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May 13, 1994

FCC RELEASES FIBER DEPLOYMENT ANALYSIS

The FCC has released a report entitled "Fiber Deployment Update - End of Year 1993."

This report presents fiber deployment data and associated information on interexchange carriers, regional Bell holding companies, urban fiber systems, and non-Bell local operating companies.

Current estimates indicate that interexchange carriers increased their deployed fiber by about 5.6% during 1993. The local Bell operating companies' deployed fiber grew by about 27% during 1993 and stood at approximately 6.3 million fiber miles at the end of the year. Total 1993 fiber reported by local operating companies exceeded 7.2 million fiber miles. Twenty urban fiber entities listed in this year's study have deployed about 242,000 fiber miles by the end of 1993.

Other local operating company data in the study include data on fiber rings, fiber trials and investment, 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's Industry Analysis Division at 1250 23rd Street, N. W., Plaza Level. Copies may be purchased by calling International Transcription Service, Inc. (ITS) at (202) 857-3800.

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FIBER DEPLOYMENT UPDATE

End of Year 1993

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Industry Analysis Division - Common Carrier Bureau

Federal Communications Commission

May 1994

FIBER DEPLOYMENT UPDATE

End of Year 1993

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 earlier reports. This information is contained in the report that was released March 20, 1992. That report, along with this update, are available on the FCC-State Link 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. 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." These reports are also available by calling International Transcription Service, Inc. (ITS) at (202) 857-3800.

The statistical data in this report 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 2.7 percent during 1992 and 5.6 percent during 1993. The local operating companies have increased their fiber in plant by about 27 percent in 1993 compared to about

31 percent the prior 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.

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 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. Sprint's recent 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.

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 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 technology in several areas was included in the survey of the local operating companies. First, information on fiber-to-the-curb trials allowing residential fiber to be shared to the pedestal or drop wire by several residences was requested along with information on other fiber technology trials including, but not limited to fiber-to-the-home trials. Second, 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. Information on buildings or 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 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 urban fiber carriers have also provided input over the past several years. 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 fiber data requested is for owned fiber to minimize the possibility of double counting. 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 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 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 addressed by some of the reporting entities. For example, Sprint no longer appears to use factors in developing its data and Williams Telecommunications had previously adjusted its historical data to account for microwave facilities that had been 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 details 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. Most likely such route

redundancy would tend to increase the 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 some instances the data may have been estimated by the carriers. Also, differences in defining project completion dates may have resulted in data distortions affecting calculated growth levels. 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 1993, interexchange carriers had deployed fiber networks totalling about 99,363 route miles. This year, growth in fiber mileage deployed by interexchange carriers was about 5.6 percent, up from last year's growth of about 2.7 percent. Total 1993 fiber mileage deployed by the interexchange carriers is presently estimated at approximately 2.5 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 36 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 10 and 12 million DS-3 miles or roughly a third of the available capacity associated with 1.2 gigabit technology, as determined from Tables 2 and 3. A portion of this reflects facility redundancy for failure restoration. Table 4 summarizes the cost per route mile of fiber backbone and the extent of shared facilities with electric utilities and the number of points of presence.

Table 1: Route Miles – Interexchange Carriers *

| Calendar Year: | Fiber System Route-Miles | | | | | | | | |
|------------------------|--------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| AT&T | 5,677 | 10,893 | 18,000 | 23,324 | 28,900 | 32,398 | 36,871 | 39,288 | 39,705 |
| Consolidated | 310 | 310 | 332 | 332 | 332 | 332 | 332 | 332 | 332 |
| CTGI | 382 | 382 | 803 | 803 | 803 | 914 | 914 | 914 | 1,257 |
| LCI | 881 | 950 | 1,210 | 1,210 | 1,210 | 1,210 | 1,406 | 1,406 | 1,406 |
| LDDS | 800 | 950 | 967 | 1,127 | 1,163 | 1,163 | 1,163 | 1,163 | 1,163 |
| MCI | 3,025 | 6,752 | 10,267 | 12,467 | 13,839 | 16,000 | 16,700 | 17,040 | 20,630 |
| MRC | NA | NA | 670 | 670 | 844 | 844 | 844 | 850 | 850 |
| RCI | 580 | 580 | 796 | 413 | 414 | 415 | 417 | 417 | 417 |
| Sprint | 5,300 | 11,915 | 17,476 | 21,938 | 22,002 | 22,093 | 22,725 | 22,799 | 22,996 |
| TCG | NA | NA | NA | 84 | 84 | 84 | 84 | 84 | 84 |
| Valley Net | NA | NA | NA | NA | 520 | 570 | 581 | 581 | 581 |
| Williams | 3,084 | 7,936 | 8,202 | 9,135 | 9,725 | 9,893 | 9,930 | 9,930 | 9,941 |
| Total Reported: | 20,039 | 40,668 | 58,723 | 71,503 | 79,836 | 85,916 | 91,967 | 94,804 | 99,363 |

* 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 | 1993 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| AT&T | 136.2 | 261.4 | 432.0 | 704.7 | 838.4 | 935.7 | 1,146.9 | 1,194.5 | 1,197.5 | 30.2 | 29.0 | 28.9 | 31.1 | 30.4 | 30.2 |
| Consolidated | 3.5 | 3.5 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 |
| CTGI | 10.0 | 10.0 | 14.0 | 14.0 | 14.0 | 14.2 | 14.2 | 14.6 | 20.8 | 17.4 | 17.4 | 15.5 | 15.5 | 16.0 | 16.5 |
| LCI | 13.7 | 17.3 | 22.3 | 22.3 | 22.3 | 22.3 | 24.7 | 24.7 | 24.7 | 18.4 | 18.4 | 18.4 | 17.6 | 17.6 | 17.6 |
| LDDS | 8.0 | 9.5 | 9.7 | 17.2 | 18.1 | 18.3 | 18.3 | 18.3 | 18.3 | 15.2 | 15.6 | 15.7 | 15.7 | 15.7 | 15.7 |
| MCI | 83.9 | 179.1 | 259.3 | 278.8 | 304.2 | 388.0 | 413.7 | 430.0 | 555.5 | 22.4 | 22.0 | 24.3 | 24.8 | 25.2 | 26.9 |
| MRC | NA | NA | 8.0 | 8.0 | 10.1 | 10.1 | 10.1 | 10.2 | 10.2 | 12.0 | 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 | 2.7 | 6.3 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 |
| Sprint | 122.4 | 249.3 | 343.2 | 449.5 | 450.8 | 453.4 | 466.7 | 466.7 | 467.2 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.3 |
| TCG | NA | NA | NA | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Valley Net | NA | NA | NA | NA | 6.1 | 6.8 | 7.2 | 7.2 | 7.2 | NA | 11.8 | 12.0 | 12.4 | 12.4 | 12.4 |
| Williams | 71.0 | 181.3 | 193.8 | 220.8 | 227.3 | 236.3 | 237.6 | 237.6 | 237.9 | 24.2 | 23.4 | 23.9 | 23.9 | 23.9 | 23.9 |
| Total Reported: | 455.7 | 918.4 | 1,293.3 | 1,723.3 | 1,899.5 | 2,093.2 | 2,347.5 | 2,411.8 | 2,547.5 | 24.1 | 23.8 | 24.4 | 25.5 | 25.4 | 25.6 |

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

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

| Calendar Year: | Percent Fiber Miles Lit | | | | | | Estimated DS-3 Miles | | | | | |
|----------------|-------------------------|-------|-------|-------|-------|-------|----------------------|-----------|-----------|-----------|-----------|-----------|
| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| AT&T | 41.6% | 45.5% | 49.6% | 44.6% | 49.5% | 50.9% | 1,294,129 | 3,024,902 | 3,656,642 | 4,383,896 | 5,188,927 | 5,203,272 |
| Consolidated | 33.0% | 50.0% | 53.4% | 53.4% | 53.4% | 57.8% | 4,224 | 7,026 | 12,672 | 29,890 | 31,616 | 8,379 |
| CTGI | 67.8% | 55.1% | 56.3% | 58.3% | 65.9% | 55.8% | NA | NA | 23,766 | 34,569 | 38,195 | 39,227 |
| LCI | 54.9% | 55.9% | 60.6% | 60.1% | 60.1% | 60.1% | 52,293 | 55,869 | 43,874 | 42,081 | 47,058 | 69,285 |
| LDDS | 69.0% | 75.0% | 90.0% | 90.0% | 90.0% | NA | 171,580 | NA | NA | NA | NA | NA |
| MCI | 40.0% | 56.7% | 64.3% | NA | NA | NA | 907,802 | 1,061,143 | 1,203,458 | NA | NA | NA |
| MRC | 50.0% | 41.7% | 65.0% | NA | NA | NA | 8,040 | 25,350 | NA | NA | NA | NA |
| RCI | 57.4% | 56.7% | 56.7% | 56.1% | 57.0% | 57.0% | 5,206 | 10,446 | 10,446 | 15,535 | 17,735 | NA |
| Sprint | 31.0% | 50.4% | 53.9% | 55.1% | 55.1% | NA | 987,000 | 1,431,985 | NA | 1,705,542 | 1,740,555 | NA |
| TCG | NA | NA | NA | NA | 80.0% | 80.0% | NA | 5,400 | NA | NA | NA | NA |
| Valley Net | NA | 37.3% | 50.7% | 40.0% | 40.0% | NA | NA | 12,250 | NA | 11,600 | NA | NA |
| Williams | 37.2% | 49.0% | 58.5% | 58.2% | 57.9% | 57.8% | 245,869 | NA | NA | NA | NA | NA |

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

Table 4: Other 1993 Fiber Data – Interexchange Carriers *

| | Estimated Backbone Fiber Investment (Millions \$) | Estimated Backbone Investment per Route ml. (Thousands \$) | Points of Presence | Fiber in Electric Utility Facilities | |
|--------------|---|--|-----------------------|---|----------------|
| | | | | Sheath Miles | Fiber Miles |
| AT&T | 3,185 | 80 | 670 | 1,194 | 28,656 |
| Consolidated | 14 | 40 | 6 | NA | NA |
| CTGI | NA | NA | NA | NA | NA |
| LCI | 84 | 60 | 34 | 220 | NA |
| LDDS | NA | NA | NA | NA | NA |
| MCI | NA | NA | NA | NA | NA |
| MRC | NA | NA | 14 | 596 | 7,157 |
| RCI | NA | NA | NA | NA | NA |
| Sprint | NA | NA | NA | NA | NA |
| TCG | NA | NA | NA | NA | NA |
| Valley Net | NA | NA | NA | NA | NA |
| Williams | 454 | 46 | 74 | 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 was reported as 38,184 for the end of 1991, 40,071 miles for the end of 1992, and 39,818 miles for the end of 1993. AT&T's point of presence data only includes its switched services.

A small adjustment has been made for historical Consolidated Communications network fiber mileage and route mileage.

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

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 which is not reflected in the tables. Investment data for CTI reflects data which was previously provided. The company's name has since been modified to Communications Transmission Group, Inc. and is now designated as CTGI in the tables. Increases in fiber during 1993 reflect new construction extending from San Antonio, Texas into Mexico.

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

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 and is now known as LDDS METROMEDIA, Communications, Inc. Listings in the tables use the acronym LDDS.

*MCI had acquired Telecom*USA which had previously been formed by the merger of Southland Fibernet, SouthernNet and Teleconnect. Data provided by MCI for last year's report, including revisions to its 1991 route mileage, were inconsistent with previously provided data. The author had therefore made the minimal adjustment 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 are reflected in Tables 1 and 2. The reader may also wish to refer to previous fiber deployment reports.*

MCI currently reports 20,630 route miles of fiber facilities and 15,174 route miles of microwave radio facilities. 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. Last year the company reported 2.9 million miles of DS-3 facilities on fiber. This year the company reports 5.29 million DS-3 miles which include spare and restoration facilities. This data appears to be affected by inconsistencies as to whether DS-3's on MCI's microwave facilities are included and inconsistencies in the way spare facilities are accounted for. (The reader may wish to 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.

Last year MCI reported 2,722 sheath miles and 65,328 fiber miles of facilities built in association with electric utilities. These systems typically use ground wire fiber as described in prior fiber deployment reports.

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

Sprint's historical data had been revised by the company. The reader may wish to refer to prior fiber deployment reports. These revisions are reflected in Tables 1 and 2 for the period since the merger of US Telecom and GTE toll facilities in 1986. In a press release dated March 14, 1994 discussing its deployment of

SONET equipment in its network the company reports that the new equipment will more than double capacity on its existing system without adding new cable as well as provide for improved network restoral capabilities. The press release also reports that as of March the company had 338 points of presence throughout the country.

The composite historical data for Williams Telecommunication Group had been adjusted downward by the author 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 in data reported for 1991 to include only backbone fiber facilities. Other downward adjustments had 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. Investment per route mile can be calculated from aggregate investment data and route mileage provided. In cases where data is not available, a rough estimate can be obtained by multiplying the route mileage by \$65,000.

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 as would be seen on a network map.

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 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.

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 for local telephone companies. It includes the Bell operating companies, rural carriers which provide data to the Rural Electrification Administration (REA), and companies affiliated with Contel and GTE, as well as the United telephone companies now owned by Sprint. 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 1991-1993 was unavailable. 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. Pair gain systems are used in this portion of the plant to increase the number of loops where there are not enough copper pairs available. Typically more than 90% of the loops do not use pair gain systems and employ a copper wire pair from the customer to the central office. 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; however, most of the fiber deployments to date in the subscriber loop have been concentrated in the feeder 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. It is also important to note that once a decision to deploy fiber has been properly justified the cable itself may contribute less to the total cost than the labor cost associated with deployment. This fact coupled with a desire to avoid costly future redeployments has contributed to placement of larger cables than would be suggested by current demand. This fact also may partially explain the large number of copper pairs currently available in the loop plant.

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.

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, pitfalls, and costs of new technologies can be explored prior to large scale deployment. Trials also provide a base of experience in dealing with equipment vendors and allow the companies to explore various 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 that would reduce the cost of serving large numbers of residential customers with some form of wide bandwidth service are also important. 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. A number of systems of this type have undergone trial by the local operating companies. They often continue as working systems beyond the trial period.

Data highlighting recent 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. Over the past two years, for example, BellSouth has reported trials of its interoffice synchronous optical network (SONET) as well as SONET 150 megabit loop trials. During this time frame 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 Bell has 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 has reported trials involving bandwidth sharing and voice and video integration capability involving off-the-shelf systems with future broadband upgrading capability but provided no new information this year. Other companies have reported little new information on trials this year and appear to be moving towards planned implementations of regularly tariffed services over fiber such as video dialtone service noted below.

In addition to the trials, several companies have announced plans over the past two years to deploy fiber to residences, video dial services, or other transactions involving fiber and cable T. V. For example Bell Atlantic announced New Jersey Bell's intention to build a video dial tone system to provide telephone service to 11,700 households in three Morris County, New Jersey communities. It also reported plans to provide Sammons Communications, Inc. a video transport service to their 8,000 customers and had announced an agreement to provide FutureVision of America Corp. with video dial tone transmission services to approximately 38,000 homes and businesses in Dover Township, New Jersey. NYNEX reported 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 announced it will use Lightspan-2000 equipment based on SONET standards. Southwestern Bell 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.

Several proposals associated with video dial tone service are the subject of pending applications at the FCC. (See Video Dial Tone, Second Report and Order, 7 FCC Rcd 5781, 1992.) For example, a recent look at filings for permanent commercial service shows that Bell Atlantic has filed 3 applications proposing to serve up to 350,000 customers; Pacific telesis has filed 4 applications proposing to serve up to 1,300,000 customers; US West and Ameritech have each filed 5 applications proposing to serve up to 974,000 and 1,256,000 customers respectively.

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 | 1993 |
| Ameritech | 3,200 | 5,200 | 6,700 | 8,700 | 10,800 | 12,100 | 15,200 | 18,300 | 21,500 |
| Bell Atlantic | 1,240 | 4,374 | 6,730 | 9,239 | 11,943 | 14,950 | 19,170 | 21,850 | 25,250 |
| BellSouth | 3,830 | 8,694 | 11,727 | 15,643 | 19,781 | 24,181 | 29,677 | 35,228 | 40,460 |
| NYNEX | 1,606 | 3,209 | 4,956 | 7,413 | 9,221 | 11,905 | 14,680 | 17,708 | 20,514 |
| Pacific Telesis | 2,318 | 2,779 | 2,964 | 3,480 | 3,767 | 5,139 | 6,564 | 8,334 | 9,820 |
| Southwestern Bell | 1,913 | 4,374 | 5,970 | 7,349 | 9,100 | 11,700 | 15,046 | 17,724 | 22,079 |
| US West | 3,527 | 5,017 | 6,937 | 10,030 | 13,425 | 17,596 | 22,152 | 27,401 | 31,301 |
| Regional Bell Total: | 17,634 | 33,647 | 45,984 | 61,854 | 78,037 | 97,571 | 122,489 | 146,545 | 170,924 |
| Contel Companies | | | | 1,100 | 9,000 | 12,807 | 14,424 | 14,236 | 14,993 |
| GTE Companies | | | | 8,999 | 11,855 | 15,827 | 17,196 | 19,773 | 24,459 |
| United Companies | | | | 2,907 | 5,002 | 5,877 | 7,443 | 12,663 | 15,206 |
| Rural Companies | | 500 | 2,584 | 4,651 | 6,369 | 8,689 | NA | NA | NA |
| Total Reported: | 17,634 | 34,147 | 48,568 | 79,511 | 110,263 | 140,771 | 161,552 | 193,217 | 225,582 |

* 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 | 1993 |
| Ameritech | 77,700 | 111,100 | 147,100 | 177,500 | 228,400 | 285,500 | 400,700 | 585,600 | 802,100 |
| Bell Atlantic | 83,085 | 150,847 | 227,507 | 311,022 | 373,398 | 522,970 | 809,740 | 1,026,640 | 1,251,290 |
| BellSouth | 50,807 | 170,092 | 218,489 | 319,248 | 445,452 | 609,201 | 768,597 | 938,704 | 1,120,974 |
| NYNEX | 83,384 | 129,743 | 207,077 | 290,600 | 357,766 | 473,274 | 636,954 | 806,658 | 964,383 |
| Pacific Telesis | 84,310 | 97,800 | 101,090 | 110,273 | 126,944 | 185,212 | 246,418 | 311,668 | 374,919 |
| Southwestern Bell | 70,490 | 151,043 | 182,911 | 214,948 | 270,300 | 352,300 | 477,654 | 576,447 | 775,040 |
| US West | 47,341 | 70,082 | 107,782 | 163,968 | 234,851 | 351,571 | 542,309 | 797,593 | 1,042,547 |
| Regional Bell Totals: | 497,117 | 880,707 | 1,191,956 | 1,587,559 | 2,037,111 | 2,780,028 | 3,882,372 | 5,043,310 | 6,331,253 |
| Contel Companies | | | | | | 103,603 | 114,410 | 141,535 | 158,915 |
| GTE Companies | | | | 134,677 | 163,396 | 213,891 | 276,139 | 372,192 | 489,948 |
| United Companies | | | | 32,287 | 54,569 | 83,540 | 115,590 | 180,941 | 301,065 |
| Rural Companies | | 2,000 | 14,236 | 28,705 | 42,260 | 68,237 | NA | NA | NA |
| Total Reported: | 497,117 | 882,707 | 1,206,192 | 1,783,228 | 2,297,336 | 3,249,299 | 4,388,511 | 5,737,978 | 7,281,181 |

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

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Table 7: Average Fiber Cable Cross Section *

| Company | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|-------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Ameritech | 24.3 | 21.4 | 22.0 | 20.4 | 21.1 | 23.6 | 26.4 | 32.0 | 37.3 |
| Bell Atlantic | 67.0 | 34.5 | 33.8 | 33.7 | 31.3 | 35.0 | 42.2 | 47.0 | 49.6 |
| BellSouth | 13.3 | 19.6 | 18.6 | 20.4 | 22.5 | 25.2 | 25.9 | 26.6 | 27.7 |
| NYNEX | 51.9 | 40.4 | 41.8 | 39.2 | 38.8 | 39.8 | 43.4 | 45.6 | 47.0 |
| Pacific Telesis | 36.4 | 35.2 | 34.1 | 31.7 | 33.7 | 36.0 | 37.5 | 37.4 | 38.2 |
| Southwestern Bell | 36.8 | 34.5 | 30.6 | 29.2 | 29.7 | 30.1 | 31.7 | 32.5 | 35.1 |
| US West | 13.4 | 14.0 | 15.5 | 16.3 | 17.5 | 20.0 | 24.5 | 29.1 | 33.3 |
| Bell Companies -- Avg. | 28.2 | 26.2 | 25.9 | 25.7 | 26.1 | 28.5 | 31.7 | 34.4 | 37.0 |
| Contel Companies | | | | | | 8.1 | 7.9 | 9.9 | 10.6 |
| GTE Companies | | | | 15.0 | 13.8 | 13.5 | 16.1 | 18.8 | 20.0 |
| United Companies | | | | 11.1 | 10.9 | 14.2 | 15.5 | 14.3 | 19.8 |
| Rural Companies | | 4.0 | 5.5 | 6.2 | 6.6 | 7.9 | NA | NA | NA |
| Bell Companies -- Avg. | 28.2 | 25.9 | 24.8 | 22.4 | 20.8 | 23.1 | 27.2 | 29.7 | 32.3 |

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

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

| Selected Recent Fiber Trial Data | | | | | |
|----------------------------------|--------------------------------|--------------|--------------------------|-----------------------|---|
| | 1993 Subscriber Trials/Systems | | Investment | | Types of Trials |
| | Systems | Fibers | Investment Million \$ | per Fiber Thous \$ | |
| Ameritech | NA | 276 | 1.9 | 7.0 | Subscriber |
| Bell Atlantic * | 2 | 132 | 0.8 | 6.1 | Subscriber FTTH |
| BellSouth * | 9 | 2,726 | 10.0 | 3.7 | SONET; Subscriber POTS, ISDN, Video |
| NYNEX | 5 | 900 | 5.1 | 5.6 | ODLC; FTTC |
| Pacific Telesis | 2 | 292 | 0.6 | 2.2 | Subscriber FTTH; ATM |
| Southwestern Bell | 3 | 853 | 1.4 | 1.6 | Subscriber (POTS only) FTTH and FTTC |
| US West | 2 | 48 | 0.9 | 18.8 | Rural/Residential |
| Contel Companies | NA | NA | NA | NA | |
| GTE Companies * | 1 | 2,406 | 16.1 | 6.7 | Subscriber Video Services, Broadband ISDN |
| United Companies | 89 | 1,436 | 12.7 | 8.8 | Subscriber FTTB; FTTC |
| Total Reported: | NA | 9,069 | 49.5 | 5.5 | |

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

* No new trials reported -- last year's data shown

Abbreviations Used Above:

- ATM-- Asynchronous Transmission Mode
- FTTB-- Fiber to Business
- 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 1993 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 \$) | |
|-------------------|---------------------------|----------------------------------|-------------------------|---------------------------|--------------------------|--|---------|
| | | | | | | Sub- scriber | Total |
| Ameritech | 43 | 750 | 44.9% | 293,000 | 1,828,000 | NA | 662.9 |
| Bell Atlantic | 13 | NA | NA | 245,136 | 3,093,005 | NA | 850.0 |
| BellSouth | 32 | NA | 28.5% | 405,972 | 214,705 | NA | 1,223.9 |
| NYNEX | 10 | 3,900 | 37.6% | NA | NA | 410.5 | 941.7 |
| Pacific Telesis | 48 | 789 | 26.0% | 935,087 | 2,152,946 | NA | 367.2 |
| Southwestern Bell | 8 | 93 | 29.9% | 900,941 | 213,455 | 421.0 | 687.2 |
| US West | 36 | 525 | 21.1% | NA | 971,527 | 348.0 | 748.9 |
| Contel Companies | 5 | 71 | 52.0% | NA | NA | NA | 151.2 |
| GTE Companies | 17 | 754 | 50.3% | NA | NA | NA | 442.3 |
| United Companies | NA | NA | NA | NA | NA | NA | 269.1 |

* 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 | 1993 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| Ameritech | 2,800 | 2,600 | 3,300 | 3,700 | 4,300 | NA | NA | 56,600 | 69,200 | 84,600 | 153,000 | 234,400 | NA |
| Bell Atlantic | NA | 4,872 | 6,543 | NA | NA | NA | 79,434 | 116,873 | 152,334 | 226,008 | NA | NA | NA |
| BellSouth | NA | NA | NA | NA | NA | NA | 136,807 | 185,795 | 267,271 | 355,163 | 440,432 | NA | NA |
| NYNEX | 1,935 | 2,656 | 3,995 | 5,388 | 7,095 | 8,976 | 45,938 | 66,823 | 90,027 | 135,876 | 209,716 | 301,989 | 404,022 |
| Pacific Telesis | 537 | 722 | 1,451 | 2,210 | 2,874 | 3,426 | 15,911 | 22,104 | 30,353 | 64,107 | 96,914 | 120,905 | 139,742 |
| Southwestern | NA | 2,500 | 2,800 | 4,498 | 5,409 | 8,008 | NA | NA | 95,400 | 135,600 | 185,283 | 221,846 | 365,360 |
| US West | 2,816 | 3,484 | 4,714 | 6,595 | 8,706 | 10,879 | 61,616 | 84,824 | 112,373 | 113,795 | 295,194 | 452,568 | 618,208 |

* 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 | 1993 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| Ameritech | 242.7 | 245.2 | 244.4 | 242.7 | 243.5 | NA | 139,588 | 140,420 | 141,930 | 142,358 | 143,166 | NA |
| Bell Atlantic | 280.3 | 290.8 | 291.3 | 288.9 | NA | NA | 187,439 | 191,674 | 194,426 | 194,378 | NA | NA |
| BellSouth | 560.0 | 564.2 | 566.1 | 570.4 | NA | NA | 238,776 | 241,225 | 243,458 | 243,641 | NA | NA |
| NYNEX | 225.5 | 229.5 | 232.7 | 232.9 | 233.2 | 233.9 | 130,893 | 134,247 | 137,882 | 139,976 | 141,616 | 143,200 |
| Pac. Telesis | 170.3 | 167.5 | 184.1 | 185.2 | 192.7 | 207.9 | 128,767 | 127,456 | 134,312 | 136,319 | 140,557 | 158,088 |
| Southwestern | NA | 338.1 | 343.3 | 345.1 | 347.4 | 350.1 | NA | 156,900 | 159,300 | 160,078 | 160,913 | 162,288 |
| US West | 384.3 | 389.4 | 395.8 | 401.7 | 407.9 | 413.2 | 154,245 | 156,229 | 158,737 | 161,144 | 163,563 | 165,738 |
| Total Reported: | NA | 2,224.7 | 2,257.7 | 2,266.8 | NA | NA | NA | 1,148,151 | 1,170,045 | 1,177,893 | 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 1993 *

| Company Name | Access Lines (thousands)** | Total Plant | | | | Per Thousand Access Lines | | | | | |
|------------------------|----------------------------|--------------------------|--------------|------------------|----------------|---------------------------|-------------|--------------|-------------|---------------|--------------|
| | | Strand Miles (thousands) | | Sheath Miles | | Miles Copper | Miles Fiber | Miles Copper | Miles Fiber | Percent Fiber | |
| | | Copper | Fiber | Copper | Fiber | Wire | Strand | Cable | Cable | Cable | Strand |
| Ameritech | 17,548 | 190,318 | 802 | 324,500 | 21,500 | 10,845 | 45.7 | 18.5 | 1.2 | 6.2% | 0.42% |
| Bell Atlantic | 18,523 | 191,917 | 1,251 | 286,370 | 25,250 | 10,361 | 67.6 | 15.5 | 1.4 | 8.1% | 0.65% |
| BellSouth | 19,209 | 245,238 | 1,121 | 576,299 | 40,460 | 12,767 | 58.4 | 30.0 | 2.1 | 6.6% | 0.46% |
| NYNEX | 15,760 | 166,475 | 964 | 258,691 | 20,514 | 10,563 | 61.2 | 16.4 | 1.3 | 7.3% | 0.58% |
| Pacific Telesis | 16,465 | 155,025 | 375 | 201,020 | 9,820 | 9,415 | 22.8 | 12.2 | 0.6 | 4.7% | 0.24% |
| Southwestern | 12,603 | 171,257 | 775 | 377,788 | 22,079 | 13,589 | 61.5 | 30.0 | 1.8 | 5.5% | 0.45% |
| US West | 14,880 | 168,883 | 1,043 | 437,971 | 31,301 | 11,350 | 70.1 | 29.4 | 2.1 | 6.7% | 0.61% |
| Total reported: | 114,990 | 1,289,113 | 6,331 | 2,462,639 | 170,924 | 11,211 | 55.1 | 21.4 | 1.5 | 6.5% | 0.49% |

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

** Access lines in place as of Jan. 1, 1993.

Table 13: Fiber and Copper in Subscriber Plant in Relation to Access Lines – End of Year 1993 *

| | Subscriber Plant | | | | | | Per Thousand Access Lines | | | | |
|------------------------|-----------------------|------------------------|--------------------|--------------|--------------------|---------------|---------------------------|-----------------|-----------------|----------------|-----------------|
| | Access Lines (000) ** | | Strand Miles (000) | | Cable Sheath Miles | | Miles | Miles | Miles | Miles | % Fiber |
| | Total | % Without Pair Gain | Copper | Fiber | Copper | Fiber | Copper Wire | Fiber Strand | Copper Cable | Fiber Cable | Sheath Miles |
| Ameritech | 17,548 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Bell Atlantic | 18,523 | 95% | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BellSouth | 19,209 | 83% | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| NYNEX | 15,760 | NA | 143,200 | 404 | 233,945 | 8,976 | 9,086 | 25.6 | 14.8 | 0.57 | 3.7% |
| Pacific Telesis | 16,465 | 84% | 158,088 | 140 | 207,900 | 3,426 | 9,601 | 8.5 | 12.6 | 0.21 | 1.6% |
| Southwestern | 12,603 | 99% | 162,288 | 365 | 350,128 | 8,008 | 12,877 | 29.0 | 27.8 | 0.64 | 2.2% |
| US West | 14,880 | 91% | 165,738 | 618 | 413,157 | 10,879 | 11,138 | 41.5 | 27.8 | 0.73 | 2.6% |
| Total reported: | 114,990 | NA | 629,314 | 1,527 | 1,205,130 | 31,289 | 10,540 | 25.6 | 20.2 | 0.5 | 2.5% |

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

** Access lines in place as of Jan. 1, 1993.

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 had reported 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 now separates interoffice and subscriber lit fiber which shows that in 1993 39.6% of the lit fiber was associated with subscriber loops. Other companies separating subscriber and interoffice fiber typically show about one-third of the total fiber as subscriber and about 88% of the copper wire as subscriber. BellSouth had confirmed that its fiber investment does not include electronics at terminal or repeater sites. BellSouth data for 1990 fiber mileage had been corrected.

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.

United Companies are now owned by Sprint. Data for United Companies in 1993 also includes data for the Central Telephone Companies acquired by Sprint in 1993.

US West indicates that it's T1 miles on copper was reported as equivalent circuit miles on T1 systems rather than miles of T1 system. The author therefore divided its figure by 24 (equivalent circuit capacity of T1 systems) as shown in Table 9.

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 1992 calendar year as reported in Statistics of Communication Common Carriers -1992/93 and represent, in effect, beginning of year 1993 quantities. Other data in those tables reflect end of year 1993 quantities. This is a change from previous reports in which data had been more precisely matched to the time frame of available access line data.

General 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.

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.

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 and 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 1992. 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 deploying 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 collocation 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 | | | | | |
|-------------------------------|-------------|------------|--------------|--------------|--------------|--------------|---------------|---------------|---------------|---------------|----------------|----------------|
| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| Bay Area Teleport | | | | 2.4 | 2.4 | 2.4 | | | | 85 | 79 | 85 |
| City Signal | | | 67.0 | 115.0 | 144.0 | 367.0 | | | 5,628 | 6,280 | 7,348 | 20,178 |
| Digital Direct | | | | 118.0 | 163.9 | 128.7 | | | | 7,144 | 7,898 | 5,361 |
| Eastern Teleologic | | 68.0 | 140.0 | 140.0 | 140.0 | 194.0 | | 2,184 | 3,666 | 3,666 | 3,666 | 4,477 |
| Electric Lightwave | | | | 6.4 | 104.0 | 126.0 | | | | 451 | 6,820 | 11,686 |
| Fibernet, Inc. | | | | 8.4 | 18.9 | 174.0 | | | | 388 | 998 | 3,418 |
| Indiana Digital Access, Inc. | 7.0 | 34.5 | 59.0 | 50.0 | 52.0 | 60.0 | 238 | 295 | 469 | 528 | 552 | 750 |
| IntelCom Group | | | | 100.0 | 115.0 | 148.9 | | | | 4,800 | 6,500 | 8,580 |
| Inter-Media Communications | 18.3 | 78.0 | 159.0 | 165.0 | 213.0 | 334.7 | 579 | 1,365 | 2,862 | 3,000 | 5,200 | 10,239 |
| Jones Lightwave | | | | 10 | 52.0 | 58.0 | | | | 80 | 550 | 1,448 |
| Kansas City Fiber Net | | | 90.5 | 93.7 | 97.0 | 200.0 | | | 2,534 | 2,624 | 998 | 6,000 |
| Metrex Corp. of Alabama | | | | | 3.5 | NA | | | | | 98 | NA |
| Metro Com | | | | 36.0 | NA | NA | | | | 650 | NA | NA |
| MFS | 117.9 | 199.6 | 308.6 | 528.0 | 1,061.8 | 1,298.0 | 5,861 | 13,374 | 17,219 | 29,338 | 39,803 | 62,154 |
| MWR Telecom (Iowa Resources) | | 60.0 | 65.0 | 75.0 | 95.0 | 121.0 | | 1,284 | 1,600 | 1,805 | 3,701 | 5,002 |
| Ohlo Linx | | | | 2.5 | 15.0 | NA | | | | 84 | 800 | NA |
| Penn Access Corporation | | | 31.0 | 80.0 | 90.0 | 128.7 | | | 1,865 | 3,331 | 3,747 | 5,360 |
| Phoenix Fiberlink | | | | 22.0 | 24.0 | 90.0 | | | | 968 | 1,056 | 2,880 |
| Public Service of Oklahoma | | 120.0 | 109.0 | 119.0 | 169.0 | 176.0 | | 2,500 | 2,631 | 2,855 | 3,196 | 3,308 |
| Teleport Communications Group | 57.7 | 232.6 | 297.2 | 427.1 | 764.0 | 1,953.0 | 5,433 | 13,030 | 16,666 | 21,398 | 36,251 | 90,700 |
| Total Reported: | 201 | 793 | 1,326 | 2,098 | 3,324 | 5,560 | 12,111 | 34,032 | 55,140 | 89,475 | 129,261 | 241,627 |

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

**Table 15 Urban Fiber Systems
Other Current Data – 1993 ***

| Company Name | Sheath Miles | Average | Investment | Percent | Cust. Loc. | Buildings Served | States Served |
|-------------------------------|-----------------|----------------|-------------|--------------|---------------|---------------------|------------------|
| | | Fiber Count | Millions \$ | Fiber Lit | | | |
| Bay Area Teleport | NA | 35.5 | 0.2 | 14% | 17 | 11 | 1 |
| City Signal | 372 | 55.0 | 18.1 | 17% | 307 | 279 | 4 |
| Digital Direct | 129 | 41.6 | NA | NA | NA | 128 | 1 |
| Eastern Telelogic | 206 | 23.1 | 17.0 | 68% | NA | 240 | 2 |
| Electric Lightwave | 181 | 92.7 | 15.9 | 6% | 115 | 120 | 2 |
| Fibernet, Inc. | 175 | 19.6 | NA | NA | NA | 121 | 1 |
| Indiana Digital Access, Inc. | 60 | 12.5 | 0.8 | 50% | 23 | 15 | 1 |
| IntelCom Group | NA | 57.6 | NA | NA | NA | NA | 5 |
| Inter-Media Communications | 335 | 30.6 | 13.9 | NA | 423 | 234 | 1 |
| Jones Lightwave | 58 | 25.0 | 0.8 | 18% | 13 | 13 | 3 |
| Kansas City Fiber Net | 200 | 30.0 | NA | NA | 60 | 60 | 1 |
| Metrex Corporation of Alabama | NA | NA | NA | NA | NA | NA | NA |
| Metro Com | NA | NA | NA | NA | NA | NA | NA |
| MFS | 1,403 | 47.9 | NA | NA | NA | 1,583 | 13 |
| MWR Telecom (Iowa Resources) | 131 | 41.3 | 6.5 | 27% | 88 | 110 | 2 |
| Ohio Linx | NA | NA | NA | NA | NA | NA | NA |
| Penn Access Corp. | 129 | 41.6 | NA | NA | NA | 128 | 1 |
| Phoenix Fiberlink | 90 | 32.0 | 16.0 | NA | NA | 61 | 1 |
| Public Service of Oklahoma | 176 | 18.8 | 4.9 | 67% | 51 | 51 | 1 |
| Teleport Communications Group | 2,179 | 46.4 | NA | 40% | 2,616 | 981 | 14 |

* 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 had previously indicated that it operated 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.

Digital Direct facilities in Chicago, Dallas, and Seattle have been acquired by Teleport Communications Group. Remaining Digital Direct facilities in Pittsburgh are shown for the current year. Prior to 1993 data for Digital Direct includes the Chicago, Dallas and Seattle facilities and correspondingly the Teleport facilities were not retroactively adjusted.

Fibernet facilities shown in last year's report only included its Rochester, New York operation. During 1993 new facilities were constructed by Fibernet in Cincinnati, and were completed in Buffalo and Albany. The Buffalo, Albany and Rochester facilities are being purchased by Metropolitan Fiber Systems (MFS) subject to regulatory approval. The Cincinnati facilities will not be acquired and will be owned by an entity called Fibernet USA. The acquisition is not reflected in the accompanying data.

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

Kansas City Fiber Net, had been a part of American Cablevision and is now jointly owned by Telecable and Times Warner. It had reported a significant decline in fiber mileage in 1992 due which was attributed to removal of fiber and updated accounting of plant; however, it now reports a significant increase in fiber and route mileage which is partly attributed to an estimated 80 route miles and 2,500 fiber miles reportedly added in 1993. The apparent discrepancy between the currently provided data and data provided previously could not be substantiated.

MFS had 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 were included starting with last year's report. Fibernet facilities are not included, since the acquisition was not finalized during 1993.

Penn Access has indicated that its 1992 and 1991 fiber mileage data was inaccurate. It has been revised downward by the author so that the average fiber count is consistent with that of the current year's data. Penn access obtains much of its fiber in conjunction with the local electric utility.

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. 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. The data shown for Teleport Communications Group prior to 1993 does not include any facilities from Digital Direct. Remaining Digital Direct facilities in Pittsburgh are shown separately for 1993. Prior to 1993 Digital Direct facilities includes those facilities acquired by Teleport Communications Group. Possible overlapping of routes associated with the consolidation should have been accounted for in 1993 data for Teleport Communications Group since Digital Direct and Teleport Communications Group had both operated facilities in Dallas and Chicago.

Teleport Communications Group also has acquired Diginet which had not constructed any new facilities during 1993 and whose data is included in the aggregate for TCG. Diginet fiber connecting Milwaukee and Chicago is shown separately in table 1 under the name TCG.

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 and facilities of Privacom in Charlotte, North Carolina and Nashville, Tennessee were acquired. Data shown for 1993 reflects the aggregate of facilities for which construction was complete as of the end of 1993. IntelCom data prior to 1993 only includes the data previously shown for Teleport Denver and the facilities for Ohio Lynx are shown separately for those years. All acquired facilities, including those of Ohio Lynx are part of the Intelcom total for 1993.

Average fiber count is calculated as the fiber mileage divided by the 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 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 -- The approximate total investment in fiber cable, deployment, repeater sites.

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 -- Some companies only report large cities or metropolitan areas while other companies report a number of small to medium sized cities.

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

Cities Served by Metropolitan or Urban Fiber Carriers

Bay Area Teleport --

California: San Francisco, Oakland, Sunnyvale, Fremont, Santa Rosa, Lodi

City Signal --

Michigan: Grand Rapids, Lansing

Indiana: Indianapolis

Nevada: Las Vegas

Tennessee: Memphis

Digital Direct --

Pennsylvania: Pittsburgh

Eastern Telelogic --

Pennsylvania: Philadelphia

New Jersey: Camden

Electric Lighwave--

Washington: Seattle

Oregon: Portland

Fibernet --

New York: Albany, Buffalo, Rochester, Brighton, Chili, Greece, Henrietta,
Penfield, Perinton, Webster

ICI (Intermedia) --

Florida: Tampa, Miami, Jacksonville, Orlando, St. Petersburg

Indiana Digital Access --

Indiana: Indianapolis, Carmel, Terre Haute

IntelCom Group (formerly Teleport Denver)--

Colorado: Denver, Colorado Springs

Ohio: Cleveland, Dayton

Arizona: Phoenix

North Carolina: Charlotte

Tennessee: Nashville

Jones Lightwave--

Florida: Tampa, St. Petersburg

Colorado: Denver

Georgia: Norcross

Kansas City Fiber Net -- (no data)

Linkatel Communications, Inc.-- not operational in 1993

Metro Com -- (no data)

Metropolitan Fiber Systems --

Georgia: Atlanta

Maryland: Baltimore

Massachusetts: Boston, Burlington, Cambridge, Lexington, Lincoln, Quincy,
Somerville, Waltham

Illinois: Chicago

Texas: Dallas, Houston, Conroe, Plano

California: Los Angeles

Minnesota: Minneapolis

New Jersey: Carlstadt, Fort Lee, Hasbrook Heights, Jersey City, Lyndhurst,
Newark, Parsippany, Passaic, Seacaucus, Verona, Voorhies, W.
Orange, Weehawkin, Whippany

New York: New York City, Bronx, Brooklyn, East Islip, Elmhurst, Far Rockaway,
Forest Hills, Great Neck, Jamaica, Jericho, Lake Success, Long Island
City, Manhattan, Queens, Roslyn Heights, Staten Island, Valhalla,
White Plains, Yonkers

Pennsylvania: Philadelphia, Pennsylvania

California: San Francisco

Washington, D. C.: District of Columbia

Virginia: Alexandria, Arlington, Chantilly, Dunn Loring, Fairfax, Falls Church,
Gainsville, Herndon, Langly, McLean, Merrifield, Oakton, Reston,
Rosslyn, Springfield, Sterling, Vienna

MWR Telecom --

Iowa: Council Bluffs, Des Moines

Missouri: St. Louis

Penn Access --

Pennsylvania: Pittsburgh

Phoenix Fiberlink --

California: Sacramento, West Sacramento (San Jose, Sunnyvale, and Santa Clara to be completed in 1994)

Public Service of Oklahoma --

Oklahoma: Tulsa, Broken Arrow

Teleport Communications Group --

Arizona: Phoenix

California: Culver City, Santa Monica, El Segundo, Hollywood, Anaheim, Santa Ana, Hawthorne, Garden Grove, San Diego, San Francisco

Connecticut: Hartford

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

Illinois: Chicago, Deerfield, Skokie, Waukegan, Des Plaines, North Chicago, Rolling Meadows

Massachusetts: Andover, Boston, Brockington, Burlington, Cambridge, Dedham, Easton, Framingham, Lawrence, Malden, Marlboro, Medford, Natick, Needham, Newton

North Reading, Quincy, Reading, Waltham, Wilmington, Woburn

Michigan: Detroit, Warren, Sterling Heights, Troy, Royal Oak, Southfield, Birmingham, Bingham Farms

Missouri: St. Louis

Nebraska: Omaha

New Jersey: Jersey City, Weehawken, Piscataway, Somerset, Princeton, New Brunswick, North Brunswick, Plainsboro, Newark, Secaucus, Carlstat

New York: New York City, Lynbrook, Garden City, Mineola, East Meadow, Uniondale, Bohemia, White Plains, Mamereneck

Texas: Dallas, Plano, Richardson, Irving, Addison, Carrolton, Farmer's Branch, Houston

Washington: Seattle, Kent, Renton, Issaquah, Bellevue, Kirkland, Seatac, Lynnwood, Everett

Wisconsin: Milwaukee, New Berlin, Oak Creek, Racine, Kenosha