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A Schumpeterian Analysis of Network Industries

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Joseph Schumpeter has argued that the life-span of monopolies were limited by the "creative destruction" forces of capitalism. For a period of time, a firm may be able to dominate an industry and earn monopoly profits. As other firms become aware of these profit opportunities, they are attracted to the industry. Through the process of innovation, the entrant may displace the first dominant firm and earn monopoly profits. In turn, the second dominant firm's high earnings will attract rivals to the industry.[1]

This mode of analysis has been used to explain the centrifugal forces operating in the telecommunications industry. In U.S. v. AT&T[2], the defendant argued that, due to the regulatory objectives of promoting universal service, the prices for some business communications services had been kept above the economic cost-of-service. High prices were set for business customers in order to provide a subsidy to residential customers.[3] According to AT&T, private telecommunications networks, as well as specialized common carriers, established service because of these regulatory distortions. If Bell had been free to establish subsidy-free

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[1]Capitalism, Socialism and Democracy (New York: Harper & Row, 1942), pp. 85-106.

[2]Civil Action No. 74-1698 (D.D.C.)

[3]American Telephone and Telegraph, "Defendants' Third Statement of Contentions and Proof," United States v. American Telephone and Telegraph, pp. 15, and 361-381, March 10, 1980.

rates, the firm believed that it could have continued to serve the entire telecommunications market at a lower cost than in its currently fragmented form.[4]

Eli Noam has argued that the same forces are currently pulling apart the network. In his paper on the "Tragedy of the Commons," he shows how subsidies can drive business customers off the common network. In order to avoid burdensome subsidies, large business customers have an incentive to establish private networks.[5]

If entry is principally due to subsidies, competition involves an efficiency loss to society. The entrant, who is not subject to the same degree of rate regulation, does not displace the incumbent through the marketing of a superior product. Instead, the new firm gains market share by taking advantage of market distortions established through the political, rate setting process.

In this paper, I argue that the emergence of new networks has less to do with subsidies than it does with changes in the macroeconomy, the organizational structure of firms, and the ability of the incumbent telecommunications firms to install new technology that meets the needs of large users.

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[4]Ibid., pp. 35, 2097-2136.

[5]"Network Tipping and the Tragedy of the Common Network," Working Paper, Columbia Institute for Tele-Information. A private network is a set of telecommunication facilities which is not available for public use. Conversely, a public network, or common carriage, is "'a public offering to provide for hire facilities...whereby all members of the public who choose to employ such facilities may communicate or transmit intelligence of their own design or choosing." National Association of Regulatory Utility Commissioners v. F.C.C. 525 F.2d 630, 641 (D.C. Cir.) cert. denied, 425 U.S. 999 (1976).

Historically, private networks have emerged in areas in which the common carrier is unable to efficiently meet the needs of the public with existing technology. As the starting point for this paper, I review the formation of the nation's first alternative private network, AT&T's private line system. As Schumpeter suggested, as the new dominant firm, AT&T's exclusive control of the market would not be permanent. In section three of the paper, I review some of the factors which led to the formation of private networks during the post-World War II era. Finally, in section four, I offer some propositions regarding the formation and demise of networks.

II. Telegraph Services and the Emergence of the Multi-Unit Firm

The large territorial span of the United States was an initial barrier to the development of large scale industrial enterprises in the United States. While the nation's population was growing rapidly during the first half of the nineteenth century, its dispersion over a wide territory limited the ability of firms to engage in large scale manufacturing. A necessary condition for the growth of large scale manufacturing was the development of technologies that lowered the cost of serving multiple markets.[6]

In the two decades prior to the Civil War, three key technologies, canals, railroads and the telegraph, played a role in

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[6]Alfred Chandler, The Visible Hand: The Managerial Revolution in American Business (Cambridge: Harvard University Press, 1977), pp. 49, 75.

the take-off of the economy. The canals and railroads lowered transportation costs and increased the nation's access to coal, an inexpensive energy source.[7]

Paralleling many of the nation's railroads was the nation's first high-speed information network, the telegraph. The telegraph improved firms's ability to coordinate marketing and production activities in different localities, helped tie together the nation's banking and financial markets, and provided instant access to price information on the nation's commodity markets.[8]

Coordination of market activities was further enhanced by the invention of the telephone, in 1876. The public rapidly accepted the telephone. According to the Bureau of the Census, "By 1899 telephony...not only had surpassed telegraphy in physical and financial magnitude, but by its very growth had seriously restricted the expansion of" telegraphy.[9]

The telephone gained almost complete control of the local telecommunications market. It was the preferred mode of communication within cities because it was more rapid, and less expensive. The telegraph operated at a cost disadvantage because of the need to use Morse telegraph operators on either end of the circuit. Telephony was less labor intensive, and consequently quickly became the dominant telecommunications technology for

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[7]Ibid.

[8]Ibid.

[9]Department of Commerce and Labor, Telephones and Telegraphs: 1902 (Washington: Government Printing Office, 1902), p.3.

intra-city traffic.[10]

Telephony also quickly dominated the long-distance market. By 1902 there were 120,704,844 long-distance telephone messages, nearly thirty million more than the number of telegraph messages. Only when a written record was required, or a long-distance communication for which the cost of telephony exceeded that of telegraphy, did the older technology sustain a competitive edge.[11]

The nation's leading long-distance telephone company, AT&T, did not limit its services to telephony. As early as 1879, Bell was marketing private line telegraph service, in competition with Western Union, to the nation's largest industrial, banking, and financial firms.[12]

Before the invention of the telephone, large users of the telegraph network requested and obtained private line service.[13] Private line telegraph service was used by four classes of customers: railroads, the press, bankers and brokers, and industrial customers. The bankers and brokers were the largest

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[10]Ibid., p.99.

[11]Ibid.

[12]M.D. Fagan, ed., History of Engineering and Science in the Bell System: The Early Years (1875-1925) (Homdal, New Jersey: Bell Telephone Laboratories, 1975), p.734.

[13]Similar to today's software controlled private line services, the subscribers to private line services rarely had exclusive control over a wire between two points. Instead, the subscriber had exclusive access to the circuit for the hours negotiated in a contract. Subscribers to private line service could not use the dedicated line service during the system peak demand hours of 10 to 12 A.M. Interstate Commerce Commission, "Private Wire Contracts," 50 ICC (1918) 731, 734-736.

customer group; in 1912 they accounted for 80 per cent of the private line business.[14] The private wire business was concentrated in the Northeast and Mid-West,[15] the regions of the nation with the greatest industrial and commercial development.

The bankers and brokers used the service primarily for exchange trading. When the wire was not being used for this purpose, market and other types of news was transmitted. Industrial firms used the private lines mainly for coordinating activity between the different branches of the multi-unit firm.[16]

For both the bankers and the industrialists, a private line provided benefits that were not available on the public network: These networks provided extra privacy, something both parties desired in order to protect trade secrets. Other advantages included: higher quality and transmission speeds, as well as the carriers' commitment to restore service first on private lines on which there was an outage due to down lines. In order to obtain the best personnel, The lessees of private lines hired highly skilled telegraph operators. These operators received a premium which was up to fifty-percent higher than the wage paid to the less-skilled operators on the public telegraph network. It was

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[14]The meat packing and steel industries accounted for the next largest block of business, approximately nine percent. The bankers and brokers accounted for a smaller proportion of the private telephone lines--27 per cent. Ibid. p. 738. The difference was likely due to the need for a written record of the financial transactions.

[15]Ibid., p. 738.

[16]Ibid., p.740-1.

because of the superior service, rather than cost savings, that most customers obtained the private line service.[17]

The railroads obtained private line service through the construction of stand-alone systems. The rail lines needed a network that could be used to coordinate the flow of traffic throughout the nation. The telecommunications common carriers did not serve all of the rural areas covered by the rail system. The telegraph companies also found it costly to provide the high-grade of service needed in the railroad business. In light of these considerations, the railroads decided to build their own private networks.[18]

AT&T's telegraph service was limited to the rental of lines to large users. Providing telegraph service to the public would have required the firm to hire workers for coding and decoding messages, as well as delivering messages. Instead, AT&T only marketed its telegraph service to customers with sufficiently large needs that they could afford to hire their own telegraph operators. While initially the market for this service was limited, the refinement of the telegraph printer around 1910 made the service more widely available.[19]

There were no technological barriers that precluded AT&T from providing telegraph service. The same transmission lines used for

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[17]Ibid., 742-3, 749.

[18]AT&T, "Third Statement," pp.540-1; and N.A., "Western Union Telegraph Company--Statistics--1912," ATT, box 10.

[19]Fagan, Engineering and Science in the Bell System, pp. 738-39, 743-44.

switched message calls could be employed for telegraph service. Because of the similarity in transmission technologies, AT&T had some concern that Western Union would retaliate and enter the toll telephone business. Since, within a city limits, the telegraph lines were not as ubiquitous as telephone lines the threat would have been expensive to carry out. Absent the construction of its own telephone exchanges, Western Union would have had to ally itself with the Independent telephone companies that were competing with AT&T. While Western Union threatened to reciprocate and provide private line toll telephone service, the threat did not deter AT&T from expanding its offerings of private line telegraph services.[20]

The competition between Western Union and AT&T for telegraph service illustrates three important concepts regarding private and public networks: the role of subsidies, technological innovation, and network design. First, the first private networks were established to meet the customers needs for better service (speed, privacy, and access to remote locations), rather than in response to regulatory distortions (the telegraph industry was not regulated during these years). It was inefficient for the public network to be designed to meet the more demanding needs of large users of information services.

Second, consistent with the Schumpeterian theory of transient dominance, new technologies eroded the power of the dominant firm,

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[20]H. Stone/J. Hudson, March 28, 1995, "Private Line Rates in Chicago," box 1284, ATT.

Western Union.

Third, AT&T was able to quickly capture the local message market because within a city, telephone facilities were more ubiquitous. Western Union could not compete in AT&T's market until it changed the way its facilities were designed. Instead of locating operator facilities at one or only a few locations in a city, Western Union would have had to spread its operations throughout the town. This would have been an expensive course to pursue.

III. Formation of Private Networks in the Post World War II Era

During the post-World War II era there has been a proliferation of private networks. In many ways the recently constructed private networks were established for the same reasons that were crucial during the first thirty years of telephony: security, the need for central management to coordinate and monitor activities in different units of the firm, the need to reach remote areas, and, more generally, "the inability of the common carriers to meet the new or specialized consumer demands in the market place."[21]

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[21]See, for example, Plaintiff's Third Statement of Contentions and Proof, in United States v. American Telephone and Telegraph, 74-1698 (D.D.C), p. 86 (quote); "Comments of Microwave Communications, Inc." in "Regulatory and Policy Problems Presented by the Interdependence of Computer and Communication Services and Facilities," FCC Docket No. 16979 (hereafter "Computer I,"), March 5, 1968, p. 26-28; Federal Communications Commission, "In the Matter of Allocation of Frequencies in the Bands Above 890 Mc," 27 FCC 359, 377-9 (1959); and Stanford Research Institute, "Policy

Immediately after World War II, a large part of the demand for new services was related to the growth of commercial television. AT&T's transmission facilities were unable to provide adequate intercity transmission facilities to the networks. Unable to obtain satisfactory transmission facilities from AT&T, the networks set up private, microwave systems.[22]

The principle factor driving the demand for private line networks was the growth of the data processing industry. As the cost of processing dropped, operating systems that provided real-time solutions to problems became more common, and electronic mail communications took-off, the need for data communication lines increased.[23] The public switched network was not capable of providing the quality transmission lines that were needed for high speed data and video transmission.[24]

In the late 1950's, the shortcomings of the public switched network were discussed extensively in the FCC docket "Above 890."[25]

Issues Presented by the Interdependence of Computer and Communications Services," Report No. 7379B-1 (1969), pp. 25-29.

[22]cite Plaintiff's third statement

[23]MCI, "Comments," p.1; "Response of U.S. Department of Justice," Computer I, March 5, 1968, p.2; Stanford Research Institute, "Decision Analysis of the FCC Computer Inquiry Responses," Report No. 7379B-3 (1969), p.13 and "Analysis of Policy Issues in the Responses to the FCC Computer Inquiry," Report No. 7379B-2, p. 115-6.

[24]MCI, "Comments," p.27.

[25]FCC, "Allocation of Microwave Frequencies Above 890 Mc.," pp. 364-379. For example, the Electronics Industries Association stated that potential users of private microwave systems included firms "which require highly specialized communications circuits which are not readily or economically obtainable over wire

A decade later, as the problems persisted, the data processing industry provided the common carriers with a list of ten ways in which service could be improved. The list included the speed of connection and disconnection, as well as the associated billing period; a greater variety of bandwidth and transmission speeds; a reduction in the error rates; improved circuit testing procedures; and the deployment of a digital data transmission network.[26]

Today, 30 years after "Above 890," large business customers have many of the same complaints about the public switched network. The users have established private networks, or obtained service from alternative local exchange carriers, because of quality-of-service, along with cost considerations. The current enumeration of complaints is little different than the issues cataloged in 1969.[27]

During the post-World War II era there has been a major change in the type of technology used in the public switched network. While manual switching systems were widely deployed in the 1940s, by 1990 the switching was largely completed by computer controlled

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communications systems..." Ibid., p. 378.

[26]Stanford Research Institute, "Analysis of Policy Issues," p.47.

[27]Eli Noam, "The Public Telecommunications Network: A Concept in Transition," 37 Journal of Communications 30 (1987); John M. Griffiths, "ISDN Network Terminating Equipment," 30 IEEE Transactions on Communications (1982), 2137; Roger G. Noll, "The Future of Telecommunications Regulation," in Telecommunications Regulation Today and Tomorrow, ed. Eli M. Noam (1983), 43; Re Pacific Bell, 69 PUR4th 225, 236 (1985); and Jane L. Racster, Michael D. Wong, and Jean-Michael Guldmann, "The Bypass Issue: An Emerging Form of Competition in the Telephone Industry," National Regulatory Research Institute, 84-17 (1984).

equipment.[28] Similar modernization activity has occurred with interoffice facilities--coaxial, N and copper carrier systems have been replaced with T-carrier and fiber optics. With respect to the local loop, loaded lines was initially an impediment to the provision of high-speed data services. Loaded cables pairs have been largely eliminated from the loops located near large business customers.[29]

Despite these changes in facilities, large users still express their dissatisfaction with the service provided by the common carriers. In part this is the result of the slow pace in which the common carriers have deployed new technology. For example, during the 1970s the Bell Systems leading product in the PBX market was the analog, Dimension Private Branch Exchange (PBX). While the Dimension PBX was satisfactory for the majority of users, it was cumbersome for data transmission. Consequently many customers chose to buy digital PBXs from other suppliers. According to Temin, AT&T's decision to market the analog technology reflected the internal management style of the firm during the 1970s. The deployment of technology was determined by engineering criteria, rather than market objectives. The engineers controlled the operations of the Bell System, and they believed that digital consumer premise technology should not be deployed until the

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[28]Federal Communications Commission, Statistics of the Communications Industry in the United States, (Washington: Government Printing Office, 1949), table 25.

[29]Byrne, Coburn, Mazzoni, Aughenbaugh, and Duffany, "Positioning the Subscriber Loop Network for Digital Services," 30 IEEE Transactions on Communications 2006 (1982).

national network was converted from analog to digital technology.[30]

While more rapid deployment of digital technology would have allowed the Bell System to maintain its market share in the customer premise market , a more fundamental problem for the local exchange carriers (LECs) is the design of the exchange switching machines. The architecture of the switches limits the ability of common carriers to compete in the market for high-speed and video services. These services have fundamentally different usage patterns that voice telephony. When only voice telephony was provided on the public switched network, engineers assumed that during the peak-demand period each customer placed one call that lasted for three to five minutes.[31] High-speed data services often involves short-bursts of information, perhaps 15 to 20 seconds in length. The number of per customer data connections during the system busy-hour is significantly larger than one. At the other extreme, some data transmissions, as well as video, will involve connections that last for the full system busy-hour.[32]

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[30]Peter Temin with Louis Galambos, The Fall of the Bell System: A Study in Prices and Politics (Cambridge: Cambridge University Press, 1987), p.150.

MCI believed that its original success in the transmission market would derive from its ability to quickly respond to customer needs in niche markets. As a new firm, they would not have to give "consideration to the preservation of other forms of types of service." MCI, "Comments of MCI," p.8.

[31]Peak-hour usage is one of the primary criteria used to determine the amount of switching equipment needed to serve customers.

[32]Kenneth F. Giesken, "ISDN Features Require New Capabilities in Digital Switching Systems," 3 IEEE Journal of Telecommunications Networks 19-28 (1984).

The switching network has been designed to satisfy the needs of voice telephony. The deployment of a switch that is used for voice, video and high-speed data transmission will increase the variance of usage patterns. In order to provide these three services through the same public switched nodes, there must be fundamental changes in the current design of the switching machines.[33]

To date, the exchange common carriers have not been able to obtain a switch that economically provides all three services. Consequently their current offerings of high-speed switched data services are offered through auxiliary machines, such as the Stromberg-Carlson Metropolitan Area Network or AT&T's Broadband Service 2000 Switch.[34]

The lack of a switching machine that can economically provide switched voice, high-speed data and video services explains in part why customers find it cost efficient to establish a private network. Due to the unavailability of a multi-purpose switch, common carriers are unable to obtain a competitive advantage by exploiting economies-of-scope.[35] Since separate switching

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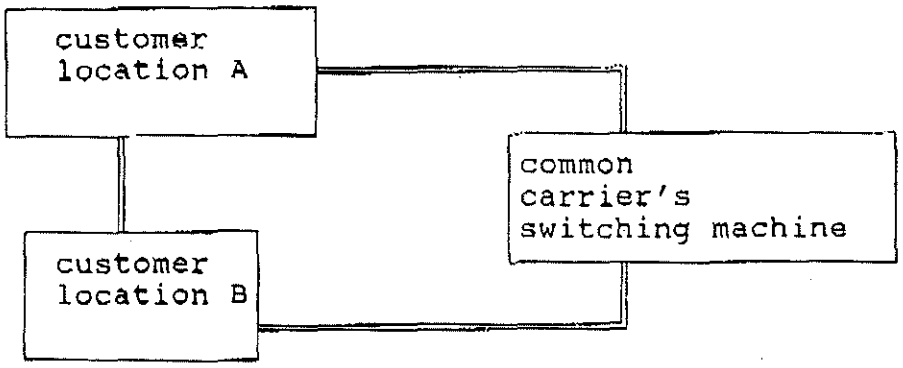
[33]Ibid., p. 20.

[34]"Bell Atlantic Set to Rollout Offerings Similar to SMDS," Network World, October 14, 1991, p. 4, 96; and "PacBell Gives SMDS Thumbs-Up," Communications Week, October 14, 1991, p.35.

[35]Economies of scope exist if
$C(Q_1,0) + C(0,Q_2) > C(Q_1,Q_2)$
where Q_1 = the output of product one
Q_2 = the output of product two
The equation merely states that it is cheaper to have product one and two produced by a single firm $[C(Q_1,Q_2)]$, than by having separate firms produce product one and two $[C(Q_1,0) + C(0,Q_2)]$.

equipment must be used for non-voice services, it may be more economical to rely on private services. By constructing a private network, transmission cost may be reduced, as well as switching costs (see figures).



To transit data between customer locations, the firm can either use a private, direct link (A to B), or use the common carriers switching machine. While the direct link involves a shorter distance, it may be cheaper to use the common carrier's facilities. The cost of the using the shared facilities could be less than the cost of constructing a private network. But when the common carrier has to install special switching equipment for high-speed data services, there are few customers who will share the responsibility of recovering the fixed cost of the auxiliary switching equipment. This will raise the unit cost of obtaining high-speed data services from the common carrier.

Will We See A Repeat of Western Union's Demise?

In the preceding section I argued that a market developed for

specialized carriers because of the technical limitations of today's switching technologies, and because it was costly to redesign the existing switched network to provide new services. The inability of the incumbent to rapidly adopt to technological changes raises the specter that today's telephone common carriers will go through the same Schumpeterian destructive phase experienced by Western Union. Unable to obtain high speed data service over the public switched network, customers will obtain service from the new suppliers.

Private digital networks are capable of providing voice services. Currently, they are used to provide intracompany voice communications. The economics of telephony suggest that it is unlikely that private networks will expand into marketing voice services on a common carriage basis. While private carriers have access to customers where conduit is readily available, in less densely populated areas providing duplicate loop facilities is difficult. In order to establish a second exchange network, the carrier would have to obtain a permit from the city for burying its cables. This is a formidable barrier-to-entry.

Furthermore, competition in the local exchange market is unsustainable because of the cost of providing interoffice calls. When a second exchange is established, it lowers the percentage of customers who are served by a given switch. For example, if a city may initially be served by one city, all exchange calls originate and terminate on the same switch. If a new carrier enters the market, the percentage of calls between switches will no longer be

zero. The cost of these switching interoffice calls is, at the minimum, twice as expensive as the cost of an intraoffice call.[36]

If rates are established to reflect the cost of connecting competing exchange switches, customers will have an economic incentive to migrate to one firm. By relying on one firm, the cost penalty of additional interoffice calls is avoided. For example, after interconnection of competing telephone service was ordered in LaCrosse, Wisconsin in 1913, almost all customers moved onto one system in order to avoid the penalty associated with interoffice calls. The Wisconsin Railroad Commission had determined that the cost of an interoffice call was five cents and that cost should be recovered from the originating party. There was no charge for intraoffice calls.[37]

In summary, just as the ubiquitous local telephone exchange gave AT&T a first-mover advantage over Western Union at the start of the twentieth century, the common carriers continue to have an important advantage today. While specialized common carriers and private networks will be able to serve niche markets, the core voice market of the common carriers are unlikely to be subject to competition.

IV> Conclusion

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[36]Switching costs will at least double because of the use of two machines. The available cost data suggests that the cost penalty is much higher. David Gabel, "Deregulation: Should the Local Telephone Market be Next?," New England Law Review 24 (1989), p. 53.

[37]Ibid., p.55.

As illustrated by the rivalry between AT&T and Western Union, new technology can lead to the rapid demise of a dominant firm. But the use of superior technology is not a sufficient condition for successful entry. Today's private data and voice networks may employ technologically that is more advanced than the LECs' facilities, but the entrants are only a limited threat to the common carrier's core, voice exchange services.

The history of telecommunications networks in the United States suggests that regulation may have been a "boggy-man" used to explain the growth of private networks. While subsidies from business to residential customers, if they do exist, may play a role in the growth of private networks, but the origin is more based in the heterogeneity of user needs, and the inability of the incumbent firm to rapidly adjust its network to efficiently meet the demands of all customer groups. The problems faced by the LECs are conceptually similar to the challenge faced by Western Union prior to the advent of regulation. Once committed to a particular architecture, it is cumbersome to modify the network so that the new technology may be rapidly deployed.