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FCC RELEASES FIBER DEPLOYMENT UPDATE

The FCC has released a report entitled *Fiber Deployment Update - End of Year 1995*. This report presents fiber deployment data and associated information on interexchange carriers, Bell operating companies, competitive access providers, and non-Bell local operating companies.

Current estimates indicate that interexchange carriers increased their deployed fiber by about 8% during 1995. The Bell operating companies' deployed fiber grew by about 18% during 1995 and stood at more than 9.4 million fiber miles at the end of the year. Total 1995 fiber reported by local operating companies exceeded 10.7 million fiber miles. Competitive access providers listed in this year's study had deployed about 761,000 fiber miles by the end of 1995.

Other local operating company data in the study include data on fiber investment and lit fiber, as well as limited information on deployed subscriber copper and fiber.

This report is available in the reference room maintained by the Common Carrier Bureau at 2000 M Street, N. W., Room 575. Copies may be purchased by calling International Transcription Service, Inc. (ITS) at (202) 857-3800. The report can also be downloaded [file name fiber95.zip] from the FCC-State Link internet site, which can be reached through a link from the Common Carrier Bureau home page (http://www.fcc.gov/ccb.html) on the World Wide Web. The report can also be downloaded from the FCC-State Link computer bulletin board at (202) 418-0241.

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FIBER DEPLOYMENT UPDATE
END OF YEAR 1995

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Common Carrier Bureau
Federal Communications Commission
July 1996

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FIBER DEPLOYMENT UPDATE

End of Year 1995

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 telecommunications common carriers. The first part provides an overview of 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 for interexchange carriers, local telephone companies, and competitive access providers (CAPs).

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 earlier reports. This information is contained in the report that was released March 20, 1992. That report, along with this update, is available on the FCC-State Link electronic bulletin board operated by the Industry Analysis Division. The bulletin board files can be accessed via the World Wide Web at http://www.fcc.gov/ccb.html or by dialing (202) 418-0241. The bulletin board also contains other related infrastructure data such as the Automated Reporting and Management Information System (ARMIS) 43-07 reports for the local operating companies, and selected data from a publication entitled *Statistics of Communications Common Carriers*.

The statistical data in this report covers three categories of carriers: interexchange carriers, local operating telephone companies, and competitive access providers. Fiber growth for the interexchange carriers was about 8 percent in 1995. The local operating companies shown in the tables increased their fiber mileage in plant by about 18 percent in 1995 compared to a revised figure of about 20 percent in 1994. There has also been significant expansion in systems of competitive access providers. While the amount of fiber in these systems is small in relation to the fiber deployed by the local operating companies, this continues to be a dynamic sector of the industry -- with fiber growth continuing to exceed 50 percent annually. Other entities such as electric utilities and cable TV companies have also been deploying fiber.

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 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 approximately 25,000 2-way circuits on a single fiber pair and more than triples 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. Sprint's announcement (press release on SONET upgrade dated March 14, 1994) that it was upgrading its fiber capacity without deploying additional fiber is a good example of this practice.

Some of the requested data has been 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 carriers or competitive access providers was requested, which was to include interconnection locations that may not be owned by the interexchange carrier. A number of carriers did not provide this data this year. AT&T provides 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.

Information on sharing of electric utility fiber with interexchange carriers was requested again this year and is also summarized in Table 4. Although it is expected that this report has only identified a portion of the total of this shared capacity, the information provides some indication of the amount of interaction among these entities.

Information on the application of fiber and associated technologies 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 technologies to enhance the capability of existing copper loops was requested. Information on the use of pair gain systems was also requested from local telephone companies along with statistics on local loop length. The data indicates 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, 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 competitive access providers, information on the number of buildings served was requested in addition to the information on the extent of deployed fiber. Information on buildings served was provided by most 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 supplemented with a written description of the survey items that is available to each participating carrier. The data collected is described along with specific data qualifications and explanations in the notes and definitions following the tables.

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 competitive access providers, have also had the opportunity to provide input over the past several years. The Bell operating companies were initially contacted by letter. 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, data may have been excluded from this report where inconsistences were detected or where data items not heretofore requested were not provided by enough of the reporting entities. Several reporting problems were identified in the past, and an attempt has been made to correct these and improve the survey by modifying and augmenting some of the surveyed items, while deleting others. First, both route and cable sheath mileage were requested of interexchange and competitive access providers to insure that carriers with multiple cables in a route make a proper distinction in these data items. Second, the fiber data requested is for owned fiber to minimize the possibility of double counting. Third, information on fiber technology, fiber-to-the-curb systems and fiber terminations was requested of the Bell operating companies. Competitive access providers were asked to supply counts of buildings and customer locations served by fiber. Finally, the interexchange carriers were asked to provide backbone investment data excluding the cost of multiplexing and DS-3 additions.

With continuing merger and acquisition activity as well as joint ventures, capacity sharing arrangements, leases, etc., it is often difficult to ensure that no double counting of capacity has occurred. In recent years, this has been a problem primarily for the competitive access providers. Also of 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 is 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 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 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 are also used in some cases to generate the DS-3 mileages and to provide lit fiber mileages. There is indication, however, that some reporting entities have addressed such problems. For example, Sprint no longer appears to use factors in developing its data, and Williams Telecommunications (now part of LDDS Worldcom) previously adjusted its historical data to account for microwave facilities erroneously included in its data.

Data in the current report reflects adjustments noted in prior reports. These are highlighted in the notes associated with Tables 1-4. These adjustments deal with rounding issues, acquisitions, overlapping routes, and improvements in data acquisition methods. Further detail on adjusted data can be found in prior reports.

Lit fiber data may have other pitfalls as well. In particular, route redundancy and backhauling may mask underlying usage levels. Route 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 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 some instances the data may have been estimated by the carriers. Also, differences in defining project completion dates may result in data distortions affecting calculated growth levels. This may tend to be more of a problem with the competitive access providers, 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 1995, interexchange carriers had deployed fiber networks totalling more than 107,000 route miles. This year, growth in fiber mileage deployed by interexchange carriers was about 8 percent. Total 1995 fiber mileage deployed by the interexchange carriers is estimated at more than 2.7 million miles, as shown in Table 2. Much of the long-haul interexchange fiber utilizes railroad rights-of-way or abandoned pipelines. In other cases the fiber 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 utility 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 36 million DS-3 miles could eventually be provided on the existing fiber using 1.2 Gbit/second terminal and repeater technology. A portion of this reflects facility redundancy for failure restoration. Table 4 summarizes the cost per route mile of fiber backbone, the number of points of presence, and the extent of shared facilities with electric utilities.

Table 1: Route Miles -- Interexchange Carriers *

Calendar Year:	Fiber System Route Miles										
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AT&T	5,677	10,893	18,000	23,324	28,900	32,398	36,871	39,288	39,705	41,664	46,083
Consolidated	310	310	332	332	332	332	332	332	332	519	NA
Frontier (RCI)	580	580	796	413	414	415	417	417	417	414	516
IXC Communications	382	382	803	803	803	914	914	914	1,257	1,357	1,365
LCI	881	950	1,210	1,210	1,210	1,210	1,406	1,406	1,406	1,408	1,408
LDDS Worldcom	3,884	8,886	9,169	10,262	10,888	11,056	11,093	11,093	11,104	11,104	11,127
MCI	3,025	6,752	10,267	12,467	13,839	16,000	16,700	17,040	19,793	21,460	23,160
MRC	NA	NA	670	670	844	844	844	850	850	850	850
Sprint	5,300	11,915	17,476	21,938	22,002	22,093	22,725	22,799	22,996	22,996	22,996
TCG	NA	NA	NA	84	84	84	84	84	84	84	84
Valley Net	NA	NA	NA	NA	520	570	581	581	581	NA	NA
Total Reported:	20,039	40,668	58,723	71,503	79,836	85,916	91,967	94,804	98,526	101,856	107,589

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

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

	Thousands of Fiber Miles											Average Route Cross Section		
Calendar Year:	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1993	1994	1995
AT&T	136.2	261.4	432.0	704.7	838.4	935.7	1,146.9	1,194.5	1,197.5	1,264.0	1,417.6	30.2	30.3	30.8
Consolidated	3.5	3.5	3.7	3.7	3.7	3.7	3.7	3.7	3.7	6.5	NA	11.2	12.5	NA
Frontier (RCI)	7.0	7.0	7.2	2.6	2.7	2.7	2.7	2.7	2.7	2.6	3.3	6.4	6.4	6.4
IXC Commun.	10.0	10.0	14.0	14.0	14.0	14.2	14.2	14.6	20.8	22.2	22.2	16.5	26.0	24.3
LCI	13.7	17.3	22.3	22.3	22.3	22.3	24.7	24.7	24.7	24.7	24.7	17.6	17.6	17.6
LDDS Worldcom	79.0	190.8	203.5	237.9	245.5	254.6	255.9	255.9	256.2	256.2	266.2	23.1	23.1	23.9
MCI	83.9	179.1	259.3	278.8	304.2	388.0	413.7	430.0	450.0	525.0	567.4	22.7	24.5	24.5
MRC	NA	NA	8.0	8.0	10.1	10.1	10.1	10.2	10.2	10.3	10.2	12.0	12.1	12.0
Sprint	122.4	249.3	343.2	449.5	450.8	453.4	466.7	466.7	467.2	467.2	467.2	20.3	20.3	20.3
TCG	NA	NA	NA	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	20.0	20.0	20.0
Valley Net	NA	NA	NA	NA	6.1	6.8	7.2	7.2	7.2	NA	NA	12.4	NA	NA
Total Reported:	455.7	918.4	1,293.3	1,723.3	1,899.5	2,093.2	2,347.5	2,411.8	2,441.9	2,580.5	2,777.3	24.8	25.6	25.8

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

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

	Percent Fiber Miles Lit						Estimated DS-3 Miles					
Calendar Year:	1990	1991	1992	1993	1994	1995	1990	1991	1992	1993	1994	1995
AT&T	49.6%	44.6%	49.5%	50.9%	49.6%	47.3%	3,656,642	4,383,896	5,188,927	5,203,272	5,243,472	5,864,031
Consolidated	53.4%	53.4%	53.4%	57.8%	53.7%	NA	12,672	29,890	31,616	NA	29,702	NA
Frontier (RCI)	56.7%	56.1%	57.0%	57.0%	57.1%	46.0%	10,446	15,535	17,735	4,135	4,326	4,329
IXC Commun.	56.3%	58.3%	65.9%	55.8%	NA	NA	23,766	34,569	38,195	39,227	NA	NA
LCI	60.6%	60.1%	60.1%	60.1%	68.8%	71.1%	43,874	42,081	47,058	69,285	94,485	131,955
LDDS Worldcom	90.0%	90.0%	90.0%	NA	NA	69.0%	NA	NA	NA	NA	NA	NA
MCI	64.3%	NA	NA	NA	NA	NA	1,203,458	NA	NA	NA	* NA	NA
MRC	65.0%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sprint	53.9%	55.1%	55.1%	NA	55.8%	77.2%	NA	1,705,542	1,740,555	NA	NA	1,840,695
TCG	NA	NA	80.0%	80.0%	NA	NA	NA	NA	NA	NA	NA	NA
Valley Net	50.7%	40.0%	40.0%	NA	NA	NA	NA	11,600	NA	NA	NA	NA

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

Table 4: Other 1995 Fiber Data -- Interexchange Carriers *					
	Estimated Backbone Fiber Investment (Millions $)	Estimated Backbone Investment per Route mi. (Thousands $)	Points of Presence	Fiber in Electric Utility Facilities	
				Sheath Miles	Fiber Miles
AT&T	2,800	61	613	1,194	28,656
Consolidated	12	22	9	65	783
Frontier (RCI)	11	22	NA	2	39
IXC Communications	NA	NA	NA	NA	NA
LCI	87	62	41	220	NA
LDDS Worldcom	NA	NA	109	NA	NA
MCI	1,208	56	NA	NA	NA
MRC	NA	NA	15	596	7,157
Sprint	NA	NA	NA	0	0
TCG	NA	NA	NA	NA	NA
Valley Net	NA	NA	NA	NA	NA

* 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. Investment data not provided can be estimated as described in these notes. 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.

AT&T's 11.6% increase in fiber mileage in 1990 included the effect of a downward adjustment of its 1990 fiber mileage and a proportional adjustment to its 1989 fiber mileage to correct for what had been characterized as rounding errors on components making up the total. Data shown in the tables includes domestic fiber only. Sheath mileage for AT&T differed from route mileage and was reported as 38,184 for the end of 1991, 40,071 miles for the end of 1992, 39,818 miles for the end of 1993, 41,664 for the end of 1994, and 46,629 for the end of 1995. AT&T's point-of-presence data is based only on its switched services. AT&T 's investment data has been adjusted from the figure reported last year.

Diginet's facilities were acquired by Teleport Communications Group (TCG in the tables). Leased facilities had previously been removed from Diginet's 1992 data and data prior to 1992 had been adjusted accordingly.

Consolidated Table 4 data shown is for 1994.

The Electra Network in Texas and Mutual Signal Corp. were acquired by Communications Transmission, Inc. (CTI). CTI had identified 52 route miles and 14,653 fiber miles of unspecified fiber in its 1989 data that is not reflected in the tables. The company's name changed to Communications Transmission Group, Inc. and more recently to IXC Communications. The name CTGI used in prior reports has been changed to IXC Communications, Inc., as indicated in the tables. Increases in fiber during 1993 reflect new construction extending from San Antonio, Texas into Mexico.

LCI International was formerly Litel. Last year its DS-3 investment was shown in place of fiber backbone investment in Table 4. This has been corrected and Table 4 now reports gross plant investment. Investment net of depreciation is $66.7 million.

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 merger with Wiltel was completed in 1995. The combined entity is now called LDDS Worldcom.

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

MCI reported 23,160 route miles of owned fiber facilities and 16,350 route miles of digital microwave radio facilities as of the end of 1995. It reported 13,815 route miles of microwave radio facilities as of the end of 1994. MCI also reports an additional 18,130 route miles of leased facilities as of the end of 1995. 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 estimates 6.8 million DS-3 miles for 1994. This data appears to be affected by inconsistencies as to whether DS-3's on MCI's microwave facilities are included, inconsistencies in the way spare facilities are accounted for, or inconsistencies in the reporting of capacity on leased facilities. (The reader may refer to prior fiber deployment reports for further details.) The company has been developing a program to construct an improved system for fiber restoration including the use of multistate fiber rings.

MCI previously reported 2,722 sheath miles and 65,328 fiber miles of facilities built in association with electric utilities as of the end of 1992. These systems typically use ground-wire fiber as described in prior fiber deployment reports. MCI's 1995 fiber mileage data is estimated and investment data shown is for 1994.

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

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

Williams Telecommunications Group has merged with LDDS. The new entity is called LDDS Worldcom and all prior data of the two companies has been combined. Prior historical data for Williams reflected 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 included the effect of prior historical data supplied by those companies. (See prior fiber deployment reports.)

Data covering the percent of fibers lit may be distorted by route redundancy and the method used to report 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 only for fiber backbone systems. Investment per route mile can be calculated from aggregate investment data and route mileage provided. In cases where data is not available, a rough cost estimate for buried facilities can be obtained by multiplying the route mileage by $65,000; however, facilities using ground-wire fiber built in conjunction with electric utilities should cost considerably less. 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.

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. (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.)

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

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

Investment in backbone fiber facilities -- The total investment in fiber cable, deployment, and repeater sites 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.

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

This section summarizes data for local telephone companies. It includes the Bell operating companies, companies affiliated with GTE, the United telephone companies now owned by Sprint, and a limited amount of information on rural carriers. 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 on the rural companies has been unavailable since 1991.

The survey of local companies leading to this report focused on a number of aspects of their fiber and copper infrastructure. This infrastructure can be generally divided into several categories. These are interoffice, interexchange access, feeder, and distribution. A primary purpose of the survey was to track the amount of fiber in various portions of the operating company's plant in relation to the amount of deployed copper.

The total sheath miles, fiber miles, and average cable size of fiber facilities in all these categories is shown in accompanying Tables 5-7. 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. Specific data on loop length and on deployments of feeder fiber in an arrangement called fiber-to-the-pedestal or fiber-to the-curb is shown in Table 8. Except for the information of fiber-to-the-curb, the companies do not provide data that separates feeder and distribution plant; however, most of the fiber deployments to date in the subscriber loop have been concentrated in the feeder plant.

Investment data, both for subscriber plant and for total plant, is shown in Table 9. Also included in this table is information on the amount of lit or activated fiber and the equipped capacities on fiber and copper facilities. Other information on the amount of subscriber fiber and copper deployed to date is shown in Tables 10 and 11. The reader should exercise caution when attempting to compare fiber and copper, since fiber strands inherently have much higher 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. For this reason comparisons of fiber and copper sheath mileage tend to be more meaningful than comparisons of fiber mileage with copper wire mileage.

Tables 12 and 13 highlight a comparison between fiber and copper deployment, both in total plant and in subscriber plant. These tables indicate that fiber constitutes less than 10% of the cable deployed to date. Table 13 also highlights the use of pair gain systems that are used as part of the subscriber or loop plant to increase the number of loops where there are not enough copper pairs available. Typically more than 80% of the copper loops do not use pair gain systems and employ a copper wire pair from the customer to the central office.

As a whole, the cable-based loop plant is significantly more costly to provide on a per-customer basis than interoffice plant. It is most costly on a per-customer basis to provide fiber to individual residential customers. Economies of scale can be more effectively exploited for the large business customers or 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 a function of labor cost that does not tend to decline with capacity increases brought about by new technology, as is the case with long-haul plant.

The above observations help to explain areas of competitive activity, the rapid growth of competitive access providers, and why fiber technology is largely being targeted to large customers whose aggregated circuit requirements often enable test marketing of new goods and services in the economy prior to wider accessibility.[1] It also explains interest in wireless access, enhancements to copper

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[1] 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, the benefits tend to spread to all customers. In the case of telecommunications access through fiber, large business users have also been the first to reap the benefits of the new technology. However, the lack of inherent economies of scale in deployment of fiber to the small subscriber means that unlike manufacturing production cost, labor-intensive deployment cost does not tend to decline over time. Furthermore, competition in this area has driven costs down to the large subscriber, leaving less opportunity for large customers to stimulate development to smaller subscribers.

facilities, and use of hybrid technologies employing more efficient architectures tailored to customer needs as lower cost alternatives. Despite the potential risks associated with construction of cable-based loop plant, there are also significant rewards. For those with a longer term view, efficient development of fiber and broadband loop plant and associated technologies to residential subscribers over time will lead to new and even more significant opportunities in the next century.

It is important to note that a fiber cable occupies considerably less conduit space than a copper cable and that once a decision to deploy fiber has been properly justified, the cable itself may contribute less to the cost of the outside plant than the labor cost associated with deployment. This, coupled with a desire to avoid costly future redeployments and to provide for future wideband digital capabilities, has contributed to placement of larger cables than would be suggested by current demand. Indeed, past deployments of copper cable and the large number of copper pairs currently available in the loop plant were also affected by the costs and lead times needed to deploy the cable. Data on fiber deployments show that most of the fiber deployed to date has been in the interoffice plant. In general, the relatively small number of voice-grade circuits that connect central offices can be provided on a single pair of fibers; however, the above considerations have typically led to deployments of cable containing more than 35-40 fibers, as shown in the tables. It should also be pointed out that aggregate fiber mileage data may not necessarily characterize coverage, since deployment of fiber may be concentrated in certain parts of a service area with little fiber 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 that of subscriber fiber. Nonetheless, all capabilities provided to the customer must be supported by the subscriber loop. For this reason, this report has attempted to separate subscriber facility data from interoffice data.[2] 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

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[2] 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.

West, for example, 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 had originally reported the use of engineering estimates to separate interoffice and subscriber fiber and copper but no longer provides subscriber fiber information. 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.

As new technologies are introduced and existing ones mature, their impact and the interpretation of data presented in this report may change over time. This report has therefore touched on the use of new technology by the operating companies. Thus, information on fiber rings and fiber-to-the-curb systems, as well as HDSL (High-bit-rate Digital Subscriber Loop) and ADSL (Asymmetric Digital Subscriber Loop) technologies for expanding the capability of existing copper pairs 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, pitfalls, and costs of new technologies can be explored prior to large-scale deployment. Trials also provide an experience base in dealing with equipment vendors, and allow the companies to explore various plant architectures and electronic configurations. There were few new fiber trials reported for 1994 and this data was not requested in 1995. The survey indicated, however, that there appear to be important differences among the companies in their present deployments and deployment plans for new technology.

Of particular current interest are technologies complementing and augmenting fiber in the loop that can provide enhancements to and increase the value of embedded copper loop plant. 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. Because HDSL and ADSL technologies enhance the capabilities of existing copper outside plant by using movable equipment rather than deploying new fixed plant, they have the potential to be used in conjunction with hybrid fiber/copper architectures and elsewhere to provide for interim applications at

lower risk, allowing customer demand to develop before committing to more extensive construction of fiber facilities.[3] It appears that this has contributed to research and development in this area, as well as implementation of technical standards.[4]

Although data rates that can ultimately be supported on copper facilities are considerably lower than on fiber, surprising advances have been made in recent years. Digital services supported on copper-based technologies used alone or in conjunction with existing fiber facilities could provide access to creative applications, such as interactive learning software, games, multimedia libraries and the like. Ultimately an intelligent mix of fiber, coaxial cable, advanced copper, and other loop technologies could be tailored to customer needs and 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 deployment rate and mix of transmission technologies that might ultimately be used will largely depend on cost, user demand, available switching technologies, specific applications to be provided and structural issues such as the distance of the subscriber from the central office and proximity to existing fiber facilities.

The companies were asked to provide information this year on their ADSL and HDSL deployments. The responses reveal that most companies do not use ADSL technologies at the present time. Bell Atlantic presently appears to be the most significant user of ADSL; however, several companies have tentative plans to introduce ADSL into their networks. Availability of off-the-shelf equipment should accelerate applications of this technology. Several companies such as BellSouth, Pacific Telesis, US West, Bell Atlantic, and NYNEX use HDSL for providing T1 or other high-capacity digital services. Ameritech reports no present or planned use of either of these technologies and Southwestern Bell (SBC Communications) presently has very limited plans for their use.

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

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

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 more than 400 areas nationwide, local telephone companies are deploying a redundant fiber structure generically known as a "ring," which provides for fiber redundancy by connecting the customer with the central office through either of two diverse paths or by similarly interconnecting central offices to each other. Often fiber redundancy arrangements established by the Bell operating companies differ from the fiber rings of the competitive access providers 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.

Fiber architectures that would reduce the cost and amount of outside plant needed to serve large numbers of residential customers with some form of wide bandwidth service are also important. One such application of a fiber architecture designed to make deployment of wideband capabilities to residences more cost-effective is the use of what is called "fiber-to-the-curb." A fiber-to-the-curb system is a type of hybrid system 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 is typically deployed to an interface point near the customer, which in newer construction sites is often referred to as a "pedestal." These systems provide for sharing of fiber and equipment to convert optical to electrical signals by more than one residence and will probably be the configuration most widely used for providing high-bandwidth services to large numbers of subscribers. Coaxial or other copper wire systems can be used for the relatively short link to the subscriber. A number of systems of this type have undergone trial by local operating companies. They often continue as working systems beyond the trial. NYNEX reports the most significant deployment of fiber-to-the-curb or pedestal with as many as 100,000 subscribers accessible to such systems. US West, Bell Atlantic, and BellSouth also have deployments, but the number of customers accessible to such systems is relatively small. Ameritech and Southwestern Bell report no present use of this configuration.[5]

Fiber technology trials have primarily been used to test various fiber-to-residence arrangements and architectures, including systems with limited switched video capability. Other types of fiber technology trials have also been conducted. Over the past few years, for example, BellSouth has reported trials of its interoffice synchronous optical network (SONET) as well as SONET 150

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[5] *See* "Design Issues for Interactive Television Systems," Computer (IEEE Computer Society Magazine), pp. 30-31, (Borko Furht, *et al.*).

megabit loop trials. BellSouth, NYNEX, and GTE have also reported trials and research projects involving medical imaging applications. A number of carriers have reported trials involving subscriber systems. In particular, Pacific Telesis reported trials of 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 trials involving bandwidth sharing and voice and video integration capability involving off-the-shelf systems with future broadband upgrading capability.

Although no new trial data was requested this year, evaluation of prior data appears to suggest that per-fiber deployment costs of most systems that have undergone trials range from about $2,000 to an amount in excess of $6,000 per fiber. In past years the cost per fiber of a significant number of the trial systems had fallen in the upper end of the above range. More recent trial investment data has tended to fall in the lower end of the above range. Aside from the fiber trials and fiber redundancy arrangements alluded to above, there presently appears to be relatively little distribution fiber in place, and it is unclear how much of the existing loop fiber deployed to date is actually in current use. Nonetheless, the operating companies are continuing to deploy new fiber to modernize their plant and at the same time bring fiber closer to the customer. The effective management of rapidly developing fiber-based 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

	Sheath Miles										
Company	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Ameritech	3,200	5,200	6,700	8,700	10,800	12,100	15,200	18,300	21,500	23,800	26,400
Bell Atlantic	1,240	4,374	6,730	9,239	11,943	14,950	19,170	21,850	27,820	32,321	35,685
BellSouth	3,830	8,694	11,727	15,643	19,781	24,181	29,677	35,228	40,460	45,590	50,960
NYNEX	1,606	3,209	4,956	7,413	9,221	11,905	14,680	17,708	20,514	23,065	25,477
Pacific Telesis	2,318	2,779	2,964	3,480	3,767	5,139	6,564	8,334	9,820	10,935	12,191
Southwestern	1,913	4,374	5,970	7,349	9,100	11,700	15,046	17,724	22,079	25,427	29,534
US West	3,527	5,017	6,937	10,030	13,425	17,596	22,152	27,401	31,301	34,728	38,490
Regional Bell Total:	17,634	33,647	45,984	61,854	78,037	97,571	122,489	146,545	173,494	195,866	218,737
GTE Companies				10,099	20,855	28,634	31,620	34,009	39,766	45,382	41,789
Sprint Companies				2,907	5,002	5,877	7,443	12,663	14,510	16,396	19,895
Rural Companies		500	2,584	4,651	6,369	8,689	NA	NA	NA	NA	NA
Total Reported:	17,634	34,147	48,568	79,511	110,263	140,771	161,552	193,217	227,770	257,644	280,421

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

Table 6: Fiber Deployment by Local Operating Companies

	FiberMiles									
Company	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Ameritech	111,100	147,100	177,500	228,400	285,500	400,700	585,600	802,100	918,900	1,095,900
Bell Atlantic	150,847	227,507	311,022	373,398	522,970	809,740	1,026,640	1,568,680	1,919,402	2,169,188
BellSouth	170,092	218,489	319,248	445,452	609,201	768,597	938,704	1,120,974	1,380,927	1,684,992
NYNEX	129,743	207,077	290,600	357,766	473,274	636,954	806,658	964,383	1,112,023	1,264,710
Pacific Telesis	97,800	101,090	110,273	126,944	185,212	246,418	311,668	374,919	424,213	481,515
Southwestern	151,043	182,911	214,948	270,300	352,300	477,654	576,447	775,040	970,789	1,234,790
US West	70,082	107,782	163,968	234,851	351,571	542,309	797,593	1,042,547	1,238,761	1,483,318
Bell Totals:	880,707	1,191,956	1,587,559	2,037,111	2,780,028	3,882,372	5,043,310	6,648,643	7,965,015	9,414,413
GTE Companies			134,677	163,396	317,494	390,549	513,727	672,434	795,238	930,402
Sprint			32,287	54,569	83,540	115,590	180,941	224,462	294,867	369,996
Rural Companies	2,000	14,236	28,705	42,260	68,237	NA	NA	NA	NA	NA
Total Reported:	882,707	1,206,192	1,783,228	2,297,336	3,249,299	4,388,511	5,737,978	7,545,539	9,055,120	10,714,811

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

Table 7: Average Fiber Cable Cross Section *

Company	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Ameritech	24.3	21.4	22.0	20.4	21.1	23.6	26.4	32.0	37.3	38.6	41.5
Bell Atlantic	67.0	34.5	33.8	33.7	31.3	35.0	42.2	47.0	56.4	59.4	60.8
BellSouth	13.3	19.6	18.6	20.4	22.5	25.2	25.9	26.6	27.7	30.3	33.1
NYNEX	51.9	40.4	41.8	39.2	38.8	39.8	43.4	45.6	47.0	48.2	49.6
Pacific Telesis	36.4	35.2	34.1	31.7	33.7	36.0	37.5	37.4	38.2	38.8	39.5
Southwestern	36.8	34.5	30.6	29.2	29.7	30.1	31.7	32.5	35.1	38.2	41.8
US West	13.4	14.0	15.5	16.3	17.5	20.0	24.5	29.1	33.3	35.7	38.5
Bell Companies -- Avg.	28.2	26.2	25.9	25.7	26.1	28.5	31.7	34.4	38.3	40.7	43.0
GTE Companies				13.3	7.8	11.1	12.4	15.1	16.9	17.5	22.3
Sprint Companies				11.1	10.9	14.2	15.5	14.3	15.5	18.0	18.6
Rural Companies		4.0	5.5	6.2	6.6	7.9	NA	NA	NA	NA	NA
All Companies -- Avg.	28.2	25.9	24.8	22.4	20.8	23.1	27.2	29.7	33.1	35.1	38.2

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

Table 8:
Data on Fiber to the Pedestal of Local Operating Companies -- 1995

	Number of Pedestal * Locations	Fiber Miles Serving Pedestals *	Customers Accessible to Pedestal	Local Loop Length (miles)		
				Average	Median	Maximum
Ameritech	0	0	0	1.4	NA	NA
Bell Atlantic	735	NA	4,425	2.3	2.9	9.6
BellSouth	734	NA	763	3.4	NA	NA
NYNEX	6,000	NA	100,000	2.3	NA	10.2
Pacific Telesis	80	159	310	3.0	3.6	16.3
Southwestern	0	0	0	2.7	NA	24.6
US West	590	4,412	3,510	2.8	NA	NA
Total Reported:	8,139	4,571	109,008			

See accompanying notes to the tables and discussion in text.

* The term "pedestal" used above includes curb locations.

Table 9: Other 1995 Fiber Data for Local Operating Companies

				Aggregate Fiber Investment (Million $)	
	Percent Lit	DS-3 Miles on Fiber	T1 Miles on Copper	Sub-scriber	Total
Ameritech	*18.6%*	*501,300*	*230,600*	*NA*	*830.6*
Bell Atlantic	*39.2%*	*255,164*	*3,692,076*	*NA*	*1,154.0*
BellSouth	*21.9%*	*511,763*	*89,814*	*NA*	*1,502.8*
NYNEX	*37.9%*	*NA*	*NA*	*601.2*	*1,170.9*
Pacific Telesis	*27.3%*	*165,500*	*1,035,278*	*191.2*	*457.3*
Southwestern	*18.8%*	*362,693*	*470,473*	*595.1*	*921.3*
US West	*22.5%*	*NA*	*731,204*	*484.6*	*933.1*
GTE Companies	*50.3%*	*NA*	*NA*	*NA*	*981.6*
Sprint Companies	*44.2%*	*NA*	*NA*	*NA*	*373.4*

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

Table 10 -- Fiber Subscriber Plant of Bell Operating Companies

	Sheath Miles						Fiber Miles					
	1990	1991	1992	1993	1994	1995	1990	1991	1992	1993	1994	1995
Ameritech	3,300	3,700	4,300	NA	NA	NA	84,600	153,000	234,400	NA	NA	NA
Bell Atlantic	6,543	NA	NA	NA	NA	NA	226,008	NA	NA	NA	NA	NA
BellSouth	NA	NA	NA	NA	NA	NA	355,163	440,432	NA	NA	NA	NA
NYNEX	3,995	5,388	7,095	8,976	10,398	12,799	135,876	209,716	301,989	404,022	510,758	615,543
Pacific Telesis	1,451	2,210	2,874	3,426	3,938	4,636	64,107	96,914	120,905	139,742	160,224	189,016
Southwestern	2,800	4,498	5,409	8,008	9,866	16,479	135,600	185,283	221,846	365,360	514,580	878,169
US West	4,714	6,595	8,706	10,879	13,047	16,340	113,795	295,194	452,568	618,208	761,925	968,561

* 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					
	1990	1991	1992	1993	1994	1995	1990	1991	1992	1993	1994	1995
Ameritech	244.4	242.7	243.5	NA	NA	NA	141,930	142,358	143,166	NA	NA	NA
Bell Atlantic	291.3	288.9	NA	NA	NA	NA	194,426	194,378	NA	NA	NA	NA
BellSouth	566.1	570.4	NA	NA	NA	NA	243,458	243,641	NA	NA	NA	NA
NYNEX	232.7	232.9	233.2	233.9	234.5	235.5	137,882	139,976	141,616	143,200	144,294	145,172
Pac. Telesis	184.1	185.2	192.7	207.9	187.9	189.0	134,312	136,319	140,557	158,088	156,357	141,379
Southwestern	343.3	345.1	347.4	350.1	354.4	357.4	159,300	160,078	160,913	162,288	169,454	170,289
US West	395.8	401.7	407.9	413.2	403.0	408.4	158,737	161,144	163,563	165,738	169,454	170,241
Total Reported:	2,257.7	2,266.8	NA	NA	NA	NA	1,170,045	1,177,893	NA	NA	NA	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 1995 *

Company Name	Access Lines (thousands)**	Total Plant: Strand Miles (thousands) Copper	Total Plant: Strand Miles (thousands) Fiber	Total Plant: Sheath Miles Copper	Total Plant: Sheath Miles Fiber	Per Thousand Access Lines: Miles Copper Wire	Per Thousand Access Lines: Miles Fiber Strand	Per Thousand Access Lines: Miles Copper Cable	Per Thousand Access Lines: Miles Fiber Cable	Per Thousand Access Lines: Percent Fiber Cable
Ameritech	21,890	191,464	1,096	322,900	26,400	8,747	50.1	14.8	1.2	7.6%
Bell Atlantic	20,705	190,427	2,169	286,320	35,685	9,197	104.8	13.8	1.7	11.1%
BellSouth	22,595	246,949	1,685	582,630	50,960	10,929	74.6	25.8	2.3	8.0%
NYNEX	18,032	162,434	1,265	256,028	25,477	9,008	70.1	14.2	1.4	9.1%
Pacific Telesis	18,782	156,630	482	202,402	12,191	8,339	25.6	10.8	0.6	5.7%
Southwestern	16,343	172,846	1,235	380,793	29,534	10,576	75.6	23.3	1.8	7.2%
US West	17,672	172,953	1,483	428,358	38,490	9,787	83.9	24.2	2.2	8.2%
Total reported:	136,020	1,293,703	9,414	2,459,431	218,737	9,511	69.2	18.1	1.6	8.2%

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

** From ARMIS 43-08 data.

Table 13: Fiber and Copper in Subscriber Plant in Relation to Access Lines -- End of Year 1995 *

	Access Lines (000) **		Subscriber Plant: Strand Miles (000)		Subscriber Plant: Cable Sheath Miles		Per Thousand Access Lines: Miles Copper Wire	Per Thousand Access Lines: Miles Fiber Strand	Per Thousand Access Lines: Miles Copper Cable	Per Thousand Access Lines: Miles Fiber Cable	Per Thousand Access Lines: % Fiber Sheath Miles
	Total	% Without Pair Gain	Copper	Fiber	Copper	Fiber					
Ameritech	21,890	81%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bell Atlantic	20,705	85%	NA	NA	NA	NA	NA	NA	NA	NA	NA
BellSouth	22,595	72%	NA	NA	NA	NA	NA	NA	NA	NA	NA
NYNEX	18,032	89%	145,172	616	235,510	12,799	8,051	34.1	13.1	0.71	5.2%
Pacific Telesis	18,782	88%	141,379	189	189,016	4,636	7,527	10.1	10.1	0.25	2.4%
Southwestern	16,343	80%	170,289	878	357,398	16,479	10,419	53.7	21.9	1.01	4.4%
US West	17,672	NA	170,241	969	408,378	16,340	9,633	54.8	23.1	0.92	3.8%
Total reported:	136,020	82%	627,080	2,651	1,190,302	50,254	8,853	37.4	16.8	0.7	4.1%

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

** From ARMIS 43-08 data.

Notes to Tables 5-13: *(NA indicates data was not available.)*

In some instances, carriers estimate certain data, such as end-of-year data received prior to the end of the year. Accuracy also varies depending on the carrier's method of collecting and assembling its data. Historical data may reflect adjustments made this year. The reader may refer to prior reports for previously reported data. Ameritech, Bell Atlantic, and BellSouth data on recent subscriber copper are not available.

Ameritech's subscriber data is based on engineering judgment. Ameritech adjusted its 1994 fiber investment data previously reported to $749.1 million. It also adjusted its 1994 data for total copper sheath miles to 324,500.

BellSouth subscriber fiber mileage for 1989, 1990, and 1991, as shown in Table 10, was estimated as 60% of the total fiber mileage based upon data provided by the company for 1987 and 1988. Other companies separating subscriber and interoffice fiber on average show about 35% of the total fiber sheath mileage as subscriber and about 92% of the copper wire as subscriber. Fiber investment of BellSouth does not include electronics at terminal or repeater sites. BellSouth data for 1990 fiber mileage reflects an earlier correction.

Data in the tables reflects the fact that prior to 1989 Southwestern Bell (now known as SBC Communications) used interexchange and toll rather than interoffice and loop subcategories. (The name Southwestern is used in the tables.) Southwestern Bell's nonfinancial data for 1989 to the present properly reflects loop and interoffice subcategories which were originally requested; however, investment data under the subscriber heading for 1995 actually represents exchange facilities, which also includes some interoffice plant. Investment data for 1994 has been adjusted from the previously reported value to $804.4 million. Copper subscriber mileage for 1994 has been revised from the previously reported value. The company confirms a inconsistency in DS-3 mileage for 1994 and 1995 data and attributed the problem to manual data collection processes.

United companies are now owned by Sprint. Data for Sprint also includes data for the Centel companies, which were acquired by Sprint in 1993.

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 1995 calendar year as reported in the Preliminary Statistics of Communication Common Carriers -1995/96 .

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

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

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

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

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

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

Access lines without pair gain -- The number of subscriber access lines in which the connection between the customer and the central office is a dedicated copper pair or fiber facility.

DS-3 miles on fiber -- Miles of DS-3 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.

Competitive Access Providers

This report has also included data on a number of entities deploying fiber in metropolitan or urban areas. They are referred to as competitive access providers (CAPs) in this report. Although several of these firms are now seeking to become local exchange carriers, the focus of this report remains on their deployment and operation of fiber networks. Data for these entities is summarized in Tables 14 and 15. This rapidly growing group of entities provides access to large business customers using a ring or loop of fiber through areas of high business concentration and attempts to offer customers very reliable service with competitive service and maintenance intervals. Interexchange carriers and financial institutions comprise a significant portion of their customer base. The tables list the key companies known to be involved in such systems. It is not intended to be an all-inclusive list and has changed dramatically 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 by the end of the year. The rapid change in this business and numerous acquisitions have made reliable data collection difficult. An attempt to document some of the key changes has been made in the attachments to the tables. Further discussion of these companies is contained in earlier reports.

The key targets of the competitive access providers 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. Both shared and dedicated fiber configurations have been used, and customers are often interexchange carriers. Fiber rings are used to provide a simple inherent route redundancy arrangement since traffic can reach the hub in either direction around the loop. Operations in a single city, with service to at least 20 buildings, initially involved a $2 million to $10 million investment.

Competitive access providers initially faced significant barriers to market entry because they had to negotiate separately with each building owner, as well as obtain municipal franchises and other permits and meet state legal and regulatory requirements. Despite the obstacles, a number of CAPs have successfully established themselves. Continued consolidation is occurring. Due to the large number of locations of these systems operated by the two largest

entities and differing interpretations of what constitutes a city or distinguishes a town from a larger metropolitan area, this report only highlights the larger or more widely known cities and provides the count of system locations in each state provided by the carrier.

The companies typically have offered non-switched services initially, and although they provide end-user to end-user links, much of their business is either for use by customers to access a long distance carrier or for use by interexchange carriers to establish or interconnect points of presence in a metropolitan area. One of the larger CAPs established the first 100 megabit per second network over its facilities and is deploying equipment based on SONET standards. Standards, availability of equipment, and customer requirements should facilitate further development of such networks.

As the competitive access providers expand to more cities and attract more customers, they selectively impact the growth of demand of the local exchange carriers. CAPs, however, can only serve those customers they can access. Their customers may, therefore, still be dependent on the local telephone companies. This has led to collocation arrangements between local operating companies and CAPs that may indirectly contribute to demand on local operating company facilities from customer locations that cannot directly access a competitive access system. CAPs appear to have motivated local exchange carriers 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 the competitive systems exist.

There has also been increasing acquisition activity with the larger CAPs purchasing or showing an interest in purchasing a number of smaller CAPs. Some of the interest in CAPs is evident from cable TV companies, which are also using fiber in their CATV systems. Shared use between cable TV and competitive access fiber systems has been noted, and the entities were asked in the survey associated with this report to separate cable TV facilities from the competitive access facilities covered in this report. These entities typically did not provide information on systems involved in such sharing arrangements. The potential for merger and acquisition activity has mitigated to some extent the risk to small startup ventures.

Table 14:

Competitive Access Fiber Systems *

Company Name	Route Miles						Fiber Miles					
	1990	1991	1992	1993	1994	1995	1990	1991	1992	1993	1994	1995
Brooks Fiber Properties	109	141	193	264	264	480	2,631	3,823	4,252	6,188	18,024	24,300
Eastern Telelogic	140	140	140	194	233	395	3,666	3,666	3,666	4,351	4,374	13,771
Electric Lightwave		6	104	126	225	764		451	6,820	11,686	20,469	117,219
IntelCom Group		105	132	151	424	637		4,800	6,500	8,580	19,049	28,779
Intermedia Commun. (ICI)	159	165	213	335	372	561	2,862	3,000	5,200	10,239	11,289	20,541
Kansas City Fiber Net	91	94	97	200	200	200	2,534	2,624	2,887	NA	3,666	3,773
MCImetro						2,338						NA
MFS	309	546	1,133	1,530	2,387	3,112	17,219	29,806	41,351	67,020	106,931	187,979
MWR Telecom (Iowa Res.)	65	75	95	121	116	NA	1,600	1,805	3,701	5,002	3,047	NA
Phoenix FiberLink, Inc.						32						3,072
Teleport Communications Grp.	328	507	854	2,082	3,902	5,428	18,531	24,729	39,998	96,060	167,314	253,285
Time Warner Communications	59	86	88	96	348	3,312	469	1,178	1,202	1,400	10,442	107,921
US Signal	67	115	144	367	554	NA	5,628	6,280	7,348	20,178	31,572	NA
Total Reported:	1,326	1,980	3,193	5,466	9,025	17,259	55,140	82,162	122,925	230,704	396,177	760,640

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

Table 15:

Competitive Access Fiber Systems -- Other 1995 Data *

Company Name	Sheath Miles	Average Fiber Count	Investment Millions $	Buildings Served	States Served
Brooks Fiber Properties	480	68.3	NA	500	7
Eastern Telelogic	471	34.9	27.5	330	3
Electric Lightwave	872	91.0	101.6	218	6
IntelCom Group	NA	45.2	74.3	1,539	8
Intermedia Communications (ICI)	504	36.6	27.9	389	3
Kansas City Fiber Net	200	18.9	NA	68	1
MCImetro	NA	NA	498.0	NA	19
MFS	3,412	60.4	NA	5,379	23
MWR Telecom (Iowa Resources)	NA	NA	NA	NA	1
Phoenix FiberLink, Inc.	32	96.0	NA	NA	1
Teleport Communications Group	4,132	46.7	NA	2,266	19
Time Warner Communications	3,312	NA	NA	NA	10
US Signal	NA	NA	NA	NA	4

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

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

Statistics shown are for backbone system and should reflect owned facilities. Due to numerous mergers and acquisitions, it has been difficult to properly adjust prior data. In most cases data for merged entities has been combined retroactively; however, some discrepancies from earlier totals have resulted from partial acquisitions and from common facilities of merged entities.

Some competitive access providers 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 competitive access system. Ownership of many of these entities is complex. In some cases parent companies have partial and overlapping ownership interests in multiple entities.

Bay Area Teleport, which has been acquired by IntelCom Group, had previously indicated that it operated 58.9 route miles and 78 sheath miles of leased facilities that are not shown in the tables.

Brooks Fiber Properties previously acquired Phoenix Fiberlink and PSO MetroLink. Facilities for these entities have been merged retroactively into the Brooks Fiber entry in the tables. Brooks Fiber has acquired a portion of Fibernet USA facilities in Cincinnati, Huntsville, Raleigh-Durham, and St. Louis which are included in the Brooks total shown. Partial acquisition of US Signal facilities in Lansing, Ann Arbor, and Grand Rapids, Michigan and Toledo, Ohio, was completed in early 1996 by Brooks Fiber Properties. Data for these facilities in 1995 was not available separately and is therefore incorporated in the Brooks Fiber total. Prior to 1995, total US Signal data are shown separately.

Digital Direct facilities in Chicago, Dallas, Seattle and Pittsburgh have been acquired by Teleport Communications Group.

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

During 1993, new facilities were being constructed by Fibernet in Cincinnati, and other facilities were completed in Buffalo and Albany. The purchase of the 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. This data has been merged into the Brooks Fiber entry.

Intermedia Communications of Florida, Inc., listed in the tables as Intermedia Communications, has revised historical route and fiber mile data which had not been reported cumulatively. Intermedia has reported the acquisition completed in early 1995 of Fibernet USA facilities in Cincinnati and additional Fibernet USA facilities that were being constructed in Huntsville, Raleigh-Durham and St. Louis. Fibernet USA data has been merged with the Intermedia data shown in the tables.

Jones Lightwave did not provide data for last year's report and has since been acquired by MFS. Its data has been combined retroactively with that of MFS.

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

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

MFS Communications Company, Inc., referred to as MFS in the tables, 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 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, 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 was adjusted retroactively. MFS acquired Virginia Metrotel in January 1995.

MWR Telecom was listed as IOR Telecom in prior reports. MWR partnered with MFS in St. Louis, Missouri to form MFS-St. Louis and maintains minority ownership. MWR data for 1994 does not include the St. Louis operation.

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

Phoenix Fiberlink and PSO Metrolink were acquired in 1994 by Brooks Fiber Communications (Brooks Fiber Properties). Brooks also acquired 6 route miles of FiveCom's system in Springfield, Mass., whose facilities were not previously listed in this report. The company was initially funded in November 1993 with $41 million of equity capital. The statistics for Phoenix Fiberlink and PSO have been merged with minor adjustment into the Brooks Fiber entry. Subsequently, new facilities under the name Phoenix Fiberlink were constructed in Salt Lake City, Utah and are listed as a separate entry in the accompanying tables.

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

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

During 1993, Teleport Denver initiated construction of new facilities in Colorado Springs and Phoenix, Arizona, and the name of the company was changed to IntelCom Group. In addition, facilities of Ohio Lynx were acquired in Dayton and Cleveland, Ohio, as well as facilities of Privacom in Charlotte, North Carolina and Nashville, Tennessee. Bay Area Teleport facilities in California have also been acquired. All acquired facilities, including those of Ohio Lynx and Bay Area Teleport, have been retroactively included in the IntelCom total.

The Time Warner Communications entry in the tables includes facilities of Indiana Digital Access and Metro Com that were listed in prior deployment reports, as well as other facilities not previously reported. It 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 it also has an interest, is shown separately.

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

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

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

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

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 - 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.

Selected Cities Served by Competitive Access Providers or CAPs

Bay Area Teleport (acquired by IntelCom Group)

Brooks Fiber (Locations shown were operational in 1995 and reflect facilities acquired from Phoenix Fiberlink and PSO Metrolink, Fibernet USA, and US Signal.)
Arkansas: Little Rock
California: Sacramento, San Jose, Santa Clara, Sunnyvale
Connecticut: Hartford
Massachusetts: Springfield
Michigan: Grand Rapids
Oklahoma: Oklahoma City, Tulsa
Rhode Island: Providence

Digital Direct (facilities acquired by TCG)

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

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

Fibernet USA (acquired by Intermedia Communications in February 1995)

Indiana Digital Access (acquired by Time Warner Communications)

IntelCom Group (formerly Teleport Denver)
Arizona: Phoenix
California: Los Angeles, San Francisco metro areas
Colorado: Denver, Colorado Springs, Boulder
Florida: Melbourne

Kentucky: Louisville
North Carolina: Charlotte
Ohio: Cleveland, Dayton, Akron, Columbus
Tennessee: Nashville

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

Jones Lightwave (acquired by MFS)

Kansas City Fiber Net (acquired by Time Warner Communications)

Linkatel Communications, Inc. (no data)

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

Metrex Corp. of Alabama (no data)

Metro Com (acquired by Time Warner Communications)

Metropolitan Fiber Systems (MFS)
(Selected major metro areas are shown along with number of reported areas within the metro areas listed.)
Arizona (2): Phoenix
California (20): San Francisco, San Jose, San Diego, Oakland, Los Angeles
Colorado (2): Denver
Connecticut (2): Hartford, Stamford
Delaware (1): Wilmington
Florida (3): Tampa, Orlando
Georgia (5): Atlanta
Illinois (4): Chicago
Indiana (1): Indianapolis
Maryland (3): Baltimore
Massachusetts (4): Boston
Michigan (5): Detroit
Minnesota (1): Minneapolis
Missouri (3): St. Louis
New Jersey (4): Newark, Jersey City, Morristown, Parsippany
New York (9): New York City (and surrounding areas), Albany, Buffalo, Rochester, White Plains
Ohio (1): Cleveland
Oregon (1): Portland
Pennsylvania (3): Philadelphia, Pittsburgh
Texas (6): Dallas, Houston
Virginia (1): Richmond
Washington (1): Seattle
Washington, D. C. (13): District of Columbia (and surrounding Virginia suburbs)

MWR Telecom (formerly IOR Telecom)
Iowa: Council Bluffs, Des Moines, Carroll
Missouri: St. Louis

Penn Access (acquired by TCG)

Phoenix Fiberlink (California facilities acquired by Brooks Fiber Properties)
Utah: Salt Lake City

PSO Metro Link (acquired by Brooks Fiber Properties)

Teleport Communications Group (TCG) (acquired portion of US Signal)
(total number of reported areas served with selected major metro areas shown)
Arizona (8): Phoenix, Tempe, Scottsdale
California (34): Los Angeles, San Diego, San Francisco, Oakland, San Jose
Colorado (2): Boulder, Denver
Connecticut (30): Hartford
Florida (5): Ft. Lauderdale, Miami, West Palm Beach
Illinois (65): Chicago, Gary
Indiana (3): Indianapolis
Maryland (3): Baltimore
Massachusetts (25): Boston, Brockton, Attleboro, Lawrence
Michigan (13): Detroit
Missouri (13): St. Louis
Nebraska (1): Omaha
New Jersey (20): Princeton, Newark
New York (28): New York City, Nassau County, Suffolk County
Pennsylvania (33): Pittsburgh
Rhode Island (3): Providence
Texas (8): Dallas, Houston, Fort Worth, Plano, Irving, Richardson
Washington (20): Seattle, Bellevue, Tacoma, Everett
Wisconsin (15): Milwaukee, Waukesha

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

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