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Innovation and New Services

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Prior to divestiture, under the AT&T monopoly regime, users came to expect "one-stop shopping" and "end-to-end service." In this environment, new network offerings were introduced on a highly restrained basis. These were also largely predictable, and terms and conditions of supply were often *not* reflective of technical limitations. Service innovation was not a carrier priority, but, instead, was a by-product or incidental result of supply-driven technical innovation or a response to limited competition. For instance, the operational improvement aspects of touch-tone were its prime motivation, not the new service possibilities that this new form of dialing facilitated. In short, customer demand assumed a relatively minor role in service development or introduction.

As the local provider for more than 80 percent of the nation's telephone subscribers and over 95 percent of long-distance customers, the Bell System wielded considerable influence in determining the direction and rate of change of innovation pre-divestiture. Bell Laboratories received enormous payments for conduct of basic research and systems engineering from all the BOCs and AT&T's Long Lines Division. In 1982 alone, the BOCs' "license contract" expenditures totaled $464.5 million for fundamental research and systems engineering (R&SE).[1] Historically, substantial "specific design and development" (SD&D) payments were also made to Bell Labs by Bell's manufacturing arm, Western Electric. For example, in 1979 SD&D accounted for 60 percent of the Labs' research budget, while the remaining 40 percent represented R&SE disbursements.[2]

In general, the perceived need for network improvements, rather than a recognition of customer demand, appeared to drive innovation in the telecommunications industry for at least two-thirds of this century. Where competition did exist, technical and service imperatives were often redirected. And, even when an effort to be innovative in a services sense occurred, the design often appeared to be left to engineers rather than marketers, sometimes with disastrous results.

Most industry observers agree the current rate of innovation in telecommunications is exceedingly brisk. For example, NTIA finds in its 1988 landmark assessment of the industry that "[e]xponential technological and commercial growth today characterizes telecommunications."[3] Similarly, MCI's industry pioneer Willam McGowan observes there has been an "explosion in services," citing, inter alia, his company's increase in core offerings from five to sixty since divestiture.[4]

Major users and the RBOCs also have characterized the rate of innovations as rapid. Indeed, in contrast to historical constraints on their options, International Communications Association members acknowledge the existence of a much wider choice of attractive communications equipment and services today.[5] Finally, Judge Harold Greene concludes, "as predicted by classic antitrust doctrine, innovation has flowered during the post-divestiture period."[6]

Despite this apparent widespread consensus, careful analysis of the events of the post-divestiture period may suffer from imprecise use of concepts and terminology. Service innovations present very considerable obstacles to recognition and precise measurement. A glance at table 7.1, "Telecommunications Mileposts," underscores some of the complexities that may be encountered. For example, the appearance of (OUT)WATS, which was introduced in 1961, and (IN)WATS, which was inaugurated four years later, clearly gave rise to a number of effi-

Table 7.1

U.S. Telecommunications Mileposts: Service and Equipment

Year	*Event*	*Year*	*Event*
1844	First commercial telegraph system (Washington, D.C.↔Baltimore)	1948	First microwave radio relay system cutover (N.Y.↔Boston)
1876	A.G. Bell awarded telephone patent	1951	Beginning of direct long-distance customer dialing
1879	First telephone switchboard (New Haven, Conn.)	1955	Colored phones offered (Bell System)
1882	First underground cable laid	1956	First transAtlantic telephone cable
1889	First public pay phone installed	1958	Hi-Speed Data Phone service inaugurated (1200 bps)
1892	First automatic switchboard (LaPorte, Ind.)	1960	Electronic switching systems developed
1896	First telephone dial (Milwaukee, Wis.)	1961	WATS, Telpak introduced
1905	First unattended central office	1963	Touch-Tone (push button phone) service begun
1915	First transcontinental call (N.Y.C. to S.F.)	1964	Facsimile machines in infancy
1918	First carrier (transmission) system	1965	First commercial international telephone service by satellite ("Early Bird"); AT&T 800 Service initiated
1920	First automatic toll board	1966	Data transmitted 4800 bps
1926	Nonblack telephones offered (Independents)	1970	Picturephone service offered
1927	First international telephone call (N.Y. to London)	1972	First commercial analog electronic switching system
1930	Data transmitted 600 bits per second via telephone		
1940	Coaxial cable introduced		
1947	Transistor unveiled by Bell Labs		

Table 7.1 (continued)

Year	Event
1974	First private line digital communications service (data transmitted 56 Kbps)
1976	First commercial digital electronic switching system
1977	First full-service lightwave communications system (Chicago)
1978	CCIS, digital PBX introduced; mobile cellular phone service started in Chicago
1979	Local area networks (LANs) inaugurated
1980	Launching of Ku-band geosynchronous satellites made customer premises applications (e.g., VSATs) feasible
1981	Shared tenant services (STS) introduced
1982	Electronic mail service introduced
1983	Single mode fiber optics developed for use in local loop beginning in 1984; tariffed T-1 links provided by AT&T
1984	Interstate access charge services offered; phased interexchange equal access initiated as part of MFJ decree; air-to-ground communication system granted experimental license
1985	First central office local area network (CO-LAN) offered (by Bell of Pennsylvania)
1986	First "external" ISDN trial (Illinois Bell and McDonald's Corp. in Oakbrook, Illinois)
1987	Electronic Data Interchange (EDI) unveiled (computer transmission of business documents); digital Centrex launched; low cost "FAX" and PC FAX boards emerging
1988	AT&T Open Network Architecture plan approved by FCC; RBOC ONA plans approved in part; numerous Comparably Efficient Interconnection (CEI) plans approved for former Bell System members relating to information gateway services
1989	Interactive 900 Services offered (e.g., polling)

cient new applications of telecommunications. But were these "special purpose" or discount services fully innovations *before* their special uses developed?

Similar problems of timing apply to the introduction of touch-tone dialing. Touch-tone dialing was technically possible in 1963, with the introduction of the push button telephone. But during the 1980s the age of digital switching and information services began to dawn and the capabilities of this equipment expanded many fold. Notably, "high speed" data phone service made its debut in 1958 with a 1200 bits per second capability. In contrast, DS-3 dedicated data services today feature speeds of 45 megabits per second. Did innovation, as it related to the touch-tone feature, appear twice, or, should the term apply only to the use of a new option?

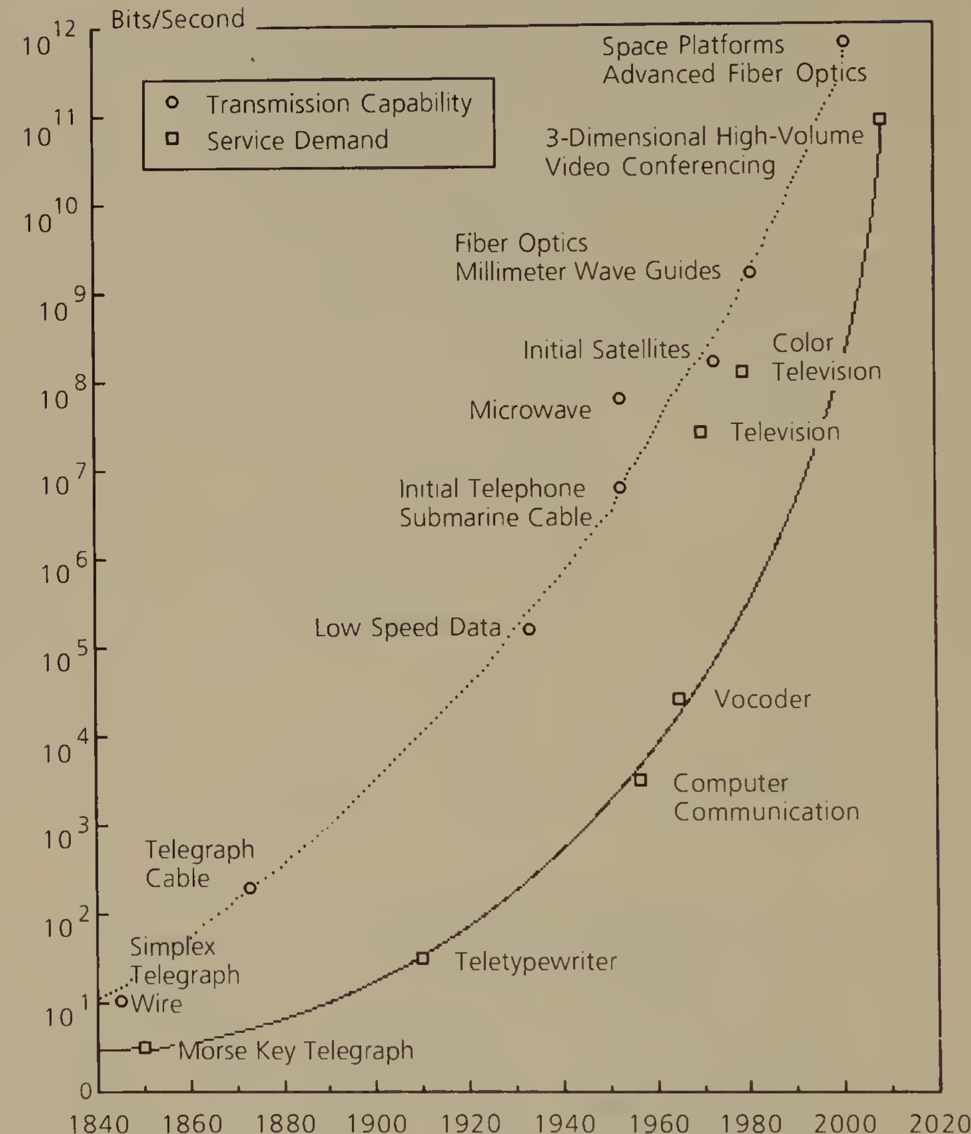
Table 7.1 illustrates the slow pace of service introduction and marketing in the demand area, when compared to the industry's emphasis on technology or supply parameters. This applies for even the most simple or trivial changes. For instance, it took approximately fifty years after the initial commercialization of telephony for the first nonblack telephones to be offered (i.e., by the Independents in 1926). Even with this "innovation" in evidence, another thirty years passed before the Bell System provided colored telephones in 1955. But nearly twenty-five *more* years were required for "Mickey Mouse" to make his appearance in the industry (i.e., as an innocuous plastic case for the basic telephone in the mid-1970s). At that point, Mickey was already in his fifties.

A corresponding history applies in the case of many services. As table 7.1 shows, the appearance of data transmission at 600 bps over telephone lines occurred in 1930, about fifty years after the introduction of commercial voice service, but another forty years went by before a visual offering was instituted (picturephone). Now it appears that about twenty-five more years will have to pass before all three services will be available concurrently over the public switched network, i.e, with the full application of the ISDN. Finally, note that the new service frontier of transcontinental service (New York to San Francisco) was breached in 1915 or about 40 years after birth of the Bell System, but Bell required another 40 years before making dependable, reasonably priced transoceanic service available over cable. Yet, innovative ("transindustry") electronic mail only made its appearance about twenty-five years later in the early 1980s, or at about the time that the Bell System was breaking up.

As shown by the difference between the "transmission capability" supply line of figure 7.1 and the accompanying plot of "service de-

FIGURE 7.1

Development of Digital Telecommunications



mand," a lag in facility applications for the telecommunications industry has at some points exceeded a decade. Recently, the gap between the incidence of technical possibility and the practical application of industry capabilities has lessened. This has reflected the increased presence of competitive pressures and heightened industry awareness of the need for greater responsiveness to users' requirements. For instance, widespread utilization of facsimile technology, which first appeared in the 1960s, has required "just" two decades. Moreover, commercial exploitation of cellular radio has taken only slightly more than a decade, after cellular's technical feasibility was established in the late 1960s. Cellular implementation has been directly impacted by the FCC's determination that competitive provision, albeit only two providers, would be an appropriate means of fostering widespread deployment of this technology. Finally, in several instances, custom calling and CLASS services have been tariffed in less than ten years after their initial development. In this instance, competitive pressures, from terminal equipment and enhanced service suppliers, were an important impetus toward more rapid deployment.

Of course, the process of translating the capabilities of the network after divestiture into a service-related form generally seems to be improving when compared to historical norms. This also applies to current attempts to define service building blocks or BSEs in the context of the FCC's plans for ONA. Indeed, this effort may be completed in the space of only a few years. But, even here, accolades for the industry's supply enthusiasts may not be in order. Notably, the technological or facility-focused breakup of the Bell System took place without *any* prior attention or even mention of the ONA applications or customer oriented process.

The pre-divestiture period of high engineering or technological innovation and low service application had an impact that was economy-wide because of its effects on dependent or served industries. Utilization of computer technology languished for well over a decade before high-speed data links became available. Similarly, in the 1960s and 1970s, firms in banking, manufacturing, and other areas found it necessary to develop private networks specially suited to their service needs because of slow industry application of available technology.

While the steady stream of technological advances during the predivestiture period were impressive, these developments pale in comparison to telecommunications' post-divestiture facility revitalization, both in terms of the pace and scope of change. Plant replacement has been implemented at a brisk pace ever since the industry realized that the new environment would be characterized by multiple supply. Indeed, in the case of the Bell companies, conditions of competitive supply are a *prerequisite* for their participation in toll and other markets. Thus, digital technology is currently supplanting most analog installations in the toll and local networks. This is remarkable when one considers that the network was basically engineered for analog transmission from its inception.

Facility changeovei is having fundamental effects on industry switching, transmission, and terminal equipment capabilities. Currently local telephone companies, led by the BOCs, are actively evolving their public switched plant toward the ISDN. Taken as a whole, ISDN implementation represents technological innovation pushed forward on a massive scale. In the near term, ISDN will offer integrated standard voice, medium-speed data, facsimile, and telemetry services. In later stages, it will be able to accommodate highly desirable broadband applications, such as video and high-speed data.

Clearly, the proportion of switching systems already digital has risen dramatically from the level existing at divestiture. According to the USTA, in 1985, 4,251 of the 20,093 Central Office Switches in service in the U.S. were digital. By 1987, digital switches were 7,381 of the 19,712 Central Offices.[7] Optical fiber transmission facilities have shown rapid expansion as well as shown by table 7.2, which indicates, during the post-divestiture period 1985–1987, that interexchange fiber miles increased fourfold. During the same interval, the number of fiber miles installed by the BOCs more than tripled. In fact, as recently as 1982, there was virtually no fiber in service.

A report for NASA prepared by IGI Consulting, Inc., predicts cable costs will go as low as $0.12 per meter by 1995 (figure 7.2) while NET expects fiber prices in 1994 to be only half as high as they were in 1986.[8] Southwestern Bell is forecasting annual price reductions of 10 to 15 percent for fiber cable by 1993, as well as annual reductions of 10 to 15 percent in prices of digital loop carrier systems, 15 to 20 percent in optical device prices, and 37 percent in laser prices.[9]

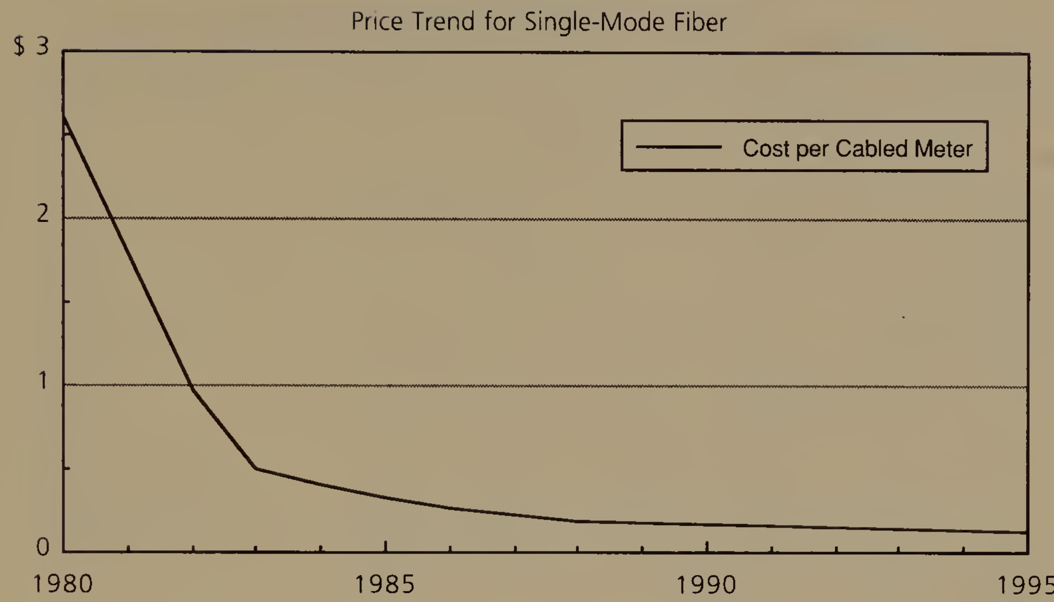
A decline in prices has also been experienced by terminal equipment for fiber systems. This is due in part to the fact that manufacturers' input prices have been rapidly declining. For instance, high-quality

TABLE 7.2
Estimated Fiber Optic Miles Deployed by Major Service Providers, 1985–1988

	Fiber-Miles (000s)			
	1985	*1986*	*1987*	*1988*
Major Interexchange Carriers	455.9	889.2	1,486.1	1,886.5
Seven regional Bell operating companies	497.1	880.7	1,192.0	1,548.5
Metropolitan fiber systems	NA	NA	NA	12.2
Total	953.0	1,769.9	2,678.1	3,447.2

Source: Jonathan M. Kraushaar (FCC), *Fiber Deployment Update, End of Year 1988*, February 17, 1989.

FIGURE 7.2



Source: Bethesda Research Institute.

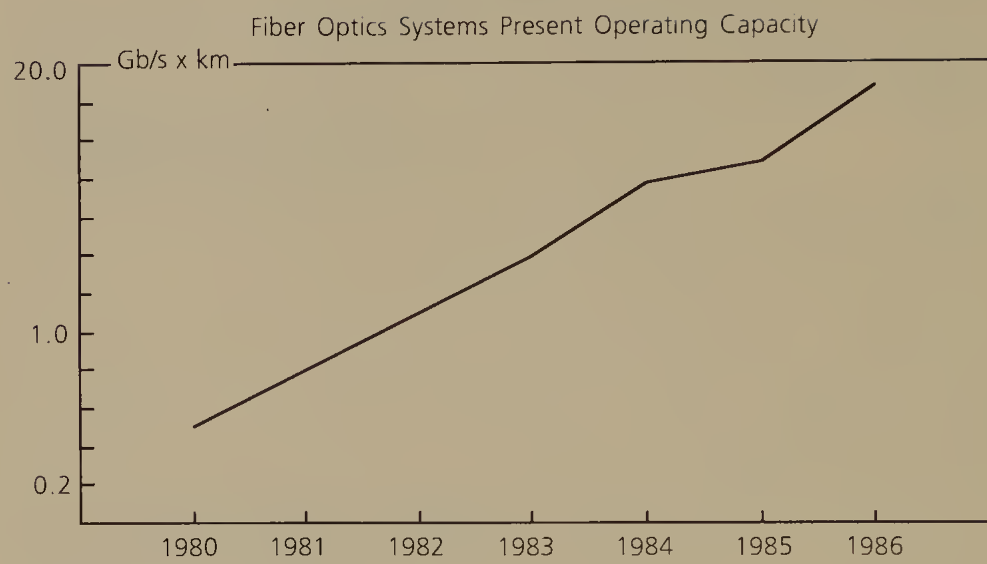
light emitting diodes (LEDs) have dropped in price from $200 to $10 in recent years. Digital switching costs are also declining. For example, these systems fell 17 percent between 1986 and 1989. While this is not as impressive as the savings experienced in fiber costs, the outlook for switching equipment economies is also quite positive.

Not unexpectedly, carriers' *operating* costs are likewise experiencing a downward trend. This directly reflects installation of the newer technologies, especially the lower provisioning and maintenance costs associated with fiber optics. But the ongoing evolution to a digital network will imply *both* a reduction in current costs and an increase in capacity. In turn, these will lead to realization of recurring future economic benefits, as providers experience increased revenues and lower costs for expansion and rearranging their networks.[10]

The declining cost of fiber optic cable is not the only aspect of the new technologies from which carriers are deriving a cost advantage. In fact, the savings these firms are experiencing from technical improvements are even more impressive than the reductions in manufacturers' equipment prices. These technical improvements have generally enhanced the performance and capacity, and lowered the cost of lightwave transmission systems since divestiture.[11]

For instance, the recent trend of bit rates times repeater spacing, as that measure of operating capacity applies to systems in commercial

FIGURE 7.3



Source: Bethesda Research Institute.

use, is shown by figure 7.3. Notably, the vertical scale for the figure is exponential, reflecting the fact the improvements have been exponential, and it is simply impractical to capture these on a linear measure. Overall, this parameter has actually improved by a factor of ten approximately every three years, while the cost of optical fiber capacity has been decreasing at a similar rate. The resultant unit cost reductions are illustrated by the same chart.

Switching capacity has also been increasing, albeit not as rapidly as that for transmission. For instance, Patrick White of Bell Communications reports "the 1ESS switch, first introduced in the mid-1960s, could process 115,000 calls per hour, while its successor, 1AESS handles 240,000 calls per hour. Current generation digital switches, such as the DMS 100, can process 330,000 calls per hour."[12] Taken together with developments in transmission, switching feature progress and capacity increments leave open the possibility for a tremendous influx in new services development.

Another potential gauge for gleaning how quickly technical progress is taking place is labor productivity. For example, as shown by table 7.3, employment in the Bell companies by the end of 1988 had declined 14.8 percent from its 1983 level. On the other hand, customers served, as measured by the number of access lines, had risen 14.7 percent, leading to an overall labor productivity gain of more than 30 percent. Overall, this gain was registered in the first year, but between

TABLE 7.3
Labor Productivity Gains for Bell Companies Lines Per Employee

			Number of Access Lines (thousands)			
	1983	*1984*	*1985*	*1986*	*1987*	*1988*
Ameritech	14,114	14,337	14,555	14,755	15,094	15,469
Bell Atlantic	14,358	14,677	15,090	15,509	16,056	16,541
Bell South	13,612	14,000	14,500	15,000	15,700	16,400
NYNEX	12,829	13,226	13,623	13,962	14,415	14,851
Pacific Telesis	10,930	11,307	11,630	12,063	12,525	13,090
Southwestern Bell	10,329	10,650	10,898	11,083	11,105	11,340
US West	10,610	10,871	11,167	11,332	11,613	11,878
Bell Totals	86,782	89,068	91,463	93,704	96,508	99,569
			Number of Employees			
	1983	*1984*	*1985*	*1986*	*1987*	*1988*
Ameritech	95,238	77,514	74,883	77,538	78,510	77,334
Bell Atlantic	80,600	77,788	73,036	77,358	80,950	81,000
Bell South	120,174	96,000	92,300	96,900	98,700	110,280
NYNEX	117,042	94,900	89,600	90,200	95,300	97,400
Pacific Telesis	97,647	76,881	71,488	74,937	71,877	69,502
Southwestern Bell	74,000	71,900	71,400	67,500	67,100	69,900
US West	73,000	70,765	70,202	69,375	68,523	69,765
Bell Totals	657,701	565,748	542,909	549,808	560,960	560,181
			Lines per Employee			
	1983	*1984*	*1985*	*1986*	*1987*	*1988*
Ameritech	148	185	194	190	192	200
Bell Atlantic	178	189	207	211	198	204
Bell South	113	146	157	155	159	163
NYNEX	110	139	152	155	151	152
Pacific Telesis	112	147	163	161	174	188
Southwestern Bell	140	148	153	164	165	175
US West	145	154	159	163	169	170
Bell Totals	132	157	168	170	172	178
Cumulative Gain		18.9%	27.2%	28.8%	30.3%	34.9%

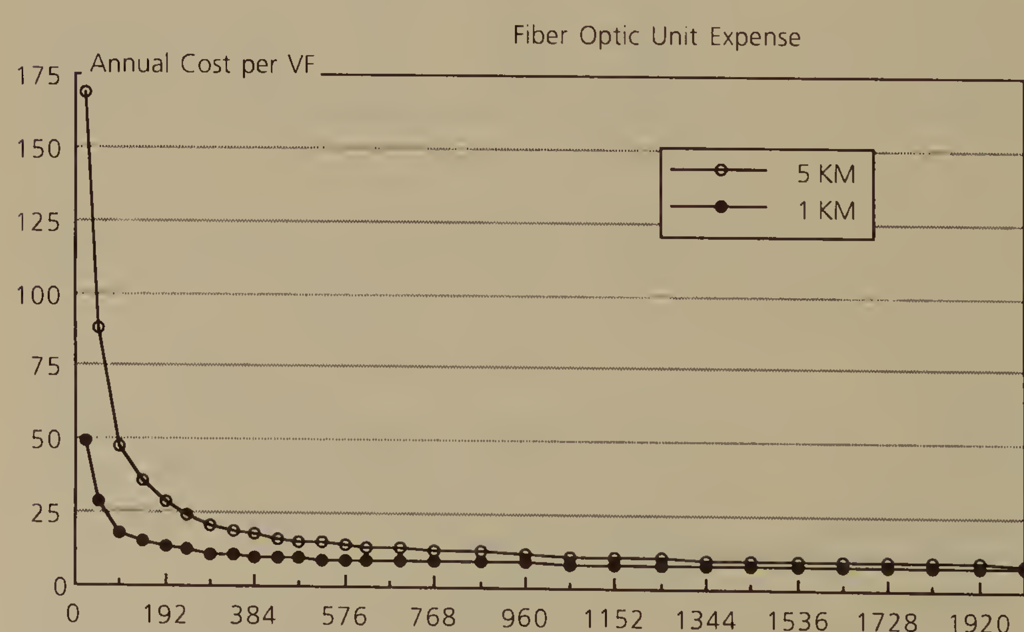
Sources: Company annual reports and forms 10K.

1984 and 1988 average Bell productivity in this area still improved by 16 percent.

The post-divestiture experience shows the telephone network to be already feature rich and to possess diverse capabilities. The technologies already in place have capacity to serve far in excess of historical demand growth or the rate of service introduction by industry providers. And, as shown by figure 7.4 (for fiber optics), the unit economies being generated consistently take hold at fairly low traffic levels. These effects are likely to be accentuated as network revitalization proceeds to completion in the early 1990s. Moreover, as gleaned from figure 7.5, the transfusion of new equipment will have been largely financed *before* its full benefits are realized, since amounts are being reserved currently at accelerating rates to pay for these installations.

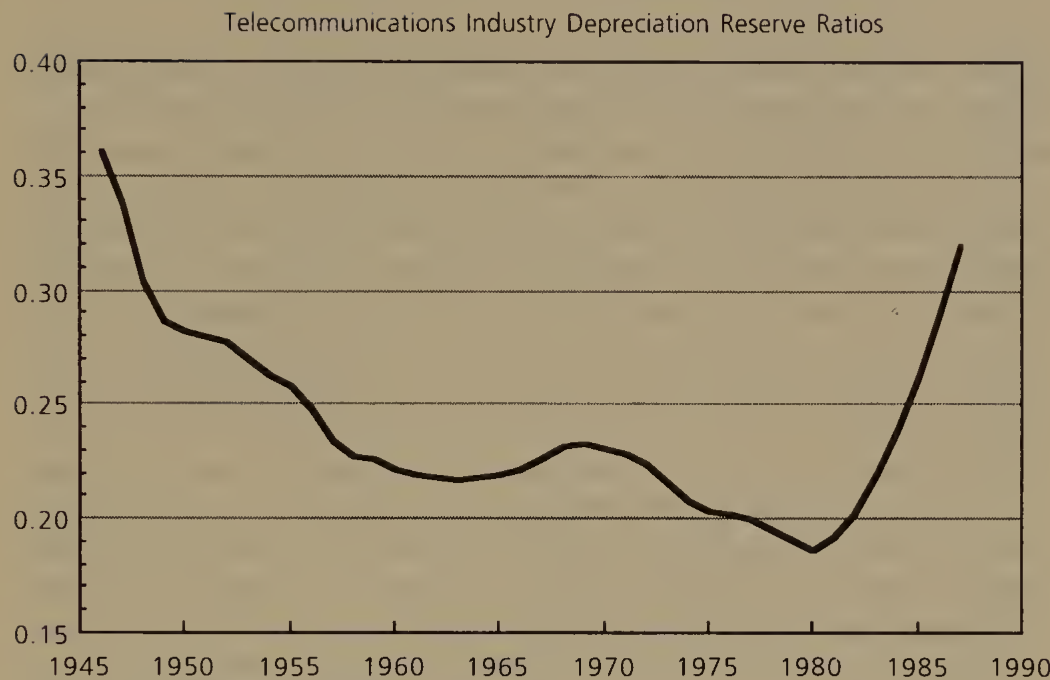
In general, the industry seems to be witnessing a speedup of technical innovation and supply improvements from a traditional span of decades to just a few years. Thus, the need to stimulate applications or demand is likewise accentuated. The magnitude of GNP that was lost prior to divestiture due to lagging application over a period of perhaps twenty-five to fifty years, could not be potentially at stake before we reach the next century, or possibly even before 1995. This points to the critical need to develop policies which ensure that service innovation also greatly exceeds pre-divestiture levels.

FIGURE 7.4



Source: Bethesda Researeh Institute.

FIGURE 7.5



Source: Bethesda Research Institute.

Since divestiture, business users have benefited from a proliferation of choice and opportunity offered by more efficient, productive suppliers, but there has been turmoil in the new operating environment and the difficult loss of "one-stop shopping." Fortunately, in the post-divestiture era, customer demand has assumed a more important role in determining the direction of service and product development. By definition, multiple entry into a given market presents users with more choice and therefore more leverage in their dealings with suppliers. Indeed, most established carriers today publicly stress their commitment to their customers, citing, inter alia, their "market driven" strategies,[13] "rededication to customer service,"[14] "responsive[ness] to customer needs,"[15] "commitment to service,"[16] and "customer satisfaction."[17]

Yet, despite the rhetoric, many within the industry still exhibit supply-driven tendencies to an important degree. For example, on the eve of divestiture, ISDN was referred to as a "grand design for tomorrow's telephones," and it was observed that:

> The big push for the digital network has come from the telephone companies in developed nations, which look to it as a new source of

revenue at a time when much of the growth in communications is going to new specialized carriers.[18]

AT&T was identified as the "driving force behind ISDN," and a French electronics firm remarked that "there will be no turning back."[19]

ISDN in its incipient stage would seem to be appropriately classified as "technically feasible but no demand." Although not as blatant in its disregard for customer input as picturephone, this network concept nonetheless is clearly an example of a "technology push" innovation. Dubbed the "great economic hope of most telephone companies" by a British Telecom marketing director, ISDN has been very slow to win approval of users, despite an increasingly rampant industry push toward its application.

Indeed, a spring 1988 survey of large nonresidential users found there had been no significant movement among corporate network planners in either adding or expecting to add ISDN capability through the end of 1989.[20] Often bewildered or skeptical users have adopted their own interpretations of the ISDN acronym, ranging from "I Still Don't (K)Now" to "Innovations Subscribers Don't Need" to "It's So Damn Near." More recently, a few large customers (e.g., McDonald's Corporation and American Express) have pioneered the use of ISDN capability.

The outcome of ISDN implementation is yet unknown. Recent intrest by some users may qualify the concept as bona fide serendipity, but at this point the outcome is still unclear. In fact, three basic ISDN scenarios appear plausible, underscoring the pivotal importance of public policy guidance in this area. One scenario is characterized by "market failure," whereby the lack of a quick consensus on standards would retard development of a public ISDN, resulting in disparate, incompatible private enhanced networks. A second scenario has a public ISDN emerging on a "piecemeal" basis, targeting large cities and featuring a shared facilities architecture rather than complete integration of voice, data, facsimile, and other services. Finally, the third scenario envisions full conversion to broadband ISDN as the technological "dream" is brought to fruition, namely, full deployment and integration based on universally accepted ISDN standards. These standards would support open entry, a myriad of wideband video and high-speed data offerings, integrated packet and circuit switching, and value-based (rather than cost-based) pricing.

Failure to develop an appropriate public policy infrastructure for the new Information Age or utilize the competitive catalyst could result in parallel development of all three scenarios, at an enormous waste of R&D funds, public monies, manufacturing resources, and public network operating systems. The possibility exists that full conversion might *never* be achieved without the necessary public guidance.

The demand for services provided via ISDN is a key element to the success of the concept. The cost to end users may not be the determining factor since the price of a service is not always the criterion used to select among alternative service offerings. Service quality and reliability are often more important than cost considerations. Technical criteria, such as the capability to interface different technologies and terminal types among users, are critical factors in other situations. And, if diverse routing is required by users, alternate suppliers can be used to provide such a feature.

Beyond ISDN, high rates of change have occurred in recent years in the U.S. telecommunications sector, and even greater rates are expected from now until the year 2000.[21] Both domestic and international telecommunications markets are growing substantially. A number of specific markets have enjoyed particularly robust growth. As shown by table 7.4, electronic information industry revenues, particularly computerized databases, have increased significantly since the pre-divestiture era. The U.S. business information services sector is projected to reach $15 billion by 1992.[22]

Several other markets have been gaining in popularity. Facsimile machines' plummeting pricing (some quality units now cost under $2,000) have fueled that brisk market. Although sales of personal computers, facsimile hardware, and software products only totaled $13 million in 1987, the figure may reach one-quarter *billion* by 1991. The number of VSATs grew by over 50 percent from 1987 to 1989 as a spate of customers have become convinced of the medium's cost effectiveness and reliability. Similar to FAX, T-1 has existed for a quarter of a century, but has only caught on since divestiture as companies set up high-quality, cost-effective private networks to replace the Bell System's end-to-end offerings.

Two markets may prove to be the most impressive in terms of growth. With respect to electronic mail, the number of in-house electronic messaging subscribers totaled 5.6 million in 1987, an increase of approximately 40 percent from the previous year. The number of messages in 1987 averaged 62.9 million per month, with 67 percent accounted for by private mail boxes. Compared to long-distance telephone calls and mail, fast-growing electronic mailbox usage currently comprises less than one percent of total U.S. message volume as this country enters the Information Age.

Another emerging service is electronic data interchange (EDI). EDI is the computer-to-computer transmission of business documents, such

TABLE 7.4
Electronic Information Industry Revenues

Computerized Databases
(1982 and 1987)

	1982 ($M)	*% of Total*	*1987 ($M)*	*% of Total*	*Growth Rate (%)*
Financial	304.5	29.1	835.2	28.6	22.4
Economics and econometrics	90.7	8.6	198.1	6.8	16.9
Industry-specific	28.2	2.7	73.4	2.5	21.1
Credit	290.0	27.7	513.9	17.6	12.1
Audience measurement	16.4	1.6	35.9	1.2	17.0
Product movement	20.1	1.9	76.9	2.6	30.8
Demographics	6.5	0.6	22.8	0.8	28.5
General business and industry	10.0	0.9	30.5	1.0	25.0
Industrial directories and catalogs	1.8	0.2	8.4	0.3	36.1
News	35.3	3.4	267.2	9.1	49.9
Scientific and technical	68.0	6.5	162.0	5.5	19.0
Library support	17.6	1.7	34.9	1.2	14.7
Legal	94.0	9.0	266.8	9.1	23.2
Government	9.0	0.8	22.4	0.8	20.0
Real estate	28.0	2.7	40.8	1.4	7.8
New professional services (medical, pharmacists, etc.)	11.3	1.1	146.5	5.0	66.9
Consumer	10.5	1.0	178.5	6.1	76.2
Other	5.0	0.5	10.1	0.4	15.1
Total	1,046.9	100.0	2,924.3	100.0	22.8

Source: *Huber Report*, Section 7.1.

as purchase orders, invoices, and advance shipping notices, in standard formats. Potential benefits include shorter procurement intervals for manufacturing materials, lower purchasing costs, and increased buyer productivity. Pacific Bell, Southern Bell, and South Central Bell are attempting to use EDI to provide enhanced billing services to customers, such as presenting monthly inventories of all BOC-provided services and equipment.

ONA is a form of equal access for enhanced service providers instituted by the FCC in response to a burgeoning market. Highly acclaimed as a concept, ONA as developed by the FCC has been criticized for its lack of specificity and for its slow development. Some claim that the RBOCs, subject to MFJ restraints, have eschewed rapid implementation of ONA in favor of CEI plans designed to help themselves, and *not* their competitors.[23]

The pivotal importance of ONA is widely recognized by the telecommunications industry. The Regional Companies see a significant market opportunity in successful implementation of the process. For example, an executive at Southwestern Bell observed:

> Increasing the use of the network—even by just one percent—promises far more revenue potential than anything we could gain by providing enhanced services ourselves. . . . ONA can aid economic development by creating a telecommunications market rich in Information Age services. New businesses or existing businesses considering relocation will look at whether an area offers a progressive environment that promotes the advantages of the Information Age.[24]

Enhanced service providers are also cognizant of this potentially lucrative market. Potential users regard the process as a means to have their information service needs better met. Public policymakers at the FCC envision ONA as an "equal access" approach to promoting competition, and assuring a more rapid and efficient delivery of Information Age services to the public.

The concept is a key element in the FCC's *Computer III* program of relaxed regulation, which was vacated and remanded by the Court of Appeals in June 1990. Notably, without its successful implementation, separate subsidiary requirements will be retained for enhanced service provision by Bell companies. This network architecture and its interim counterpart, CEI, represent essential elements of the much touted broadband ISDN network of the 1990s and beyond.

Local telephone companies have not passively accepted entry into their traditionally secure markets, and have turned to network developments in the attempt to meet the challenge. Centrex was initially offered by the local exchange carriers in the early 1960s as an alternative to PBXs, that is, switching equipment located on a customer's premises. In the 1970s, PBX began its resurgence as microprocessor technology advanced and the FCC's procompetitive policies gathered momentum. The FCC's decisions in the areas of equipment registration, rate unbundling, and cost-based pricing fostered considerable competitive entry. As a result, by the 1980s, there was much greater emphasis on meeting customer needs and growth in the PBX sector, particularly respecting equipment offered by competitors of the Bell System.

Apparently, in an attempt to meet changed marketplace conditions and combat incursion of new competitors, the Bell System launched a marketing program in the late 1970s that has been termed a "migration strategy." Under this new strategy, Centrex was deemphasized as an offering. Instead, marketing focus and development of new features were shifted to Bell's recently upgraded CPE project line (e.g., Dimension PBX). Within a few years, Centrex systems' growth and customer acceptance suffered through increasing replacement by Bell's electronic PBXs.

The divestiture altered these conditions and incentives dramatically. These new regional companies and their BOCs inaugurated an energetic program to innovate, i.e., to remarket and upgrade their Centrex services. Resurgence of Centrex growth is expected to continue as a result of this sales push, corollary actions (e.g., a lowering of the minimum 100-line requirement formerly imposed on Centrex users), and technological enhancements in the late 1980s. In addition, central office local area networks (CO-LANs) have been developed to enhance existing Centrex lines to allow the BOCs to provide an alternative offering to LANs obtained from independent suppliers.

The structure of the U.S. telecommunications sector today is the product of major technological forces, increased competitive entry, and a myriad of facilitating public policies instituted by federal and state agencies, the courts, and the U.S. Congress. The relatively simple era of few choices, fewer suppliers, rental phones, electromechanical networks, and extensive regulation has been superseded by a competitively inspired greater diversity of offerings, multiple sources of supply, sophisticated CPE for sale to users, digital electronic networks, and relaxed regulation.

As we have indicated, during the early post-divestiture era, options have widened significantly for users, and customers have strengthened their role in impacting the rate and direction of innovation; clearly demand has become more important in shaping technological advance in the industry. However, the supply factor and strategic view of the impact that competition may have remains the pivotal consideration in new service and product development in the telecommunications sector. Established carriers have effected a dramatic upgrading and rapid expansion of facilities in vigorously responding to competitive pressures in the 1980s. As a result, the industry is currently faced with excess network capacity and unexploited capabilities. These facilities are likely to be utilized efficiently only if "outside applications" (e.g., by new entrants) supplement those contemplated by traditional suppliers.

Consolidation is a structural fact in key markets, whether by merger, acquisition, joint venture, or withdrawal. For example, in interexchange markets, a second tier of companies has formed new corporate combinations reminiscent of the bolstering of MCI and US Sprint in the early eighties. Never crowded, the ranks of large switching equipment manufacturers were thinned by ITT's abandonment of the market. PBX, key system, and modem vendors have all been beset by market "shakeouts."

Over an extended horizon, there is evidence that conditions of (incipient) economies of scale and scope may arise in the industry, especially after telecommunications traverses the first decade after divestiture. Unexpectedly, this situation is a direct result of new competition and the accommodating Bell System divestiture, which have been the catalysts for existing carriers to overexpand and sharply upgrade the scale of their plant. These programs, when complete, will position traditional suppliers to meet competitive threats and forestall further entry. In addition, these firms believe their upgraded capabilities are justified because they can be employed in meeting new customer requirements. Yet, in many instances, these perceived needs can only be characterized as being a remote likelihood or distant fruition. Thus, they will apparently not be the bases for fully loading in a timely manner the facilities that are coming on line.

Given these network conditions, there is a need to direct public policy toward encouraging the near-term utilization of huge network and other resources which would otherwise be left idle. Importantly, from society's viewpoint, the benefits of such exploitation are essentially "free." However, without intervention, this plant is likely to be left underutilized over the next several years. If this is the case, the increased industry and national economic growth, service options and operational economies, and other benefits that could have been derived from our paid-for and greatly enhanced communications network will simply be lost forever.

At the same time, vertical integration has become fashionable again as service providers seek to recapture the "one-stop shopping" capability of the pre-divestiture period and preempt their competitors. The RBOCs, AT&T, and many independent telephone companies have indicated their belief in this corporate goal.[25] For example, BellSouth and Ameritech telephone companies have combined their service and CPE operations pursuant to *Computer III*.

Despite the much publicized specter of bypass, the nation's local exchanges apparently remain securely in the grasp of the BOCs and the Independents in their respective operating territories. This has slowed the pace of innovation significantly. There are no compelling signs that exchange carriers will lose their grip on local markets. Entry, whether real or imagined, has clearly helped to spur the BOCs and other LECs to modernize their networks, and to become leaders in implementing many of the so-called bypass technologies such as fiber optics, digital switching, cellular radio, and short-haul microwave.

The road to ISDN and UIS-type[26] comprehensive solutions, once navigated, should reaffirm the public switched network as the undisputed backbone of this nation's telecommunications capabilities. High supplier concentration will likely remain or even heighten in interexchange services, large switching equipment, and many CPE markets. A brisk rate of innovation should be evident in these markets, born of the reactions of financially and otherwise solid oligopolists to the clashes of less stable, but more adventuresome legions of competitors characteristic of the early and mid-1980s. Market instability should lessen, but so will "derring do" as "me too" pricing and other forms of mutual interdependence may evolve.

Thus, a key to maintaining a lively pace of new service and product development will center on the nature and extent of the access afforded competitors to the "network of the future" and the role of competition itself. The ability of alternative facilities providers to enter without restriction, and public policymakers to encourage competition in the enhanced information services resale market, will determine whether the network's capacity and capabilities are utilized on a timely basis. In turn, these should, in large measure, determine whether the Information Age is properly fueled for the journey ahead.

Elliot E. Maxwell

Walter Bolter and James McConnaughey argue that competition spurs innovation—few people would disagree. Unfortunately Bolter and McConnaughey present little empirical evidence on the central question of how innovation has been affected by the MFJ and related regulation.

If one measure of innovation is the bringing of new services to market, there are several ways one could demonstrate the delays introduced into the process by the MFJ and regulatory requirements. One simple method would be to measure the intervals between the filing of proposed MFJ service waivers with the DOJ, and a favorable decision by Judge Greene. That delay would be a direct consequence of the MFJ. A preliminary review of the twenty waivers filed by Pacific Telesis Group and approved by the District Court between 1984 and 1987 shows a total delay of 4,131 days. For those who wish to offer services in increasingly competitive markets, these numbers provide little comfort. Similarly, in the federal or state regulatory arena, one could calculate the time it takes a service proposal to move through the regulatory system by examining when CEI or ONA plans are filed, and when they are authorized.

My thesis is this: the MFJ, FCC, and public utility regulations, established to govern the activities of the BOCs, have discouraged these companies from offering new products or services, or engaging in development activities that typically lead to new products and services. The practical effect has been to exclude the local exchange companies from competing in a number of markets to which they would bring considerable skills and resources, and to reduce competition and innovation by these large, technologically competent and well-capitalized firms. Although it may be argued that this reduction in competition has led to increased innovation by other firms, one should hesitate to restrict *actual* entry, and therefore competition, on the *theoretical* basis that the restriction will promote competition.

The negative effects of regulation are illustrated in many cases. Among the most glaring was the long delay in the FCC authorizing cellular radio service. Yet, there are other illustrations of the impact of regulation on innovation. One area of particular interest, given the convergence of telecommunications and computing, is the regulation of enhanced services.

In 1980, the FCC noted the need to examine issues surrounding protocol conversion subsequent to issuing its *Computer II* rules. However, the first protocol processing waiver, one providing little freedom for the BOCs to meet market needs, was not granted to a BOC by the FCC until 1984. Other data-oriented services, the so-called "Custom Calling II" features, had been proposed by AT&T in the late 1970s and early 1980s. The AT&T proposals involved offering the services on an integrated basis, rather than through separate subsidiaries, and were rejected by the FCC as being inconsistent with the emerging *Computer II* ruling. Potential competitors told the FCC that they would be dissuaded from entering the marketplace if AT&T were allowed to compete on an integrated basis—i.e., in the same way others would provide such a service—and the FCC accepted this line of reasoning. Following divestiture, the FCC's prohibition on integrated provisioning of these services was applied to the BOCs, just as it had been earlier imposed on AT&T.

The results of this FCC experiment in promoting competition were not encouraging. Several years passed and the services in question still were not generally available. The Commission eventually concluded its strategy of excluding the BOCs had been unsuccessful, and it adopted *Computer III* rules, eliminating the separate subsidiary requirement and allowing the BOCs to provide the services on an integrated basis.

However, *Computer III* created newer complications. Under the *Computer III* rules, the BOCs had to file interim plans for these services, and indicate how they would provide competitors with CEI to underlying BOC facilities. This resulted in further delays. In addition, competitors sought to delay integrated provision of services by advocating an FCC ban on BOC information service provisioning until ONA was implemented. And most recently, the Ninth Circuit vacated and remanded the *Computer III* decision and we are, at least temporarily, back to *Computer II* and separate subsidiaries.

MFJ proceedings also contributed to delay. Even though the FCC had found BOC provisioning of these data services to be in the public interest, Judge Greene was unconvinced. The MFJ still barred the BOCs from providing information services. Not until March 1988 did the District Court allow the BOCs to make a general offering of information transmission, storage, and retrieval services. Judge Greene based his decision on the grounds that BOC participation was the only way the new services would be made available to the mass market—a rationale strikingly similar to that invoked by the FCC in adopting *Computer III* several years earlier. If Judge Greene and the FCC were correct, the years of delay had deprived the public of useful new services to which the BOCs brought unique strengths.

This example provides only an anecdotal measure of the impact of the MFJ and regulation on innovation. But it understates the problem. The uncertainty about the effect of regulation and judicial intervention on these data services continues. The D.C. Circuit's remand of Judge Greene's Triennial discussion on information services may lead to significant changes in the MFJ ban, but that may not be known for some time. Even after FCC and MFJ approval, there are nagging questions about how to offer such services economically. For example, some aspects of these services raise possible interLATA questions. The District Court has held that the MFJ requires a BOC to place a gateway processor in every LATA to avoid any interLATA carriage, regardless of whether that is the most economically efficient way to provide the service. No similar configuration requirement exists for any non-BOC competitor. What is the social impact of this requirement? Does it mean the service will be priced too high for the casual user? Will the interLATA prohibition have the effect of preventing these services from being offered successfully to the mass market? The delay and uncertainty surrounding such questions, faced only by the BOCs, are terrible impediments in the planning and offering of innovative products and services. When proposed new service offerings must compete for resources within a BOC, the prospect of regulatory delay or legal disapproval associated with the offering is often enough to remove the proposed new services from the BOC's list of top priorities.

I have focused on the MFJ's prohibitions on information services because of the great potential the RHCs possess to provide mass market telecommunications services. Former Assistant Attorney General William Baxter obviously thinks the RHCs should not be in information services, so the problems I raise are irrelevant to him. According to Baxter's comments in this volume, it would have been better had Judge Greene continued to "just say no" to any BOC role in the information services area.

Yet during the first Triennial Review of the MFJ, the two parties to the decree, the DOJ and AT&T, agreed that flatly prohibiting a BOC role in information services was inappropriate. The DOJ took the position that the information service ban should not have been written. AT&T said that the ban was imposed due to a mistaken analogy with the problems in the long-distance market that had triggered divestiture.

The information services prohibition was premised on fear that BOC participation might result in anticompetitive behavior in the information services market. The BOCs had the "incentive and ability" to discriminate against their competitors, and regulatory solutions to the "incentive and ability" issues were impossible. This thesis may be "elegant," in Baxter's words, but it is wrong. It is belied by the results of the RHCs' involvement in CPE distribution, where the same "incentive and abilities" could be said to exist.

Although the initial settlement agreement between AT&T and the DOJ proposed to exclude the RHCs from distributing CPE, the District Court rejected the prohibition thesis and allowed RHC distribution. Critics claimed that the BOCs would misuse their freedom, for example, by providing more favorable connections to RHC-provided PBXs than to PBXs offered by competitors. But this has not happened. Similarly, in theory, GTE has the same incentives and even a greater ability to act anticompetitively than the BOC. GTE participates directly in the local exchange market, the information services market (Telenet), the intraLATA market (US Sprint), and in the manufacturing of telecommunications equipment. But here too, the real world and actual behavior of GTE has provided little empirical support for the prohibition thesis. It is also worth noting the nation's expert agency in telecommunications, the FCC, has not adopted a strategy of prohibition in the case of information services. Rather, it is defining a regulatory response via "comparably efficient interconnection" requirements and ONA plans.

The very processes for change in both the MFJ Court and at the regulatory commissions also impede innovation. When one of the seven RHCs obtains a waiver from the MFJ Court or an approval from the FCC, the other six can and often do follow with exactly the same proposals. This "me too" mentality is the cheapest and fastest way to obtain permission to enter a particular market. What has been created is a government stamp of approval on one particular procedure and course of action. There is a great regulatory cost in seeking approval for an alternative way of providing the service, even if that alternative approach is more effective in the long run.

The MFJ also affects innovation due to its definition of manufacturing. The MFJ has always prohibited the RHCs from engaging in the manufacturing of telecommunications equipment. The District Court has now interpreted the definition of that "prohibition" to include barring the RHCs from the "design and development" of such equipment, although they are permitted to engage in "research."

Most authorities believe there is an important connection between levels of R&D, productivity, and innovation. Michael Noll of the University of Southern California has published a series of papers on AT&T and BOC spending on R&D.[27] He observed that the BOCs were now spending about 1.4 percent of their revenues on research, much less than AT&T's expenditures both before and after divestiture, and much lower than other firms. (For example, Hewlett Packard spends 10.5 percent of sales on R&D.)[28] Other studies have shown that the BOCs' expenditures on R&D per employee are relatively small compared to industry averages.

Why are the BOCs not spending more? As a March 1989 NTIA report noted, "The AT&T consent decree's manufacturing restriction, particularly as it is currently construed, is creating uncertainties which appear to deter research and development on the part of the Bell companies."[29] It is not surprising that expenditures are not growing when the activities to be funded may carry with them potential criminal liability.

BOC innovation has also been negatively affected by challenges to the ability of BOCs to obtain economic returns from innovation in the telecommunications equipment arena. If the BOCs were to be prohibited from retaining economic rights to their discoveries due to a broad interpretation of the definition of "manufacturing," they clearly have less incentive to invent. If they were to encourage activity in a prohibited area, they would face punishment by the Court. It is a striking irony that the RHCs may be forced to warn their employees against wasting time on innovation.

The present legal construction of the manufacturing prohibition presents yet another challenge to the RBOCs' ability to innovate. The definition of "manufacturing" is based on a simple linear view of telecommunications equipment manufacturing: research, design, development, then fabrication, with the RHCs allowed to perform research and to issue generic specifications. Many suppliers see the development process as requiring substantial interaction between purchasers and suppliers. Yet the RHCs are prohibited from engaging with suppliers in any design activities that concern the implementation of generic specifications.

As NTIA noted, the uncertainties about the distinction between permissible and impermissible research and design activities "appear to be adversely affecting the ability of Bell company suppliers to interact with them efficiently. Both the pace at which innovations are being brought to market, and the overall cost of that process, appear to have been adversely affected."[30] In this regard, the BOCs differ from other telecommunications service suppliers around the world who "can and do work actively and affirmatively with their suppliers in ways that would almost certainly be ruled illegal under prevailing interpretations of the AT&T consent decree."[31]

Brief mention should also be made of the negative effects of a particular type of regulation on innovation. Under rate-of-return regulation, incentives to develop and deploy new services are dampened. Profits are limited to a set return on assets, and the deployment of profitable new services does not increase profits unless they also increase the asset base. Thus, there are limited incentives to deploy new services or make a non-capital-intensive investment to bring new services to market.

Rate-of-return regulation also arguably creates incentives for firms to shift costs from competitive markets to monopoly markets, therefore subsidizing competitive profits at the expense of monopoly ratepayers. A switch to incentive-based regulation such as price caps would be desirable, in order to eliminate any incentive to shift costs (which could not be recouped from monopoly ratepayers) and to encourage service deployment by allowing the firm to profit from the fruits of its own creativity.

Any discussion of telecommunications innovation today must examine carefully the impact of the MFJ and regulation. Regulation of essential monopoly services continues to be necessary, and certain safeguards may be required to prevent anticompetitive behavior by a dominant supplier. But no matter how well-intentioned, regulation should not be immunized from critical review. If telecommunications is to be part of the engine for societal progress, and if innovation is to be the fuel for the engine, we cannot allow unnecessary or counterproductive governmental policy to be the sand in the gas tank.

Jerrold Oppenheim

It is easy to assume innovation is an unmitigated blessing. The telephone itself was a spectacular innovation, and it is difficult to imagine what American life would be like today without such innovations as the transistor, the assembly line, and the personal computer. But innovation has its drawbacks. After all, one consequence of the transistor is "boom boxes" in city streets; the assembly line brought a new form of boredom to the workplace; and computers made possible error on a scale never before imagined.

The first response raises caveats about two aspects of technological development in telecommunications. First, to the extent that faster innovation is a product of competition, there are negative economic consequences that may outweigh the benefits achieved. (This conclusion is underscored when social disadvantages of innovation, such as threats to privacy, are considered.) Second, the history of telecommunications innovation teaches that those who benefit from innovation are often the last to pay for it.

The policy conclusion I draw is that regulation of telecommunication remains essential to (1) protect the public from deleterious consequences of innovation and competition, and (2) apportion fairly the costs of innovation to those who benefit from it. The relatively free forces of the marketplace cannot be relied upon to perform these functions.

The proliferation of novelty phones—shaped as dogs, cars, even a red high-heeled shoe—illustrates the point that some innovations may be worth more than others. The innovations of digital switching and touch-tone signalling make possible such useful services as credit card shopping at home, bill paying and banking at home, appliance control by telephone (so you can turn on your home air conditioner as you leave the office), a display of the phone number of the person calling, and even games at a distance. A glass fiber cable can already carry 100–

250 times as much as a copper cable; telephone engineers predict this will rise to 1,300 times copper's capacity. The fiber cable innovation may bring us switched video services in the next decade and ultimately full-motion broadcast-quality TV, dial-from-anywhere security cameras to watch for fire and burglary or to check up on the teen-age party upstairs, dial-from-home videocassette libraries that save trips to the video store. The telephone companies' fiber optic entry into the cable television business is also on the agenda.[32]

As Bolter and McConnaughey document, some telecommunications innovations have already arrived more broadly for consumers. These include facsimile transmission, computer-based services such as banking by teller machines and shopping by modem, audio services such as tax information lines and recorded "Yellow Pages" information.

However, there is a darker side to innovation. For example, the increased regulatory emphasis on competition made it possible for AOS to enter the marketplace on a broad scale as resellers of long-distance service. Their "added value" is little more than a surcharge on captive customers. Resulting proceeds are then shared with such customer captors as hospitals, hotels, and private pay phone operators. Thus, a hospital signs up with an AOS, then reaps new revenues as the AOS charges higher rates than the hospital did before for the same service and pays the hospital a commission based on the higher rate. It is difficult to recognize what additional level of service to consumers the innovation of increased charges purchases. In Massachusetts, consumers have complained about paying seventy-five cents via an AOS for pay phone calls that ordinarily cost twenty-five cents, and about being charged $3.45 for a call that without an AOS would have cost $1.00.[33]

As Sharon Nelson discusses earlier in this volume, another serious drawback to telecommunications innovation is its potential to erode privacy and First Amendment freedoms. Tomorrow's telephone system, with digital switches and fiber optic cable to nearly every home, could become a super cable television system, doing everything cable TV does now and more. It is also not unreasonable to project it will remain a natural monopoly—there will only be one telephone cable system entering each home—and the BOCs will attempt to free themselves of almost all common carriage obligations[34] as cable operators have successfully done.[35] This could mean that local monopolies would have unfettered control over what a subscriber could receive from a community's only carrier of television, only source of movies (movie theaters having been displaced by videocassettes), only carrier of news (newspapers by then having been converted to teletext, a transition that has been predicted since 1971),[36] only carrier of Congressional sessions, town meeting debates, and classified ads—and perhaps the only carrier of pictures from inside your home to the local police (watching for burglars, of course). Not only could local monopolies thus control access to information, they could maintain records of information and entertainment habits of its customers. Indeed, they would arguably need it for billing purposes.[37]

Thus, even before we reach economic issues, we see that telecommunications innovation requires management on behalf of the public to prevent antisocial results. Much telecommunications innovation, for better and for worse, is at least partly due to competition—including competition spawned by divestiture. But perhaps we assume too easily that competition leads to greater innovation. As Bolter and McConnaughey suggest, for example, divestiture may not have significantly changed the innovation structure in the telecommunications industry. On the other hand, the lack of change may merely reflect the failure of divestiture to stimulate much competition. AT&T, after all, continues to dominate the long-distance (toll) market, controlling 70 to 80 percent of it.

There is an alternative explanation, however, to any failure of divestiture to stimulate innovation: competition may retard innovation. As J.A. Schumpeter has said, "The introduction of new methods of production and new commodities is hardly conceivable with perfect—and perfectly prompt—competition from the start. . . . As a matter of fact, perfect competition is and has always been temporarily suspended whenever anything new is being introduced. . . ."[38] By requiring short-term perspectives and by failing to reward innovations that are easily duplicated, "competitive markets may hinder efficiency in production by stifling technological advances."[39] The great success of Bell Labs during AT&T's monopoly days may provide evidence for this point.[40] So deregulating telecommunications carriers to stimulate innovation may have the opposite result. On the other hand, the bureaucracy usually spawned by monopoly and oligopoly is not famous for its tolerance of new ways of doing things.[41]

Be this as it may, the competition that may spawn innovation requires examination. Not only is the innovation itself a mixed blessing, but innovation-spawning competition is also far from an unmitigated blessing on consumers.

I do not mean to imply there are no consumer benefits from competition. The outcome of the deregulation of telephone set sales (which predates diverstiture) is a vivid illustration of the potential power of competition. At the same time telephone set technology was developing and marketers were providing a bewildering new variety of choices, prices dropped like a spent rocket. It is hard to recall that, as late as 1980, the rental payments to New York Telephone over the fifteen year life of a telephone set would total $212.40[42] although sets could then be purchased for $25. Today low-quality sets can be purchased for less than the 1980 New York one-year rental cost of $14.16.

However, competition has consequences in addition to dropping some prices. Ordinary competitive markets do not guarantee to meet all demand, nor do they assure just, reasonable or stable prices—indeed, volatile prices and shortages are part of the normal competitive cycle. In contrast, the goals of regulation include justice, stability, guaranteed service, and universal service. Competition may produce many important benefits in certain contexts, as, for example, diversity and efficiency, but these regulatory goals are not among them.[43]

This is not to say that regulation, at least as developed to date, is without blemishes. As Roger Noll suggests in this volume, it is, in fact, as messy, slow and as often controversial as any political process. However, as Winston Churchill concluded in describing democracy to the House of Commons in 1947, the alternative is worse.

Even if we determine that, for the general society, competition-induced innovation is generally worth the price, the first specific sector of society to benefit from a telecommunications innovation is often the last to pay for it. A telecommunications utility has the incentive to lower prices to customers with high elasticities of demand (especially in its competitive markets), and recover the resulting lost income by raising prices to customers with low elasticities of demand in monopoly markets. In this way, captive monopoly residential consumers can be required to pay costs of innovations enjoyed only by customers in other, more competitive (or simply more price elastic) sectors.

Such cross-subsidy in the telephone business is a very old problem. It seems as though each technological advance was paid for in large measure by those who did not need to use it. Two historical examples make the point. AT&T began improvements to telephone plant very early in order to improve long-distance service. Indeed, the purpose of the complete integration of local and long-distance calling into one network in the 1890s was to expand the long-distance business, although the costs for the resulting upgrading of the local network were largely assigned to the local business.[44] Similarly, the national conversion to seven-digit dialing and 1+ long-distance dialing did away with the ease of three, four and five-digit dialing in many localities, in order to make direct dialing of long-distance calls possible everywhere. Direct dialing also required additional investment in the local portion of the network for equipment to recognize, route, and bill for the additional digits. Additional costs are and will continue to be imposed as the area code numbering system is changed to defer exhaustion of local office numbering codes. Indeed the entire fixed plant is very different than it would be if it had been constructed only for local calling.[45]

There is nothing inherently wrong with these innovations. They only become problems with respect to pricing. The question of which service—local or long-distance—should pay what portion of the fixed plant costs is almost impossible to answer without controversy when the services share the plant in unquantifiable proportions. This battle has been fought for at least eight decades.[46]

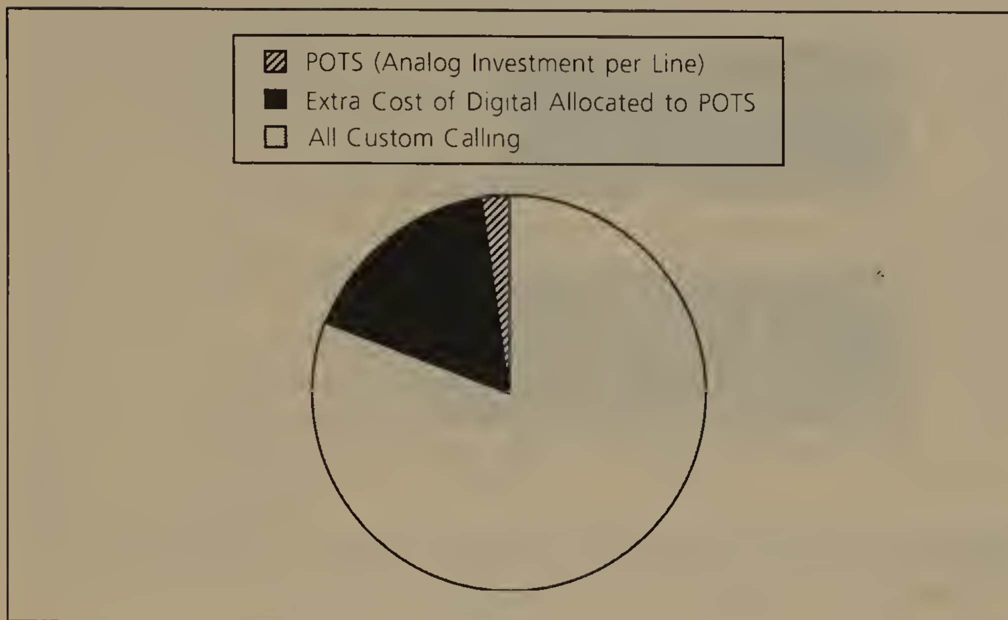
New digital services offer another current example of the difficulties created by the potential for cross-subsidy among services rendered by joint and common plant. High-speed data services and new custom calling services such as call identification and call tracing were made possible by the introduction in 1981 of digital switching machines, essentially the computerization of central office switches (this advance also made touch-tone service much more economical to provide on a marginal cost basis). Thus, the new switches provide ordinary local and long-distance service and also make possible new digital services.[47]

According to one telephone company study of this new switching technology (figure 7.6),[48] this advance increased the company's current incremental investment per line by $52. Thus, assuming that the older analog machines continued to render acceptable basic local and long-distance voice service, the incremental investment cost per line of digital service is $52. (There are also some offsetting savings in circuit equipment used to translate digital signals to analog or back, but these are not germane to basic voice service.) However, digital services are optional services for which the customers have relatively high elasticities of demand. Therefore a utility offering both optional, high elasticity digital and essential, low elasticity local monopoly service has an incentive to cross-subsidize digital services with local service revenues.[49]

Telephone companies will often contend that, on the basis of economies achieved by the new technologies alone, their investment in digital switching is justified on behalf of local and toll services. However, these economies are often created by such means as artificially raising the depreciation expense ascribed to it. Indeed, increased depreciation rates are ascribed to innovation but largely collected from users who do not use or need the innovations. The industry's depreciation reserve ratio, for example, increased by 56 percent from 1980 to 1986 (from 18.6 percent to 29.0 percent), due to telephone companies' need to replace equipment more frequently to keep up with technological

FIGURE 7.6

Investment Allocated to POTS

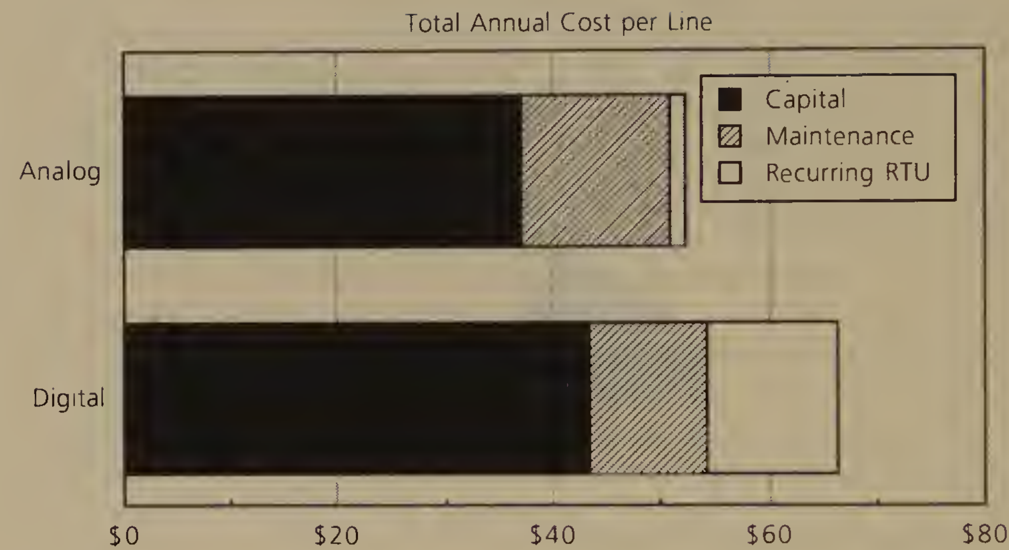


Sources: Mass. D.P.U. 86–33, Ex. NET-120 (Incremental Cost Study)—Book 1, Tab C2, p. 3, @ 3CCS, (April 1986); Book 3, Tab 22, p. 196; Book 3, Tab 10, p. 136.

innovation. However, the bulk of this expense is allocated in rates to basic local subscribers via assignment to local switching machines, although the local machines thus depreciated more quickly are rendering perfectly adequate basic grade service.[50] Even so, telephone company data show the digital machines are not economical for voice service alone (figure 7.7).[51] At least one Bell company spokesman, in response to this presentation, acknowledges that new technology has higher unit costs.[52] He argues that the extra costs are justified by the value of the new functions performed by the innovative technology.[53]

To the extent that new functions are thus the justification for the new technology, the incremental costs of the new technology should not be recovered from ratepayers other than those who benefit from the new functions. Although the digital machines are, by one accounting, somewhat less expensive to maintain, this is more than offset by their much greater capital cost. Furthermore, counting recurring software costs ("right to use" or "RTU" fees) as additional maintenance erases the digital machines' maintenance advantage as well (figure 7.7). Nevertheless telephone companies have installed digital machines in place of analog machines. Such innovation may be as much a product

FIGURE 7.7



Sources: Mass. D.P.U. 86-33, Ex. NET-120 (Incremental Cost Study)—Book 1, Tab C2, pp. 3,4,6, @ 3CCS, (April 1986); DR ATTCOM-35.

of telephone companies' ability to find a monopoly customer base to finance it as of any other factor. The immediate beneficiaries of telecommunications innovation are thus often the last to pay for it.

My comments should not be interpreted as arguing against innovation, competition or divestiture. Rather I have argued for the maintenance of vigilant regulation alongside innovation, competition, and divestiture. All of this should be guided in accordance with consensual social values such as economic equity, privacy, adequate supplies of essential services, and prices for essential services that are just, reasonable, stable, and least-costly.

Bailey M. Geeslin

The dawning of the Information Age is presenting new opportunities and creating new challenges for the industry as well as its customers. I will offer an insider's perspective on a few of those opportunities and challenges which will affect the rate of deployment of innovative new services.

Consider the following fundamental change in network usage, the staple of the public networks supplied by the telephone companies: the growth potential of network usage is limited and it is obvious that "voice grade usage" is a mature business, continuing to grow, but within predictable growth limits. Many telecom managers agree that from a financial and economic perspective future viable business growth in the transport of information will be represented by the phenomenon of Information Age "applications"—the use and packaging of telecommunications network functionalities by enhanced service providers into retail end-user services.

However, the characteristics of Information Age applications versus voice grade transmission are startling and have a profound effect on the management of the business as well as regulation. Take, for example, the effects on marketing. With the voice grade network, the product of transmission of information on the supplier's side is the same as the product of a telephone call from the consumer's side. That is, the network companies are retail businesses dealing directly with consumers. The product as seen by both parties is identical: the transmission of voice information.

The Information Age is changing that fundamental product perception. In the Information Age, applications of telecommunications services go well beyond voice grade transmission. The transport of voice information—indeed the transport of information—ceases to be the product that is bought by the telecommunications services customer. Two examples will help crystalize this concept.

A very simple example is accessing a database, which is done frequently at work as well as at home. The product being bought here is definitely not the transmission of information. The product being bought is a screen of information, either on a monitor or through a printer. A more complex example is sophisticated health monitoring services such as those contracted for by a county health department. The customer using this Information Age application may not even be the one who is paying the bill, and again, the transport of information is no longer a retail product.

This change in telecommunications products from retail to wholesale affects both the people who deal with the industry and the industry which deals with the people wanting to use its services. Both have a lot to learn about marketing Information Age applications.

First, consider the effect of wholesaling on a telecommunications business which thinks of itself as a retail business. With the redefinition of the transport product by the Information Age application, the retailing telephone company often looks upon people who want to use its services as intruders and rejects them, sometimes rather rudely. The history of the old Bell System has proved this to be true in the past, and that tendency still exists with some of its current successors.

The problem with this less than amicable relationship is not one-sided. Sometimes the people knocking on the door, wanting to use the network, do not try to gain entry very politely. Users of network services in applications in which transmission is apparently not the primary product very often say that they have problems doing business with the telephone companies. The users feel that one of the problems which leads to resentment is that they must go to the Bell people and convince them to provide services, even when the use of the service by the users may be a good deal for Bell. But is anything wrong here? Bell companies do that with vendors all the time. Building sound business relationships is part of management's job.

Sound industry/network user relationships do not end with understanding customer focus, and shifting retail/wholesale markets. The telecommunications industry must feel comfortable that there are a number of reputable retailers in business using their services. In addition, retailers must feel comfortable that they are getting a fair deal from the wholesalers; they must like and use the industry's services and see terms as reasonable. The onus is also on the company to modernize the network so that the "wholesale" machine is producing what users are seeking. This leads to another misperception.

There is a tendency today to define the capacity of the network in terms of voice grade telephone calls. This tendency leads to a belief that the capacity of the network is well beyond that which will ever be used. However, the use of network capacity of bandwidth for services other than voice telecommunications will not leave an excess inventory of capacity. On the contrary, the capacity problem being faced right now is not one of excess, but rather a lack of bandwidth beyond 2.4 kilobits on an end-to-end basis through the switched network. Aside from the 56-kilobit services used primarily with personal computers, there is very little end-to-end capacity to provide Information Age services such as point-to-point full-motion video. This requirement to invest in increased end-to-end capacity leads to a final phenomenon. That is, the telecommunications networks in the United States have the characteristics of infrastructure. Infrastructure traditionally provides capabilities prior to identifiable assessable applications for its use.

That causes great difficulty in convincing upper management to invest in new network capabilities. With the prevailing short-term business orientation in this country (as well as the regulatory restrictions of rate-of-return or profit regulation), very often senior management wants names, addresses, social security numbers, and checking account numbers of the customers who are going to pay for this investment. This concern on the part of management is only justified to the extent that regulation will not allow returns to the company's shareholders which are commensurate with the risk incurred (incentive regulation in the form of price regulation would reduce the risk concerns of management). This is certainly true when you examine the major trends toward services with increasing bandwidth and the growth of data usage in this country. Regulatory risk aside, the investments in the infrastructure which are required to satisfy wholesale markets are in my opinion risky, but worth making. These capacity and usage trends are a good barometer of what will be a healthy and vibrant partnership between the telecommunications industry and enhanced service providers, if both the industry and the users "step up" to meeting the challenges which will accompany the opportunities.

As we move into the Information Age, there are many opportunities for both the industry and the users of network services. However, both the industry and the users of the industry's services must work at developing business relationships. The industry must strive to understand and service our wholesale markets and to modernize the network, within regulatory constraints. Retailers have to develop a reputation as good business partners and providers of services which will benefit the community. Together, the industry and the users of telecom services can make the Information Age a reality.

Thomas W. Cohen

It is clear that one of the chief reasons for ending AT&T's monopoly in the equipment and long-distance markets was to foster greater innovation. Moreover, the increased innovations presumably would more closely match the needs and demands of users, and would come on the market more rapidly. There was a strong belief that while "mother" was useful for a network to develop, once that network had developed, the customer, not "mother," knew what was best.

Prior to divestiture, AT&T controlled the pace of technological development and innovation. Virtually every product in the telephone network was developed and made by Western Electric. Those few products which came from the outside were either of little consequence or had to pass AT&T's extremely rigorous—some say, unreasonable—standards. As Walter Bolter and James McConnaughey indicate, Ma Bell decided when a new feature would be offered and who could use it. In other words, the American consumer had no choice. He had to wait for something other than a black telephone, yet was brought the Picturephone without wanting it.

The downfall of the old system did not come from some government policymakers adding up the number of innovations in the telephone network, and deciding that something should be done. Rather, it came about in a typically American fashion. Other firms saw the profits that could be made, and recognized that the technology was available to offer competing products. Much of this technology, somewhat ironically, came from AT&T's Bell Labs. When these new firms came to the government seeking permission to offer various new goods and services, it was many years before the government let them in. It was many more years before they were able to compete on an even footing. In fact, it was not until divestiture that outside providers had a fair opportunity to sell to the telephone company, or interconnect to provide service.

If one were to test whether the old AT&T was, in fact, providing state-of-the-art products and services, one might look at what happened just after divestiture was announced. In the switch market, for example, Northern Telecom quickly shot ahead of Western Electric in selling to the local telephone companies. A major cause was that the AT&T switch was not the most innovative. It took AT&T several years to update its product and regain the lead in switch sales to the local telephone companies. It appears that greater competition has its rewards.

The U.S. telecommunications market is far different today than it was even a decade ago. There are well over one thousand more services, and the consumer (which in certain instances may be the local telephone company) is largely king, getting almost all he wants. However, policy concerns and debates remain.

Elliot Maxwell in this chapter forcefully argues that the manufacturing restrictions of the MFJ may limit certain efficiencies that come from integrating the research, development, manufacturing, and marketing operations. The model used in the MFJ, however, has precedent in the telephone operations in other countries, such as Germany and France. Moreover, the MFJ restriction seeks to strike a balance between the evils that arose from vertical integration in the old Bell System, and any advantages that might come from such integration. While we may be missing some economies, there is little doubt that we are avoiding the costs the old structure imposed. We still lack the necessary and sufficient remedies to deal with the incentives and abilities of the telephone monopolist to self-deal or cross-subsidize. At the same time, there is good reason to continue to refine the MFJ to try to reduce uncertainty and help speed the introduction of new products and services.

I have heard no one cogently argue that the U.S. telephone network has fallen behind that of the rest of the world, or that it is in danger of doing so. But consider the following: total amounts spent on R&D have risen, construction budgets also are increasing, and new services and products are constantly coming onto the market. Just look at the size of any of the trade shows, and the frequency of product announcements. There are now over fifty companies and firms around the U.S. testing ISDN services and products.

The twin policies of competition and divestiture have thus become largely successful. That does not mean that continued vigilance is unnecessary. For example, with the old AT&T, the standards process required little coordination. Today, with the great number of providers, significant coordination in the setting of standards is essential. There is also the need for the government to ensure that trade laws are effectively administered and enforced.

The U.S. telephone network is fundamental to our nation's industrial future. The telephone industry is to be congratulated for ensuring this network remains the finest in the world. There is every reason to believe that the industry will continue to innovate, and bring users the products and services to guarantee the network remains state-of-the-art.

ENDNOTES

1. See Walter G. Bolter, Jerry B. Duvall, Fred J. Kelsey, and James W. McConnaughey, *Telecommunications Policy for the 1980s: The Transition to Competition* (Englewood Cliffs, N.J.: Prentice-Hall, 1984), p. 176. This book was sponsored by the Washington Program of the Annenberg Schools of Communications.
2. Notice of Inquiry, In the Matter of License Contract Agreements and Other Intrasystem Arrangements of the Major Telephone Systems, CC Docket 80-742, FCC 80-700, released February 6, 1981, at 30.
3. National Telecommunications and Information Administration (NTIA) *Telecom 2000: Charting The Course For A New Century*, Special Publication 88-21, October 1988, p. 4.
4. See "McGowan knocks FCC's 'piecemeal deregulation,'" *Network World*, February 6, 1989, p. 48.
5. See, e.g., "ICA urges caution in deregulatory efforts," *Network World*, January 30, 1989, pp. 1 and 37.
6. Address, Communications Week Symposium, December 8, 1988, pp. 3–8.

7. *Telephone Statistics 1988* (Washington, D.C.: United States Telephone Association, 1988), 1:21.

8. New England Telephone and Telegraph Company, Depreciation Rate Study (1987), Intro., p. 12, filed with the Massachusetts D.P.U. in Case No. 86-33.

9. Myron Keller, area manager for loop technical planning, Southwestern Bell, at the Fifth Annual Bypass Conference sponsored by Phillips Publishing, Inc., April 4, 1988.

10. The important savings in current costs manifest themselves in virtually every area of operation. For example, power costs are reduced due to the low energy consumption of fiber systems. Installation costs also fall because of the lower number of repeater sites, and because cables are small and lightweight, require less security protection, and can be converted from one type of use to another merely by changing electronics. In addition, the lower number of repeater sites leads to savings in maintenance costs, which are even further reduced because optical cables are less susceptible than other technologies, such as microwave, to corrosion and electrical or radio interference. Moreover, the greater processing power of the digital switches used with optical cables offers opportunities for automatic remote diagnostics, as well as automatic record keeping and traffic tracking, all of which contribute to maintenance savings. Notably, New England Telephone, which has extensively studied the relative cost savings, reports that "fiber system maintenance costs were approximately one-fifth of those of copper cable facilities." See James McDade, response to data request No. BTUG 5-77 for New England Telephone, MA D.P.U. Case No. 86-33.

11. R. W. Dixon and N. K. Dutta, "Lightwave Device Technology," *AT&T Technical Journal* (January/February 1987), p. 80.

12. Patrick White, Testimony for New England Telephone and Telegraph Company, Massachusetts D.P.U. Case No. 86-33, January, 1987, pp. 20–21.

13. "Annual Forecast," *Telephony,* January 16, 1984, p. 58 (quote attributed to GTE chairman and CEO).

14. Id., January 14, 1985, p. 61 (executive vice president, Central Telephone System).

15. Id., January 13, 1986, p. 42 (chairman, Bell Atlantic Enterprises).

16. Id., January 12, 1987, p. 54 (chairman and CEO, BellSouth).

17. Id., January 18, 1988 (executive vice president, Contel).

18. "A Global Data System is Seen as Telephones Use More Digital Gear," *Wall Street Journal,* December 23, 1985, p. 1.

19. Id.

20. "Users Aren't Getting The ISDN Message, Study Reveals," *Communications Week,* May 30, 1988, p. 22 (Coopers & Lybrand survey of one hundred users at the annual International Communications Association (ICA) conference in Anaheim, California.)

21. NTIA, *Telecom 2000,* p. 4.

22. Link Resources, July 1988 estimates.

23. See, e.g., "The RBHCs should be urged to get on with it," *Network World,* February 6, 1989, p. 46.

24. Remarks given by Richard J. Vehige, Southwestern Bell Assistant Vice President, before the Columbia University Center for Telecommunications and Information Studies Seminar, June 29, 1987, p. 2.

25. See, e.g., "The CPE Marketplace Is a Dog-Eat-Dog World," *Telephony*, May 11, 1987, pp. 30–54.

26. UIS, or Universal Information Services, is AT&T's goal of providing modern, sophisticated services on an "equal access" basis for its customers.

27. Michael Noll, "Bell Systems R&D Activities," *Telecommunications Policy* (June 1987) and "The Effects of Divestiture on Telecommunications Research," *Journal of Communications* (Winter 1987).

28. Noll, "Bell Systems R&D Activities," pp. 161–68.

29. NTIA, The Bell Company Manufacturing Restrictions and the Provision of Information Services, U.S. Department of Commerce, March 1989, p. 4.

30. Id.

31. Id. While some foreign PTTs, as Tom Cohen will point out, do not fabricate equipment, there is no PTT that is prohibited from engaging in developmental activities with its potential suppliers as are the BOCs.

32. New England Telephone Co. (NET), *1987 Depreciation Study*, Ex NET-93 in Mass. D.P.U. 86-33, 159, 171, 337, 466–67.

33. *International Telecharge*, D.P.V. 87-72, slip op. at 3-5, 8-9 (Mass., October 11, 1988); Comments of the Attorney General in D.P.V. 88-45 at 20 (Mass., April 20, 1987).

34. See generally, *Applicability of the Common Carrier Concept*, Order Institution Proceeding (New York Public Service Commission Case 89-C-099, May 24, 1989).

35. See *Century Communications Corp v. FCC*, 835 F. 2d 292 (D.C. Cir. 1987), *cert. den sub nom. Office of Communication of United Church of Christ v. FCC*, 1085. Ct. 2014, 100 L. Ed. 2d 602 (1988) (rules requiring carriage of certain stations invalid under First Ammendment).

36. Chicago Tribune Educational Services Dept. *Big City Newspaper* (1971).

37. See generally re cable tv privacy concerns, J. Oppenheim, "The Coaxial Wiretap? Privacy and the Cable," *Yale Journal of Law and Social Action* (1972), 2:282.

38. J. A. Schumpeter, *Capitalism, Socialism, and Democracy*, 3d ed. (New York: Harper, 1950), p. 105.

39. B. L. Copeland, Jr. and A. Severn, "Price Theory and Telecommunications Regulation: A Dissenting View," *Yale Journal on Regulation* (1985), 3:53, 82.

40. See, generally, L. S. Reich, *The Making of American Industrial Research* (New York: Cambridge University Press, 1985).

41. See H. H. Gerth and C. W. Mills, *From Max Weber: Essays in Sociology* (New York: Oxford University Press, 1946), pp. 52–54, 196.

42. Witness J. Hopley at Tab B in N.Y.P.S.C. Case 27710 (1980). Mr. Hopley argues that New York Telephone's sale price would have been $33 if maintenance, depreciation, and an alleged subsidy to local service were deducted {Innovation session tr. at 10.} (He might have also included the company's

insurance, income taxes, and cost of money). Assuming so *arguendo*—and there is some validity to the claim about maintenance—the facts remain that (1) under the anti-competitive regulatory structure consumers paid $212 rather than $33 and (2) New York Telephone's $33 price would still have been 32 percent above the market price of $25.

43. For example, a Southwestern Bell executive argues that there should be no mandatory carrier of last resort obligation in competitive markets. D. L. Weisman, "Competitive Markets and Carriers of Last Resort," *Public Utilities Fortnightly*, July 6, 1989.

44. N. H. Wasserman, *From Innovation to Innovation* (Baltimore: Johns Hopkins University Press, 1985), p. 39 and n. 33; M. D. Fagan, ed., *A History of Engineering and Science in the Bell System/The Early Years* (Bell Telephone Labs, 1975), pp. 198–99, 202–04. The added cost for local service due to the new two-wire system was about 35 percent. D. Gabel, "Technological Change, Contracting and the First Divestiture of AT&T," Columbia Center for Telecommunications and Information Studies (February 1989), p. 7.

45. R. Gabel, "Allocation of Telephone Exchange Plant Investment," in *Adjusting to Regulatory, Pricing, and Marketing Realities* (East Lansing, Mich.: 1983), p. 468 (Ex. AG-35 in Mass. DPU 86-33); M. D. Fagan, ed., *A History of Engineering and Science in the Bell System/The Early Years* (Bell Telephone Labs, 1975), pp. 1007–08.

46. New York Telephone Co., 2 PSC (2d Dist.) 710 (1910). In the latest phase of the battle, average local flat rate bills jumped 47 percent since divestiture while interstate long-distance rates dropped 30 percent. *State Telephone Regulation Report* 9, September 7, 1989. See FCC CC Dockets 78-72, 80-286.

47. New England Telephone Co. (NET), *1987 Depreciation Study* (Ex-NET-93 in Mass. D.P.V. 86-33) 154–55, 157, 159, 181–82, 359; NET, *Incremental Cost Study* (Ex. NET-120 in Mass D.P.V. 86-33), Book 3, Tab 11, pp. 138–39.

48. New England Telephone Co., *Incremental Cost Study* (Ex. NET-120 in Mass. D.P.U. 86-33), Book 1, Tab C2, p. 3 and Book 3, pp. 136, 196 (April 1986). Total investments required per line are $271 per line (digital) v. $219 (analog growth), making assumptions in favor of the economics of digital machines.

49. In this instance, a utility makes a $52 incremental investment that is not essential to basic local or long distance voice service. Then the telephone company asserts that no incremental investment in switching is needed for digital data services and that only $6.18 (12 percent of the incremental investment) is due to Custom Calling, services that it could not physically provide without the $52 incremental investment in new technology. In so claiming, it lays the foundation for a relatively low "cost-based" price for digital services, raising prices of other services to cover the investment costs that might fairly have been allocated to digital services instead.

50. R. Gabel, "Who Pays the Freight? The Development and Allocation of Telephone Depreciation Expense," in D. W. Wirick, ed., *Proceedings of the 6th NARUC Biennial Regulatory Information Conference* (National Regulatory Research Institute, 1988), 3:563, 569, 575.

51. New England Telephone Co. (NET), *Incremental Cost Study* (Ex. NET-