JACKSON DECLARATION

Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Implementation of the Local Competition Provisions in the Telecommunications Act of 1996	)))	CC Docket No. 96-98

Declaration of Dr. Charles L. Jackson

1. My name is Charles L. Jackson. I am a director in the consulting firm LECG, Inc., which has offices at 1600 M Street, Washington, DC. I received my undergraduate degree in applied mathematics, with honors, from Harvard College in 1966. I received an M.S. from Massachusetts Institute of Technology (MIT) in 1974 and a Ph.D. in Electrical Engineering from MIT in 1977. I have worked for more than 30 years in the electronics and communications industry. A copy of my full biography is attached and incorporated herein by reference.

Introduction and Summary

2. The purpose of my declaration is to examine the alternatives for switching and interoffice transmission available to new entrants into the local exchange business. First, I describe alternative switching machines and transmission facilities that are already deployed by new entrants in many areas. Local carriers can and do use switches located at significant distances from their customers and provide them with competitive local telephone

service.[1] Second, I examine alternatives for interoffice transport and that connection of competitive local exchange carrier (CLEC) fiber to a specific incumbent local exchange carrier (ILEC) central office provides an alternative fiber route to all other ILEC central offices that are also connected to CLEC fiber.

Switching

3. In telecommunications, switches allow us to make more efficient use of transmission facilities — and vice versa. Historically, the expense of signal transmission and the degradation of signals as they were transmitted over long distances, led to a world in which switches were located relatively close to the end users they served. In the last several years, new technologies have broken those geographic limits on the area served by switches. For more than two decades, telecommunications circuit switches have been able to connect directly to signal formats containing multiple voice signals such as a DS-1—formatted signal carrying 24 digital voice channels. Those capacities were developed, in part, to support systems such as digital loop carrier systems that use high-capacity digital links out to remote terminals to economize on the cost of loops to telephone subscribers. Voice signals in digital formats, such as the DS-1 format, can be transmitted long distances without significant degradation. The combination of these two elements (digital line interfaces on switches and digital transmission) give modern telecommunications switches the capability to serve terminals located at long distances — many hundreds of miles — from the switch.

4. We can get some hints about the feasibility of operating a switch to serve users dispersed over a large geographic area from the marketing materials of the switch manufacturers and of the carriers. For example, Lucent describes its equipment saying:

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[1] The use of switches located at long distances from the consumer is not the unique province of LECs. Most notably, call-back operators often use switches in one country to switch calls travelling between two other countries. Switches for wireless telephony are also often used to serve cells located at great distances from the switch. I discuss the wireless case further below.

> Also, remote switch modules can be located up to 600 miles from the host switch, making it easy to enter new territories.[2]

Lucent also says,

> The AnyMedia Access Interface Units (AIUs) are a global set of line side products that interface with Lucent's 5ESS Switch. The AIUs enable service providers to increase the capacity or services offered from a 5ESS, expand the reach of a 5ESS, or to quickly provide services in a new geographic location from an existing 5ESS.[3]
>
> The AnyMedia EAIU features the same functionality of the AIU, plus added flexibility. It services remote locations, allowing you to expand your network capabilities up to 2000 miles from the host central office. Like the AIU, the EAIU has the capacity to handle POTS, ISDN, Coin and ADSL while dramatically decreasing floor space needs and reducing power consumption.[4]

5. Nortel makes similar claims.

> Using a highly reliable and economical *counter-rotating ring* architecture, FDS-1 extends services from DMS-family switches that provide local access (the DMS-10, DMS-100, and DMS-500), S/DMS AccessNode, and other remote access vehicles to areas that could not be served cost effectively in the past. The ring can be up to 150 miles (240 kilometers) round trip, for maximum extension of up to 75 miles (120 kilometers) from the central office. The counter-rotating topology provides survivability, scalability, high capacity, route diversity, and interruption-free maintenance. Only two fibers are required for full redundancy, greatly reducing fiber costs.[5]
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> (emphasis in original)

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[2] http://www.lucent-sas.com/switching/switch.shtml.

[3] http://www.lucent-sas.com/access/swaius.shtm.

[4] Lucent, *AnyMedia Access Interface Units*, Product Brochure, 6 pages, April, 1999.

[5] Nortel, 56056.16/1-96 Issue 1, S/DMS AccessNode Fiber Distribution System-1

Below is a diagram of that Nortel system.

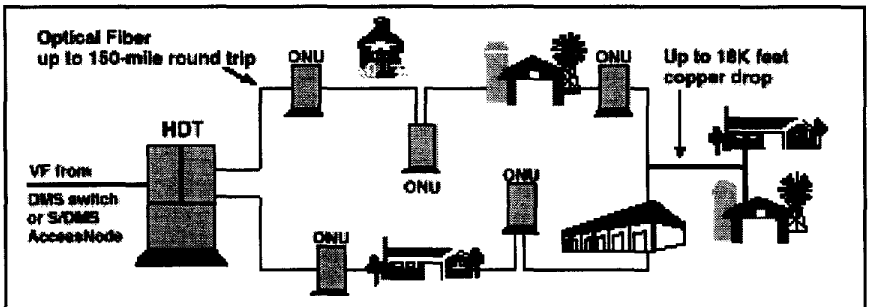

Figure 1. With a fiber ring of up to 150 miles, FDS-1 lets providers reach schools, farms, strip malls, and other subscribers in low line-size areas.

Figure 1. Nortel FDS-1 Diagram.

6. Similarly, in a document titled *High-Speed Access Business Case,* Nortel provides an outline of the analysis a firm would need in deciding whether to become a CLEC. One assumption in that analysis is "Remote sites must be within 500 miles of host switch."[6]

7. A Nortel system planning document describes their Star Remote System.

> This compact module provides a smaller, more cost-effective way to deliver DMS services across a very broad geographical area (up to 650 miles with no more than a 13-millisecond roundtrip delay between host and subscriber) into low-density areas, offices, or apartment buildings. For example, a 500-line Hub frame can serve DMS Meridian Digital Centrex services to a mid-sized business in a neighboring city, while up to ten Star Remote Modules extend the Centrex group services to locations hundreds of miles away in another state.[7]

8. Below is a system diagram of the Nortel Star Remote that shows both the hub and the remote modules.

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[6] Nortel ISP Partner Program, *High Speed Access Business Case*, http://www1.nortelnetworks.com/pcn/isp/resource/bchisped.htm.

[7] *Guide Update 1999 Dms-100/200 Supernode System Feature Planning*, Nortel, p. 138.

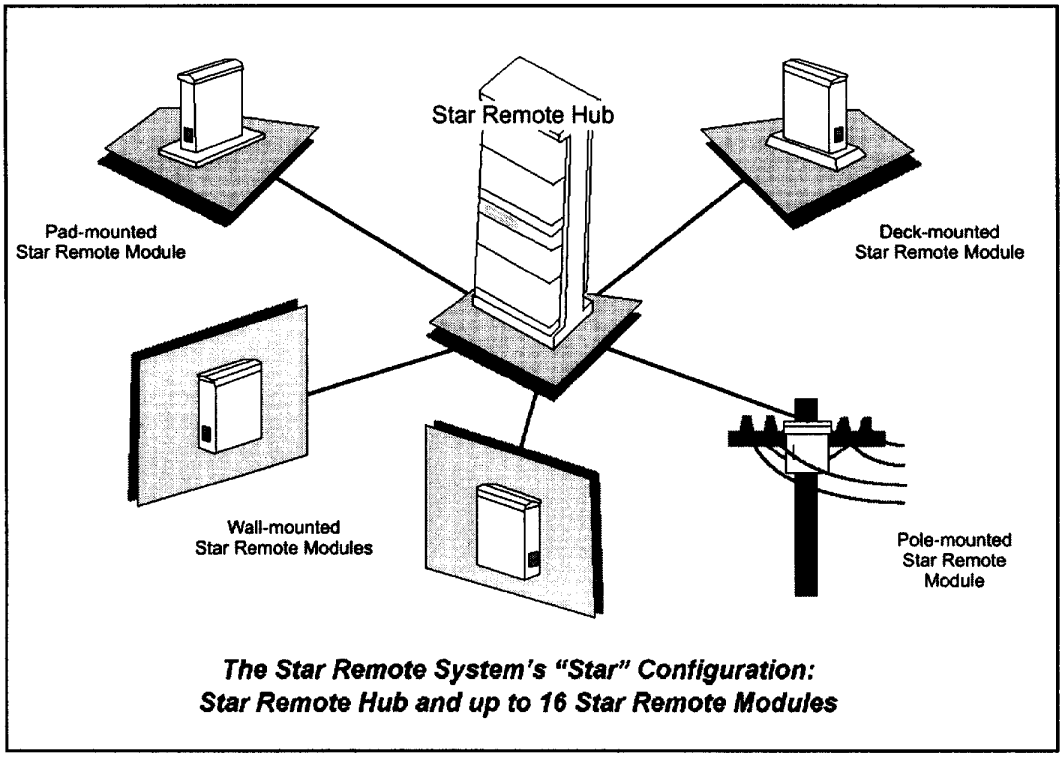

Figure 2. Nortel Star Remote — Service up to 650 Mile Separation.

Using the Star Remote, a CLEC could offer service to users in several states and serve those loops from a switch 500 miles away.

9. In addition to such manufacturer's claims, I am aware of several instances in which carriers have used switches located many tens or hundreds of miles from the user location to provide service. For example, Cox Associates is a consulting firm that specializes in the application of operations research — including optimal network design — to industrial problems, including the design of wireless networks. Figure 3 below is taken from Cox Associates promotional literature. It shows the optimized version of a mobile network serving southern California. Notice that the area served by a single switch (Mobile Switching Office or MSO) in this figure stretches from Ventura in the North to

Tijuana in the South — a distance of more than 200 miles — and to Imperial in the East — about 300 miles from Ventura.[8] The large M denotes the MSO and the Hs denote intermediate hubs.

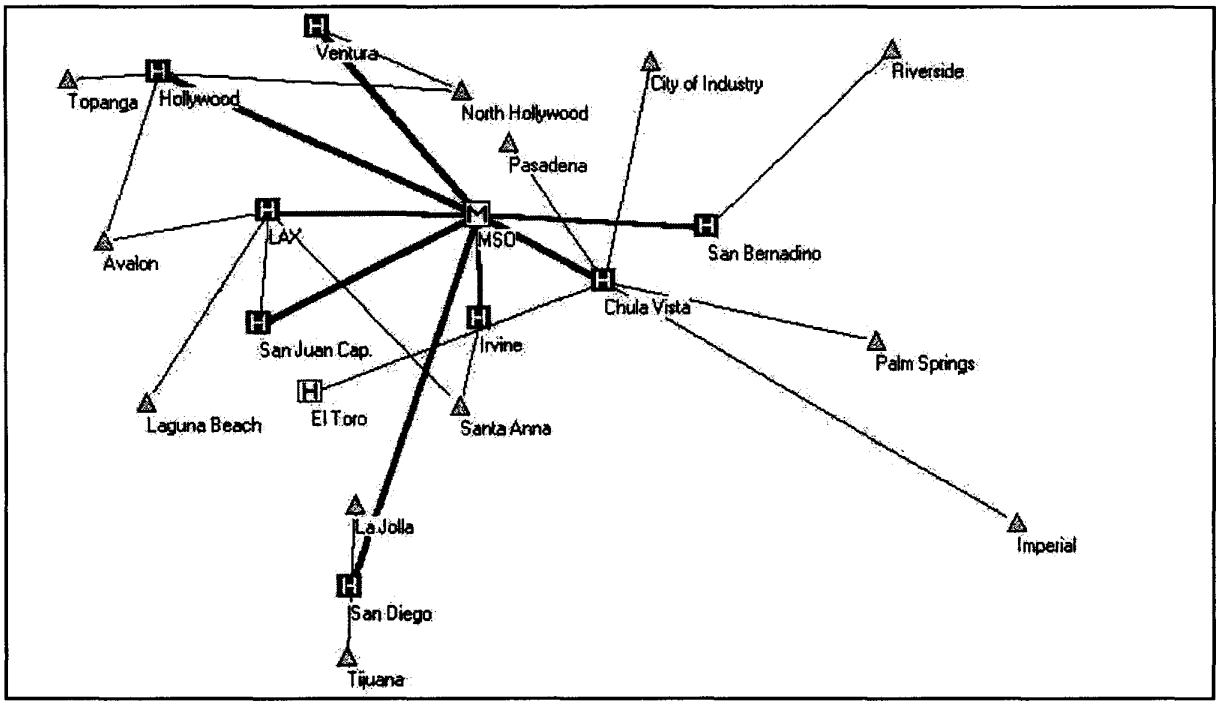

Figure 3. Cox Associates Diagram of a Cost-Optimized Mobile Network.

10. AirTouch's cellular operations in Michigan provide a specific example of switches serving wide areas. AirTouch provides service in seven cellular market areas in Michigan covering 21 counties. All of AirTouch's cellular switches are located in the Detroit area (four in Oakland County and two in Wayne County). Cellular traffic is backhauled from western Michigan cities such as Benton Harbor, Grand Rapids, or Muskegon to the switches in Detroit. Figure 4, taken from a recent AirTouch filing before the Michigan

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[8] The Cox Associates paper is available at http://www.cox-associates.com/NetOpt.htm. Some of the surprising routings (e.g., Pasadena to Chula Vista to LA MSO) are due to the fact that capacity comes in discrete DS-3 chunks and it may be more cost effective to haul traffic in the apparently wrong direction if there is an otherwise empty pipe available to carry the traffic.

Public Service Commission, shows the AirTouch service area in Michigan and northern Ohio and the location of the AirTouch switches.[9] Cities in the AirTouch service area are at significant distances from Denver. Muskegon is about 175 miles from Detroit. Grand Rapids is about 140 miles from Detroit and Bay City is about 100 miles north of Detroit. One would expect that AirTouch is being rational about network operating costs. The clustering of switches produces many benefits. For example, maintenance technicians can work on any of the six switches without travelling a substantial distance. Spares can be pooled — with a reduced inventory of spares providing the capability for rapid repair in time of failure.

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[9] Petition of AirTouch Cellular, Inc. for Arbitration to Establish an Interconnection Agreement, Case No. U-11973, April 29, 1999, Appendix I. The cellular service area outlined on the map in Appendix I has been shaded in Figure 4.

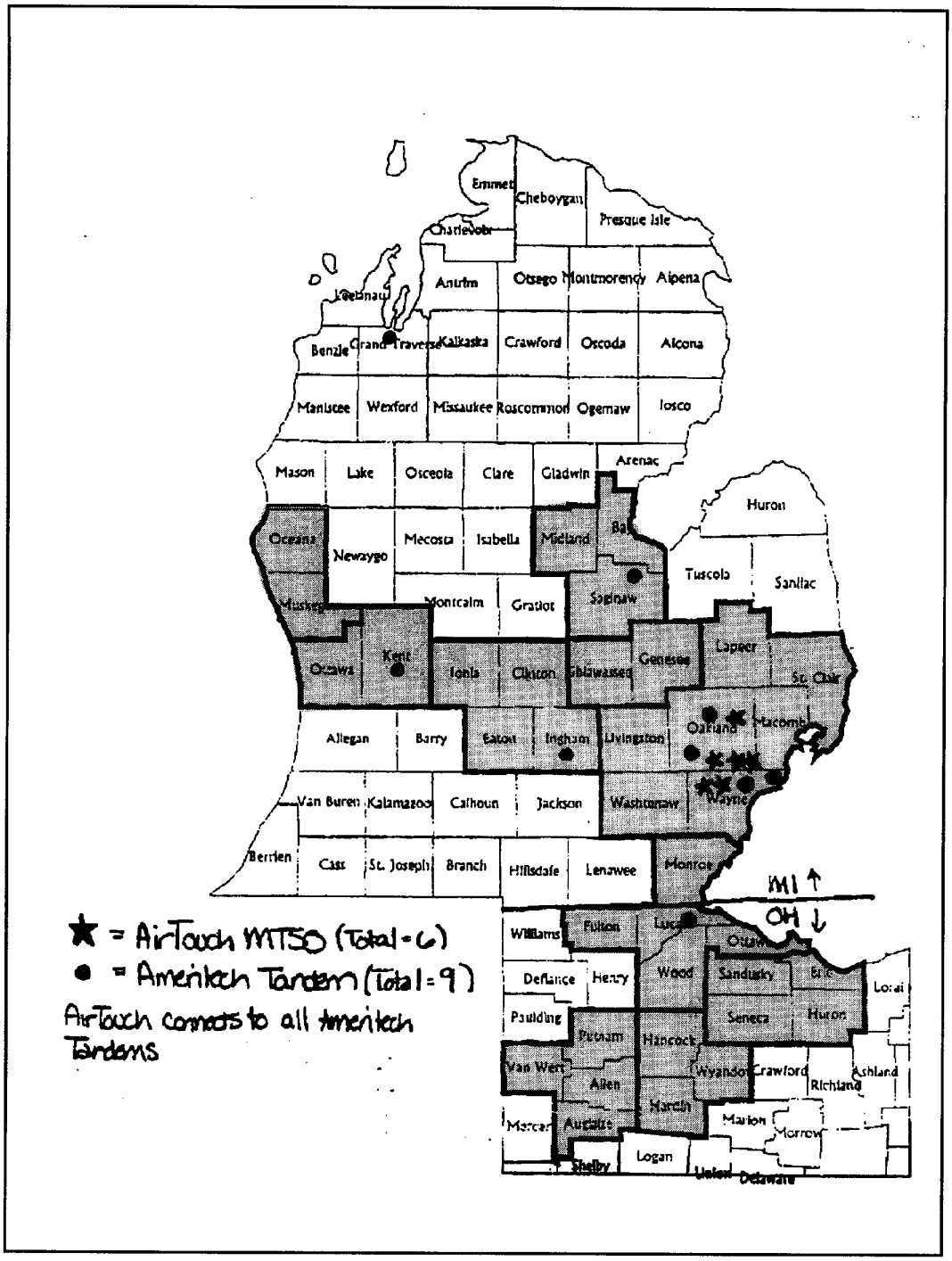

Figure 4. AirTouch Service Area and Switches Locations in Michigan.

11. AirTouch has stated that the use of cellular switches to serve multistate areas is valuable and will grow. In a presentation to the FCC on May 2, 1996, AirTouch said, "The number of multi-state CMRS systems served by a single MTSO will soon increase with the deployment of PCS Systems designed to accommodate multi-state MTSOs." AirTouch went on to say that switches restricted to serving only a single state could, under certain circumstances, be impractical and grossly inefficient.[10]

12. Once it became economical for switches to serve wide areas, switch manufacturers changed the switch software to remove restraints on the area that could be served by a switch. For example, Nortel system documentation describes one such system upgrade.

> This enhancement expands the Directory Number Inventory (DNINV) table to support the spread of directory numbers over all the possible 8171 NPA/NXX combinations in a DMS-100 SuperNode system. Such an expansion addresses Competitive Local Exchange Carrier (CLEC) table exhaust issues — calculated to be possible for large offices spanning multiple NPA/NXX combinations (say, in a regional switch deployment scheme) — that result in numerous discontinuous directory numbers.[11]

13. This example is particularly interesting because in this case Nortel modified its software to permit a CLEC to be able to use a single switch to serve customers in every area code/local exchange combination (NPA/NXX). Nortel saw a market need to respond to what it called *regional switch deployment schemes.* That is, Nortel is building switch software to support the wide serving areas that CLEC switches cover.

14. Other similar upgrades to switch software have occurred as well. For example, classes of service can now be assigned based upon the full 10-digit telephone number, not just the

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[10] AirTouch presentation in CC Docket 95-198 and 96-98, Kathleen Abernathy and Thomas Krattenmaker, May 2, 1996.

[11] *Guide Update 1999 Dms-100/200 Supernode System Feature Planning*, Nortel, p. 157.

7-digit number. This allows a CLEC to provide call waiting for the customer with telephone number 678-1234 in Des Moines but not to the customer with telephone number 678-1234 in Kansas City.

15. Backhauling traffic to a distant CLEC self-provided switch also has several other operational advantages. The CLEC has complete control of the programming and setup of such a switch. The CLEC can thus ensure that the switch provides the full range of services that the CLEC wishes to offer and that those features are implemented in a consistent fashion for all consumers. Such consistency simplifies product promotion, administration, and technical support — thereby lowering costs.

16. The CLECs typically install fiber rings serving a city or urban area and then locate a switch on that ring or haul the traffic from that ring back to another city to be switched. This CLEC behavior shows that the tradeoff between switching and transmission has altered radically in favor of transmission.

17. The larger CLEC firms (AT&T, MCI WorldCom) have switching capabilities and efficient networks for the backhaul function that they could use either for the self-provision of switching capacity or to provide switching services to others. Modern switches, for example, the Nortel DMS 500 or the Lucent 5ESS-2000 can carry both local and long-distance traffic. New entrants can use a single switch to serve an entire region (urban area, state, multistate region) or to enter into a new market region without physically installing a switch in that region. A CLEC could install a switch in Atlanta and provide service through much of the southeastern U.S. If the CLEC's traffic in Florida grew, it could install a second switch in Miami or Tampa.

Interoffice Transport

18. The fiber networks built by competitors provide alternatives to the incumbent LEC's interoffice transport facilities. When CLEC fiber or microwave connects to an ILEC central office, then interoffice transmission services to all other ILEC central office locations also connected to CLEC fiber or microwave have competitive alternatives. Consider Figure 5, which represents the locations of the ILEC central offices in a hypothetical community.

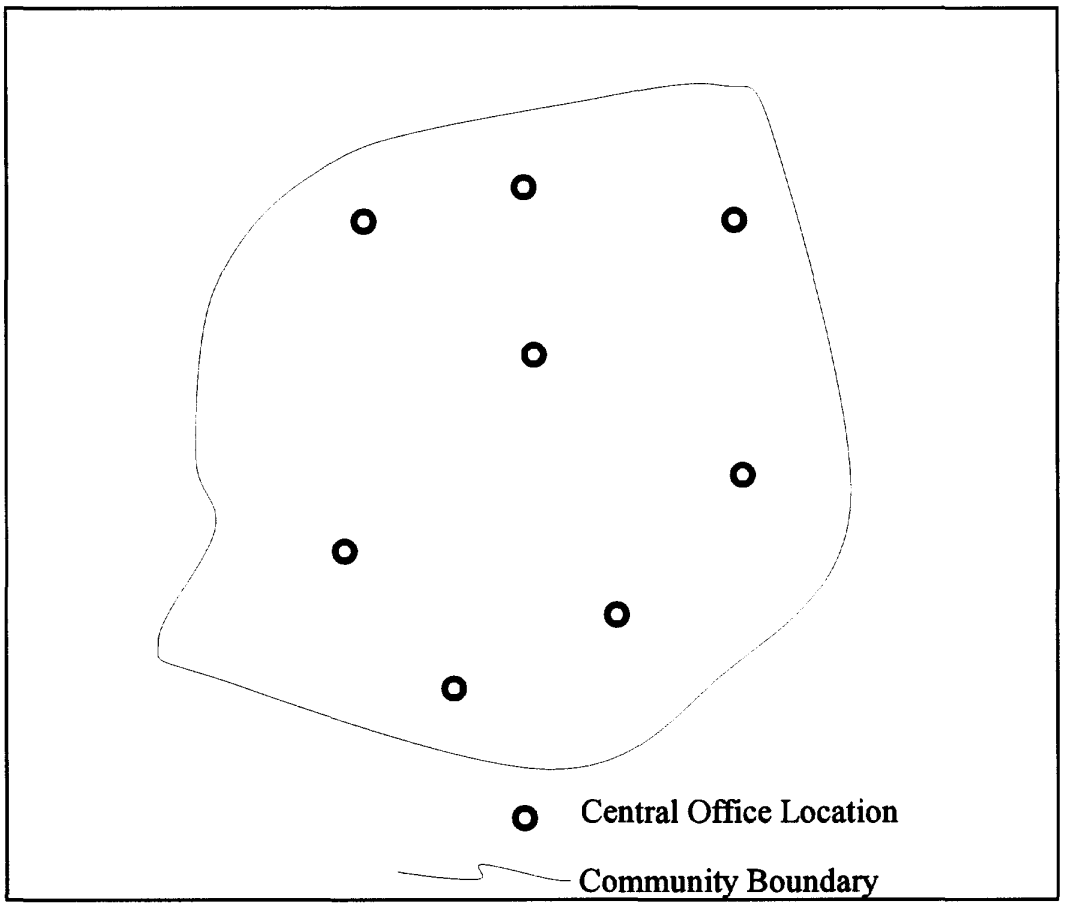

Figure 5. Community Boundaries and ILEC Central Office Locations.

19. Clearly, the ILEC must have a mechanism for moving traffic from each of these offices to all of the other offices. One approach to doing that is illustrated in Figure 7 as a pair of

hypothetical SONET rings with a traffic exchange point at one of the central office locations.

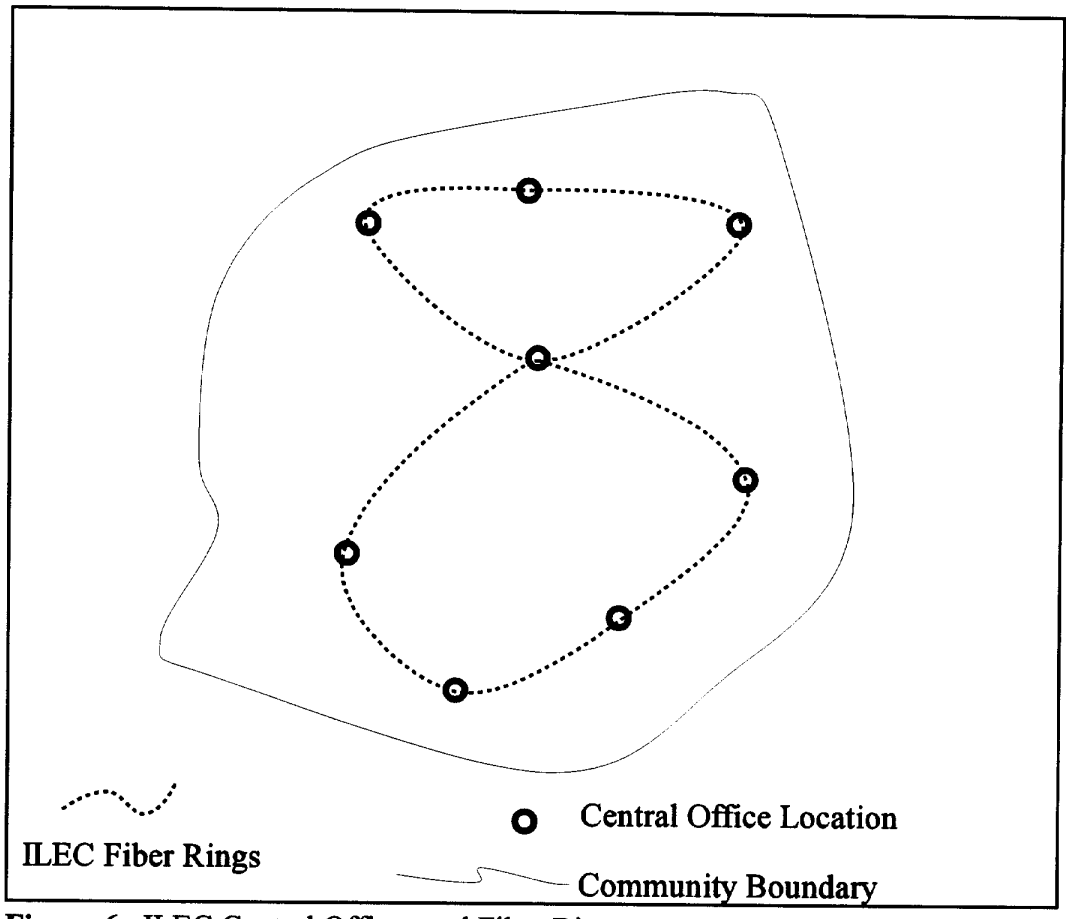

Figure 6. ILEC Central Offices and Fiber Rings.

20. A CLEC might also build a fiber facility serving the same community and connecting to some of the ILEC central offices as shown in Figure 8.

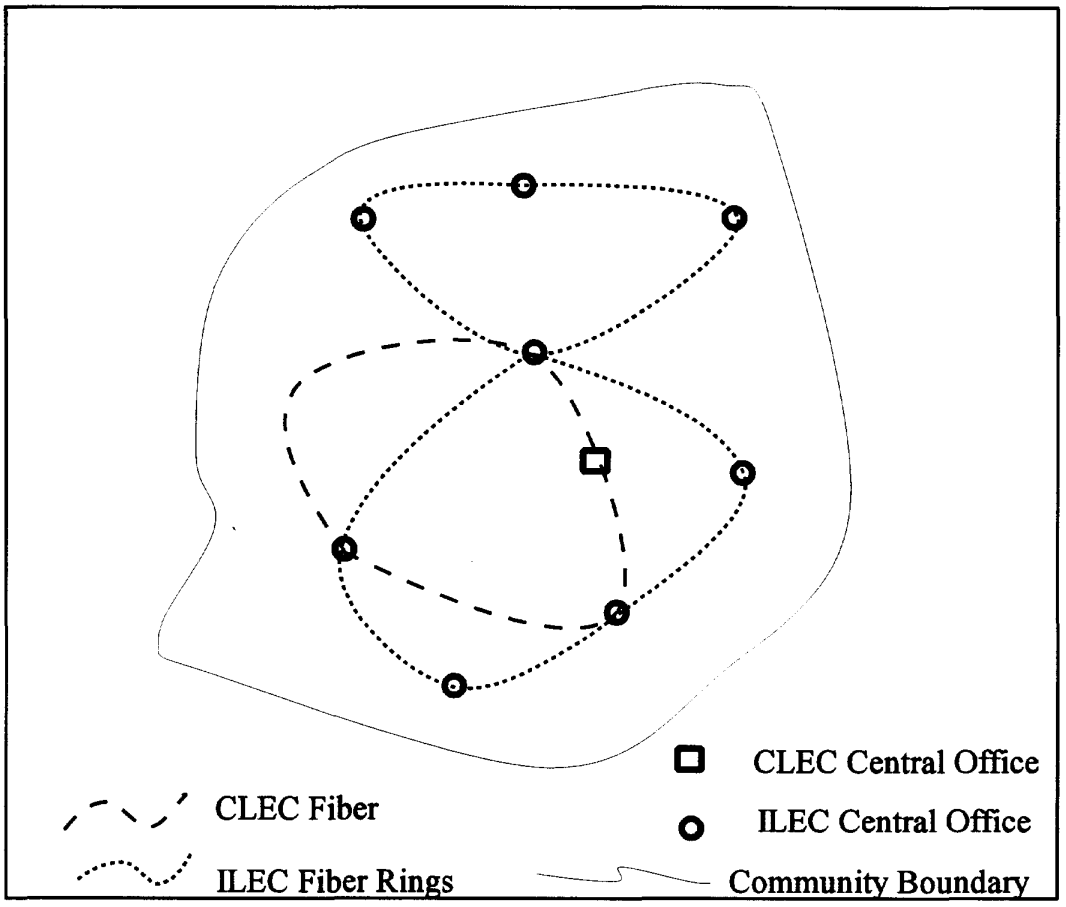

Figure 7. ILEC and CLEC Fiber Connections.

21. If a second CLEC also builds a network in the community, it is virtually certain that there will be a non-ILEC route between the networks of the two CLECs. For example, it is highly likely that both CLECs will connect to an AT&T point-of-presence (POP). In many communities, there are locations where the facilities of several telecommunications carriers come together.[12] It is natural for CLECs to connect to such nodal points. The network with two CLECs is shown in Figure 8.

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[12] One particularly well known such location is 60 Hudson Street in New York City. See http://www.x-changemag.com/articles/941bigd.html.

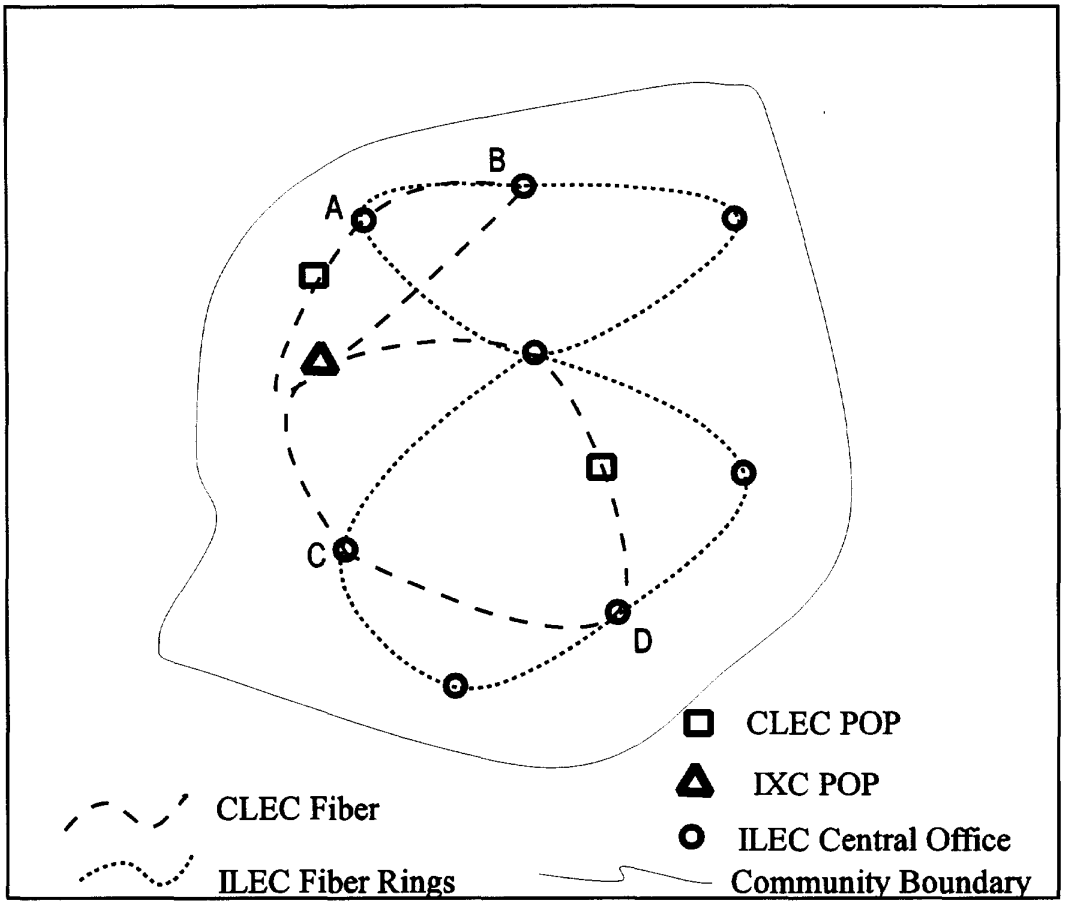

Figure 8. ILEC and CLEC Fiber Connections — Two CLECs.

22. Clearly, there are alternatives to the ILEC interoffice transmission facilities on the A-B and C-D routes. But, because the CLEC networks can be interconnected, the CLEC networks also create alternatives to the ILEC interoffice facilities on routes A-C, A-D, B-C, and B-D.

23. Another way to look at this connectivity is to consider alternative connectivity as a cloud — just as we consider the PSTN or the Internet to be a cloud. Whenever a central office is reached by a CLEC facility, then it is connected to the alternative connectivity cloud and there is an alternative route (alternative to the ILEC route) to all other ILEC central offices connected to the cloud. Figure 9 illustrates the growth of this cloud in the

hypothetical community considered above. It shows the same connectivity as in Figure 8 — but the connectivity is shown as a cloud rather than as individual links.

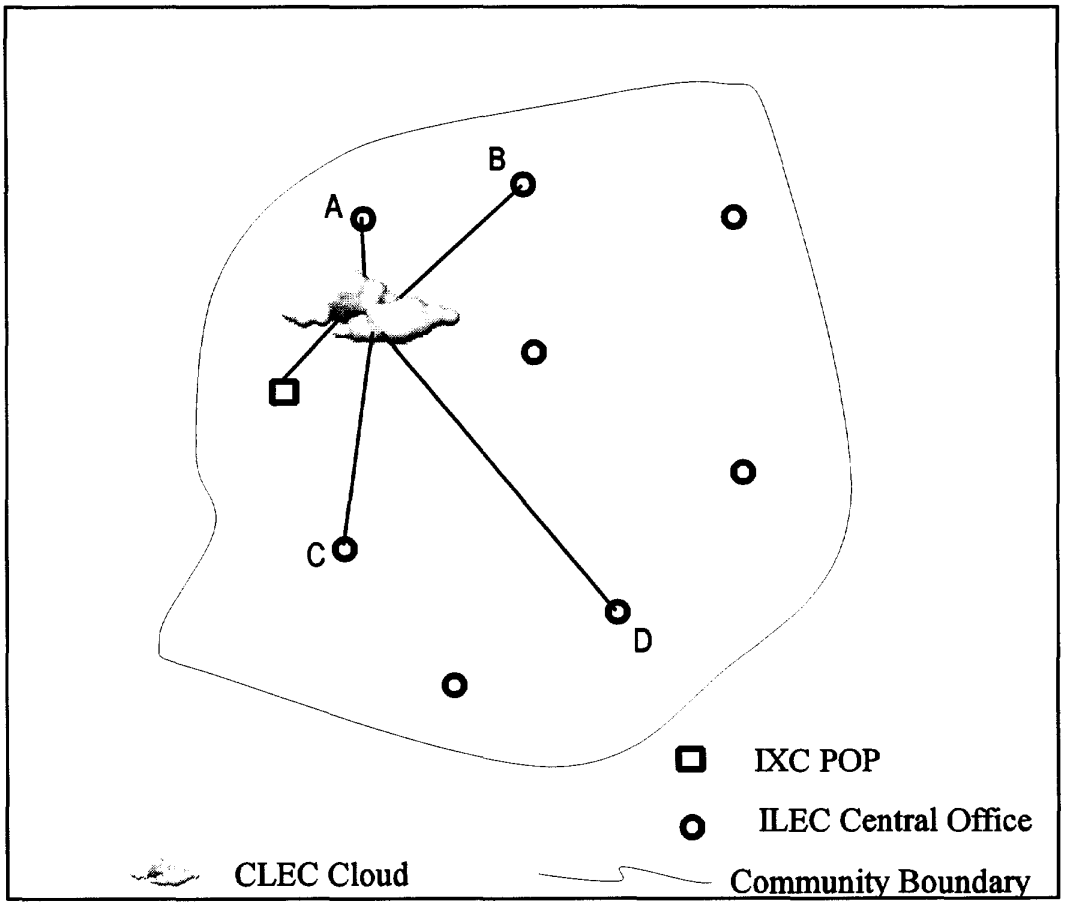

Figure 9. Cloud Representation of CLEC Connectivity.

24. As CLEC fiber reaches more and more ILEC central offices, the cloud of CLEC connectivity grows as shown in Figure 10:

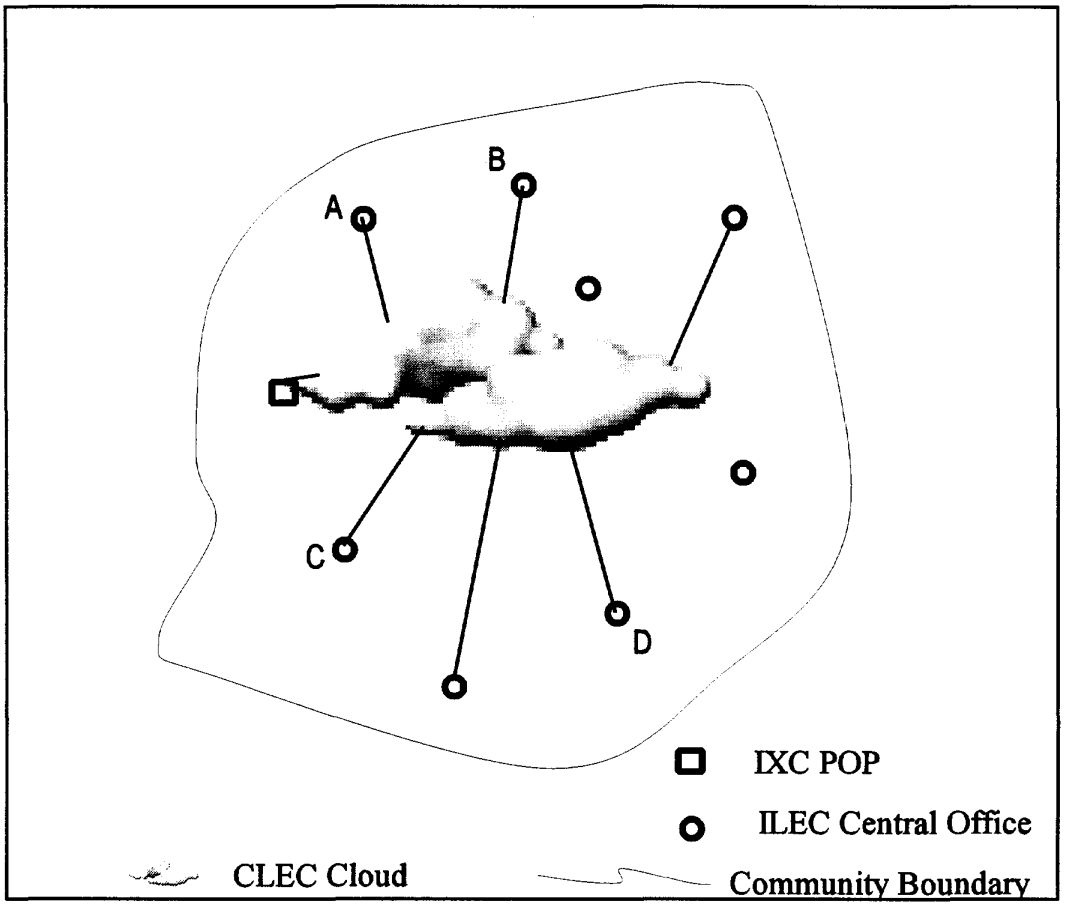

Figure 10. Growth of the Connectivity of the CLEC Cloud.

25. To recapitulate, when CLEC fiber touches a central office, alternatives appear for the interoffice routes to all the other ILEC central offices touched by CLEC fiber.

26. In the above discussion, I focused on fiber connectivity. But, one should also consider the impacts of modern radio-based carriers. Radio carriers with area licenses, such as the DEMS and LMDS carriers, can quickly install transmission capacity whenever a line-of-sight path exists from their premises (or premises they have rights to use) to the served premises. WinStar, a radio carrier that characterizes its service as *wireless fiber* in describing the services it offers to other carriers, states,

> WinStar offers the same capability without digging up the streets. And **our Wireless Fiber service can be installed quickly**. All it takes is a pair of one-to two-foot diameter antennas aimed at each

> other atop roofs or in windows. These devices are then linked through a "hub-and-spoke" network to WinStar's own local switching center or to an existing fiber-optic network already in the ground.[13] (Emphasis added.)

27. The implication here is that any ILEC central office that is in line-of-sight of a radio carriers should also be regarded as being connected to the CLEC cloud. That is, where CLECs have the ability to quickly add transmission facilities, such installations on such routes should be regarded as competitive alternatives.

Conclusions

28. Modern telecommunications switches and modern fiber optic transmission systems have greatly expanded the capability of communications systems. One of the expansions has been in the area that switches can serve. It is now commonplace for switches to serve customers located hundreds of miles from the switch. The fact that modern telecommunications switches can efficiently serve terminal equipment located at substantial distances from the switch gives CLECs two ways to obtain switching capabilities in addition to use of the facilities of the ILEC. A CLEC can backhaul traffic to a remote CLEC switch. Alternatively, a CLEC can purchase switching from another firm, such as AT&T or MCI WorldCom, that is positioned to efficiently backhaul traffic to its switches.

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[13] http://www.winstar.com/indexCarrServ.htm

29. Fiber optics, together with efficient interconnection capabilities such as add-drop multiplexers, makes it economical for carriers to share capacity. Whenever a CLEC connects to an ILEC central office, that ILEC central office is connected to the entire cloud of alternate connectivity. Therefore, there are alternatives to the interoffice facilities offered by the ILEC to all of the other ILEC central offices also connected to the cloud of alternate connectivity.

I hereby declare, under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Charles L. Jackson

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May 26, 1999

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Dr. Jackson received a B.A. degree from Harvard College with honors in applied mathematics and M.S., E.E., and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology. At MIT, he specialized in operations research, computer science, and communications. While a graduate student at MIT, he held the faculty rank of Instructor, taught graduate operations research courses, and was codeveloper of an undergraduate course in telecommunications.

Before associating with LECG, Dr. Jackson was staff engineer for the Communications Subcommittee of the U.S. House of Representatives. At the Federal Communications Commission, he was special assistant to the Chief of the Common Carrier Bureau and engineering assistant to Commissioner Robinson. He has also worked as a digital designer and computer programmer. After leaving government, Dr. Jackson cofounded both the telecommunications consulting firm of Shooshan & Jackson Inc., whose practice was later combined with that of National Economic Research Associates, Inc., and Strategic Policy Research, Inc.

Dr. Jackson has served as an expert witness in litigation on cellular telephony, cable television, and other telecommunications and computer issues and has testified before several state utility commissions.

He has authored or coauthored numerous studies on public policy issues in telecommunications and has testified before Congress on technology and telecommunications policy. Over the last several years, he has also directed or participated in projects on acquisition analysis, market planning, and product pricing. He has written for professional journals and the general press, with articles appearing in publications ranging from *The IEEE Transactions on Computers* to *Scientific American* to *The St. Petersburg Times*. He holds a U.S. patent on an alarm signaling system.

Dr. Jackson is a member of the IEEE, the Internet Society, the American Mathematical Society, and Sigma Xi. He is an adjunct professor of electrical engineering and computer science at George Washington University, where he teaches a graduate course in mobile communications. From 1982 to 1988, he was an adjunct professor at Duke University. He is a member of of the U.S. Department of Commerce's Spectrum Planning and Policy Advisory Committee (SPAC) and of the Federal Communications Commission's Technological Advisory Committee.

EDUCATION

Massachusetts Institute of Technology
Ph.D., Communications and Operations Research, 1977
M.S. and E.E., Electrical Engineering, 1974

Harvard College
B.A., Honors in Applied Mathematics, 1966

EMPLOYMENT

Currently **Law and Economics Consulting Group.** (LECG), Washington, DC, **Director**

Strategic Policy Research, Inc. (SPR), Bethesda, MD
1992–1997 **Principal.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.

National Economic Research Associates, Inc. (NERA), Washington, DC
1989–1992 **Vice President.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.

Shooshan & Jackson Inc., Washington, DC
1980–1988 **Principal.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.

Communications Subcommittee, U.S. House of Representatives, Washington, DC
1977–1980 **Staff Engineer**. Was responsible for common carrier legislation and spectrum-related issues.

Common Carrier Bureau, Federal Communications Commission, Washington, DC
1976–1977 **Special Assistant to Chief**. Was responsible for technological issues and land mobile policy.

Federal Communications Commission, Washington, DC
1975–1976 **Engineering Assistant to Commissioner Robinson.**

CNR, INC., Boston, MA
1973–1976 **Consultant.** Worked on the implementation of digital communication systems over dispersive channels.

Massachusetts Institute of Technology, Cambridge, MA
1973–1976 **Instructor.**
1971–1973 **Research and Teaching Assistant.**

Signatron, Lexington, MA
1968–1971 **Research Engineer.**

Stanford Research Institute, Menlo Park, CA
1966–1968 **Programmer.**

PROFESSIONAL ACTIVITIES

Member, Sigma XI, Institute of Electrical and Electronics Engineers (IEEE), IEEE Computer Society, IEEE Communications Society, IEEE Information Theory Society, American Association for the Advancement of Science, the Internet Society, and the American Mathematical Society.

From 1987–88, served on the Board of Directors of the Telecommunications Policy and Research Conference. Chairman of the Board, 1988.

Chairman, IS/WP1 (Policy and Regulation) of the FCC's Advisory Committee on Advanced Television.

Executive Committee Member, University of Florida's Public Utility Research Center (PURC).

Member, U.S. Department of Commerce Spectrum Planning and Policy Advisory Committee.

Member, Federal Communications Commission Technological Advisory Committee.

TESTIMONIES

Statement of Dr. Charles L. Jackson before the Federal Communications Commission En Banc Hearing on Spectrum Management.

Declaration of Dr. Charles L. Jackson before the FCC in *1998 Biennial Regulatory Review — Spectrum Aggregation Limits for Wireless Telecommunications Carriers, WT Docket No. 98-205*, Prepared for Bell Atlantic. January 25, 1999.

Testimony of Charles L. Jackson, in re: *GWI PCS1, Inc., at al., Debtors and GWI PCS1, Inc., et al., Plaintiffs vs. Federal Communications Commission, Defendant,* in United States Bankruptcy Court for the northern District of Texas, Dallas Division, April 16, 1998.

Preliminary Statement of Dr. Charles Jackson, in *Amarillo CellTelCo v. Southwestern Bell Wireless, Inc. et al.* in United States District Court, Northern District of Texas, Amarillo Division, March 27, 1998.

Deposition of Charles L. Jackson, in re: *GWI PCS1, Inc., at al., Debtors and GWI PCS1, Inc., et al., Plaintiffs vs. Federal Communications Commission, Defendant,* in United States Bankruptcy Court for the northern District of Texas, Dallas Division, March 19, 1998.

Declaration of Charles L. Jackson, Prepared in the United States Court for Federal Claims for Plaintiff CellularOne in *Washington Baltimore Cellular Limited Partnership (d/b/a CellularOne Washington/Baltimore) Plaintiff, and Bell Atlantic Mobile, Inc. Intervenor-Plaintiff, v. United States, Defendant,* Case No. 98–50C (Judge Hodges), March 4, 1998.

Declaration of Charles L. Jackson, Prepared in the United States Court for Federal Claims for Plaintiff CellularOne in *Washington Baltimore Cellular Limited Partnership (d/b/a CellularOne Washington/Baltimore) Plaintiff, and Bell Atlantic Mobile, Inc. Intervenor-Plaintiff, v. United States, Defendant,* Case No. 98–50C (Judge Hodges), February 25, 1998.

Joint Rebuttal Statement of Charles L. Jackson and Jonathan L. Kramer, Expert report prepared for the defendants in *Playboy Entertainment Group, Inc. v. United States of America et al.,* Civil Action No. 96–94/96–107–JJF, January 1998.

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With Jeffrey H. Rohlfs and Ross M. Richardson. *The Depreciation Shortfall.* Prepared for submission before the Federal Communications Commission, CC Docket No. 96–262: *USTA Comments,* Attachment 15, filed January 29, 1997. *Reply Comments* filed February 13, 1997.

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Declaration filed before the Federal Communications Commission on behalf of the United States Telephone Association, *In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996*, CC Docket No. 96–98. May 16, 1996.

Declaration filed before the Federal Communications Commission on behalf of Bell Atlantic Network Services, Inc., *In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996*, CC Docket No. 96–98. May 15, 1996.

Testimonial declaration filed before the United States District Court for the District of Delaware on behalf of the United States Department of Justice, *Playboy Entertainment Group, Inc., and Graff Pay-Per-View, Inc., v. United States of America, et al.*, Civil Action No. 96–94/96–107–JJF, Consolidated Action. May 13, 1996.

Remarks on spectrum policy before the Federal Communications Commission *en banc* hearing. March 5, 1996.

Affidavit filed before the Federal Communications Commission on behalf of The Wireless Communications Council, *In the Matter of Omnipoint Communications, Inc. New York MTA Frequency Block A*, File No. 15002–CW–L–94. January 16, 1996.

Testimony filed before the Public Service Commission of South Carolina on behalf of Southern Bell Telephone and Telegraph Company, *BellSouth Telecommunications, Inc. d/b/a Southern Bell Telephone and Telegraph Company Request for Approval of the Consumer Price Protection Plan in South Carolina*, Docket No. 95–720–C. September 1995.

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