161,144	163,563
<b>Total Reported:</b>	NA	2,224.7	2,257.7	2,266.8	NA	NA	1,148,151	1,170,045	1,177,893	NA

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

**Table 12: Fiber and Copper in Total Plant in Relation to Access Lines -- End of Year 1991 \***

Company Name	Total Plant						Per Thousand Access Lines					
	Total Access Lines (thousands)	Cent. Office Fiber Terminations	Strand Miles (thousands)		Sheath Miles		Miles Copper Wire	Miles Fiber Strand	Miles Copper Cable	Miles Fiber Cable	Percent Fiber	
			Copper	Fiber	Copper	Fiber					Cable	Strand
Ameritech	17,146	26,043	189,811	401	323,800	15,200	11,071	23.4	18.9	0.9	4.5%	0.21%
Bell Atlantic	18,451	12,715	194,517	810	289,130	19,170	10,543	43.9	15.7	1.0	6.2%	0.41%
BellSouth	18,874	50,220	242,740	769	569,784	29,677	12,861	40.7	30.2	1.6	5.0%	0.32%
NYNEX	15,541	35,667	167,922	637	261,196	14,680	10,805	41.0	16.8	0.9	5.3%	0.38%
Pacific Telesis	15,854	35,076	155,053	246	201,842	6,564	9,780	15.5	12.7	0.4	3.1%	0.16%
Southwestern	12,129	42,330	169,416	478	374,735	15,046	13,967	39.4	30.9	1.2	3.9%	0.28%
US West	14,561	51,363	166,886	542	433,452	22,152	11,461	37.2	29.8	1.5	4.9%	0.32%
<b>Total reported:</b>	<b>112,555</b>	<b>253,414</b>	<b>1,286,345</b>	<b>3,882</b>	<b>2,453,939</b>	<b>122,489</b>	<b>11,429</b>	<b>34.5</b>	<b>21.8</b>	<b>1.1</b>	<b>4.8%</b>	<b>0.30%</b>

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

**Table 13: Fiber and Copper in Subscriber Plant in Relation to Access Lines -- End of Year 1991 \***

	Access Lines		Subscriber Plant				Per Thousand Access Lines				
	Lines In Thousands		Strand Miles		Cable Sheath Miles		Miles	Miles	Miles	Miles	% Fiber
	Total	Without Pair Gain	(thousands)		Copper	Fiber	Copper Wire	Fiber Strand	Copper Cable	Fiber Cable	Sheath Miles
Ameritech	17,146	NA	142,358	153	242,700	3,700	8,303	8.9	14.2	0.22	1.5%
Bell Atlantic	18,451	17,873	NA	NA	NA	NA	NA	NA	NA	NA	NA
BellSouth	18,874	16,023	NA	NA	NA	NA	NA	NA	NA	NA	NA
NYNEX	15,541	14,599	139,976	210	232,867	5,388	9,007	13.5	15.0	0.35	2.3%
Pacific Telesis	15,854	NA	136,319	97	185,209	2,210	8,599	6.1	11.7	0.14	1.2%
Southwestern	12,129	12,084	160,078	185	345,093	4,498	13,197	15.3	28.5	0.37	1.3%
US West	14,561	12,745	161,144	295	401,680	6,595	11,066	20.3	27.6	0.45	1.6%
<b>Total reported:</b>	<b>112,555</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>9,835</b>	<b>12.5</b>	<b>18.7</b>	<b>0.30</b>	<b>1.6%</b>

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

Notes to Tables 5-13:

In some instances carriers may have estimated certain data, such as end of year data received prior to the end of the year. 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. The reader may wish to refer to prior fiber deployment reports for previously reported data.

Ameritech reports subscriber data based on engineering judgment.

Bell Atlantic and BellSouth data on subscriber copper are not available.

Bell Atlantic data did not include fiber associated with video dialtone systems in New Jersey planned for 11,700 households. Bell Atlantic reports a digital loop system in West Virginia as part of its normal growth and network modernization.

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. BellSouth has separated interoffice and subscriber lit fiber which shows that 38% of the lit fiber is associated with subscriber loops. Other companies separating subscriber and interoffice fiber show an average of about 33% of the total fiber as subscriber and about 88% of the copper wire as subscriber. BellSouth has confirmed that its fiber investment does not include electronics at terminal or repeater sites. BellSouth investment data for 1992 is through November. BellSouth data for 1990 fiber mileage has been corrected. Its data for internal company fiber only includes Florida, Georgia, North Carolina, and South Carolina.

Data in the tables reflects the fact that prior to 1989 Southwestern Bell used interexchange and toll rather than interoffice and loop subcategories. Southwestern Bell Data for 1989 to the present properly reflects loop and interoffice subcategories which were originally requested.

Non pair gain lines shown for GTE also includes its Contel Companies.

Total access line counts (switched and special access combined) were taken from the annual Form M submissions of the carriers covering the 1991 calendar year.

Definitions and descriptions of the items in Tables 5-13:

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. (Typically 12 to 36 fibers are contained in a given sheath.)

**InterLata fiber Systems** -- The route mileage and fiber mileage of owned fiber systems used for internal company business.

**Fiber-to-the-curb systems** -- The number of fibers and systems employing shared fiber and electronics.

**Fiber trials** -- The number of recent or current fiber trials with the capital investment and the associated number of fibers.

**Fiber Rings** -- The number of cities in which fiber rings or other redundant fiber arrangements are in use.

**Fibers Terminating at the Central Office** -- The number of fibers which terminate on central office facilities used or available for local loops.

**Customer Locations Served by Fiber Rings** -- The number of customer locations served by rings or other redundant fiber configurations.

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

**InterLata fiber for internal company business** -- The route and fiber mileage of facilities dedicated to internal company use.

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

**Access Lines not Derived from Pair Gain** -- The number of subscriber access lines in which the connection between the customer and the central office is a dedicated copper pair or fiber facility.

**DS-3 Miles on Fiber** -- Miles of DS-3 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 can typically support up to 24 64 Kb/s or equivalent links.

### Urban Fiber Systems

For the last few years, this report has included data on a number of entities deploying fiber in metropolitan or urban areas. This rapidly growing group of entities access large business customers using a ring or loop of fiber through areas of high business concentration and are attempting to offer the customer very reliable service with competitive service and maintenance intervals. Interexchange carriers and financial institutions are a significant portion of their customer base. Table 14 lists the key companies known to be involved in such systems. It is not intended to be an all inclusive list but has been expanded since data on these companies was first reported. It excludes companies that only operate microwave systems or that were constructing fiber plant that was not operational in 1991. Further discussion of these companies is contained in last year's report.

The key targets of the urban systems are large downtown office buildings in cities where the deployment cost and regulatory constraints of new fiber systems are not excessive. Typically a cable several miles in length containing 20 to 200 fibers is deployed in existing conduit or in subway tunnels in a ring structure. The ends of the fiber cable are connected at a hub location. At least one fiber pair in the ring is typically dedicated to a single office building and capacity is often electronically subdivided for customer access within the building. Some carriers are serving more than one customer with each fiber pair, while others have dedicated one or more fiber pairs for a single customer, which is often an interexchange carrier. In either case, the fiber rings afford a simple inherent route redundancy arrangement since traffic can reach the hub in either direction around the loop.

Metropolitan or urban carriers have faced significant barriers to market entry because they must usually negotiate separately with each building owner, as well as obtain municipal franchises and other permits and meet state legal regulatory requirements. Despite the obstacles, a number of entities have successfully established themselves, and at least two are now operating in a significant number of metropolitan areas. There has also been increasing acquisition activity with the larger entities purchasing or showing an interest in purchasing a number of smaller entities. Some of the interest in metropolitan fiber systems is evident from Cable TV companies which are also using fiber in their CATV systems. The potential for merger and acquisition activity has thus mitigated to some extent the risk to small startup ventures. An operation in a single city typically involves a \$2 million to \$10 million investment and serves at least 20 buildings.

The companies typically offer non-switched services, and although they provide end user to end user links, most of their business is either for customer access to a long distance carrier or for links between interexchange carrier points-of-presence. One of the larger entities has established the first 100 Megabit per second network over its facilities and is beginning to deploy equipment based on SONET standards. Standards, availability of equipment, and customer requirements should facilitate further development of such networks.

As the urban fiber systems extend to more cities and attract more customers, they can be expected to selectively impact growth of demand of the local telephone companies. However, urban fiber systems can only serve those customers they can access. Their customers may, therefore, still be dependent on the local telephone companies. This has led to colocation arrangements between local operating companies and urban fiber carriers. Urban fiber systems appear to have motivated local telephone companies to price special access closer to cost, and to serve larger customers by means of redundant facilities and fiber rings. Of particular note is the fact that a number of fiber rings or fiber redundancy arrangements have been reported by the Bell operating companies in many of the very same cities where urban fiber systems exist.

**Table 14 -- Urban Fiber Systems \***

Company Name	Route Miles						Fiber Miles					
	1987	1988	1989	1990	1991	1992	1987	1988	1989	1990	1991	1992
Bay Area Teleport					2.4	2.4					85	79
City Signal				67.0	115.0	144.0				5,628	6,280	7,348
Diginet			5.4	24.0	26.3	37.2			684	1,147	1,160	1,247
Digital Direct					118.0	163.9					7,144	7,898
Eastern Telelogic			68.0	140.0	140.0	140.0			2,184	3,666	3,666	3,666
Electric Lightwave					6.4	99.8					451	4,259
Fibernet, Inc.					8.4	18.9					388	998
Indiana Digital Access, Inc.		7.0	34.5	59.0	50.0	52.0		238	295	469	528	552
Inter-Media Communications		18.3	78.0	159.0	165.0	213.0		579	1,365	2,862	3,000	5,200
MWR Telecom (Iowa Resources)			60.0	65.0	75.0	95.0			1,284	1,600	1,805	3,701
Jones Lightwave					10	52.0					80	550
Kansas City Fiber Net				90.5	93.7	97.0				2,534	2,624	998
Metrex Corp. of Alabama						3.5						98
Metro Com					36.0	NA					650	NA
MFS	88.5	117.9	199.6	308.6	528.0	1,061.8	3,059	5,861	13,374	17,219	29,338	39,803
Ohlo Linx					2.5	15.0					84	800
Penn Access Corporation				31.0	80.0	90.0				1,865	6,800	8,160
Phoenix Fiberlink					22.0	24.0					968	1,056
Public Service of Oklahoma			120.0	109.0	119.0	169.0			2,500	2,631	2,855	3,196
Teleport Communications Group	44.5	57.7	227.2	273.2	400.8	726.8	4,711	5,433	12,346	15,519	20,238	35,004
Teleport Denver					100.0	115.0					4,800	6,500
<b>Total Reported:</b>	<b>133</b>	<b>201</b>	<b>793</b>	<b>1,326</b>	<b>2,098</b>	<b>3,320</b>	<b>7,770</b>	<b>12,111</b>	<b>34,032</b>	<b>55,140</b>	<b>92,944</b>	<b>131,113</b>

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

**Table 15 Urban Fiber Systems  
Other Current Data -- 1992 \***

Company Name	Sheath Miles	Average		Percent			Buildings Served	Cities Served	States Served	Major Metro Areas
		Fiber Count	Investment Millions \$	Fiber Lit	Cust. Loc.					
Bay Area Teleport	3	26.4	0.2	15%	16	9	5	1	1	
City Signal	144	51.0	6.1	28%	218	194	3	1	3	
Dignet	37	33.5	NA	25%	82	45	12	2	2	
Digital Direct	199	39.6	28.1	7%	46	142	7	2	3	
Eastern Telelogic	140	26.2	14.2	68%	NA	230	2	2	1	
Electric Lightwave	65	65.3	10.4	18%	73	106	8	2	2	
Fibernet, Inc.	21	48.1	NA	NA	44	99	3	1	3	
Indiana Digital Access, Inc.	52	10.6	0.7	65%	21	13	2	1	1	
Inter-Media Communications	213	24.4	21.0	100%	NA	148	5	1	5	
MWR Telecom (Iowa Resources)	102	36.3	5.2	32%	77	90	3	2	2	
Jones Lightwave	52	10.6	0.6	40%	6	6	4	3	3	
Kansas City Fiber Net	112	8.9	NA	19%	NA	NA	1	1	1	
Metrex Corporation of Alabama	4	28.0	0.8	9%	5	15	1	1	1	
Metro Com	NA	NA	NA	NA	NA	NA	NA	NA	NA	
MFS	1,139	34.9	NA	90%	NA	1,049	14	12	14	
Ohio Linx	15	53.3	2.0	2%	12	14	2	1	2	
Penn Access Corp.	90	90.7	NA	NA	70	150	1	1	1	
Phoenix Fiberlink	24	44.0	2.0	NA	65	60	1	1	1	
Public Service of Oklahoma	169	18.9	4.7	68%	41	41	2	1	1	
Teleport Communications Group	833	42.0	NA	NA	NA	NA	38	8	12	
Teleport Denver	165	39.4	12.0	13%	50	45	2	1	1	
<b>Total Reported:</b>	<b>3,579</b>	<b>26.0</b>	<b>108.0</b>	<b>72%</b>	<b>826</b>	<b>2,456</b>	<b>116</b>	<b>45</b>	<b>60</b>	

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

Notes to Tables 14 and 15: (NA indicates data was not available)

Statistics shown are for backbone system and reflect owned facilities. Bay Area Teleport, for example operates 58.9 route miles and 78 sheath miles of leased facilities which are not shown in the tables.

Some urban fiber carriers are either owned by Cable TV companies or share cable capacity with Cable TV services. Fiber mileage associated with the separate operations was requested separately in such cases known to exist. Route mileage should reflect the route mileage of the metropolitan or urban system.

Diginet fiber data shown in Tables 14 and 15 does not include fiber connecting Milwaukee and Chicago that is shown in Tables 1 and 2.

Fibernet facilities shown in the tables only include its Rochester, New York operation.

Intermedia Corp. revised historical route and fiber mile data last year which had not been reported cumulatively.

Kansas City Fiber Net, a part of American Cablevision, reports a decline in fiber mileage due to removal of fiber and updated accounting of plant.

MFS has acquired New England Digital Distribution and the Atlanta facilities of Metrex during 1992. Totals for MFS include those acquired facilities, as well as the facilities of I. C. C. which was acquired in 1991. Historical MFS data has been 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, previous reports did not include fiber associated with building access which are included in the current report.

MWR Telecom was listed as IOR Telecom in prior reports.

During 1992 TCI, the parent company of Digital Direct acquired an interest 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. The data items provided by Teleport Communications anticipating the consolidation have therefore been reduced by the amounts reported separately by Digital Direct, and data for the two entities is reported separately. Possible overlapping of routes could not be accounted for, since Digital Direct and Teleport Communications Group have both operated facilities in Dallas and Chicago.

Average fiber count is calculated as the fiber mileage divided by the sheath mileage.

Definitions and descriptions of items in Tables 14 and 15:

Route miles of fiber -- The total number of miles of fiber routes as would be seen on a network map.

Total 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 cable weighted by the number of fiber strands.

Sheath miles of fiber -- The total number of miles of fiber cable used. (Equal to or greater than route mileage.)

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.

Investment in fiber backbone facilities -- The total investment in fiber cable, deployment, repeater sites but not including electronic or optoelectronic equipment.

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

Customer Locations -- The total number of customer locations or sites in buildings accessed by fiber.

Cities Served -- The number of cities served by fiber facilities. A city has been loosely defined for this report and includes both small and large cities. Some companies only report large cities or metropolitan areas while other companies report a number of small to medium sized cities. A separate category major metro areas was added by the author to show the number of large cities served.

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