Table 11-3--Open Network Architecture: Factors Affecting the Choice of Federal Options

1. Apart from its value to individual stakeholders, of what value is the setting of standards in this area from a societal perspective?	Extremely important insofar as entire regulatory policy is built on the assumption of achieving acceptable ONA standards. Important for industry structure/antitrust implications, as well as for assuring rules of access.
2. What is the cost of waiting for standards to be established in the marketplace or through a voluntary consensus process?	Costs would be great in terms of slowing down decisions relating to the structure of the communication industry. Negative implications for network modernization, as well as for extent of access to information services. In the long run, could have costs in terms of ability of the United States to compete in the global economy.
3. How likely is it that, in the absence of government involvement, de facto or voluntary standards will be adopted in the near term? a. To what extent do vendors share a common interest in developing standards and agree on the appropriate standard? b. To what extent are users eager to standardize? Do they agree on a standard? What leverage do they have vis a vis vendors in the marketplace? In the political arena?	Unlikely, given the complexity of the problem, differences among stakeholders, and jurisdictional issues that need to be resolved. RBOCs are basically agreed on value of standards. However, they differ with respect to some aspects of their approaches. Approaches adopted are a significant determinant of competitive position. Competition among vendors likely to grow with standardization. Users warming up to the standards process after initial skepticism. Unsure of their own needs from the process. Outcomes in terms of competition are highly uncertain. Market power vis a vis vendors more or less balanced, with both requiring cooperation. Political power to stall process.
4. To be effective in promoting standards, what level of government involvement would be required? How far would the Federal Government need to go in the direction of setting standards? What kinds of government involvement might be appropriate in this regard?	Extensive/long term. Need to establish guidelines that reflect public policy goals. Greater technology/R&D support to deal with complexity. Support for broader public policy input into the process Resolution of outstanding jurisdictional issues.
5. How susceptible are standards to technological change? How many possible options or choices of standards are there?	Very susceptible to technological change. Complexity of problem confounded by need for multiple standards.

SOURCE: Office of Technology Assessment, 1989.

Chapter 12

Modernization and Technological Development in the U.S. Communication Infrastructure

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Chapter 12

Modernization and Technological Development in the U.S. Communication Infrastructure

INTRODUCTION

As information comes to play a greater role in all aspects of life, many more demands will be made on the communication infrastructure. As seen in chapter 5, for example, a growing number of large businesses, dissatisfied with the limited capabilities of the public communication infrastructure, have begun to develop their own, more technologically advanced networks. In addition, it is clear from the discussion in part 11 of this report that taking full advantage of new communication technologies in the realms of politics and culture, or for individual development and growth, will require significant advances in the communication infrastructure. As the United States takes its place in the emerging global economy, its communication infrastructure will have to be more and more advanced to compete in meeting communication requirements at the international level.

For the U.S. communication infrastructure to adequately meet and balance all of these communication needs, it needs to keep pace with, and take maximum advantage of, advances in communication and information technologies. And it needs to do so in the most efficient and cost-effective manner. However, there is no real consensus concerning which needs should be met. Although people generally agree on the need for a modern communication infrastructure, they view questions of how much modernization is required—as well as how and by whom it should be accomplished, where in the communication infrastructure and in what timeframe it should take place, and how and by whom it should be paid for—as matters of intense debate.

THE PROBLEM

Historically, the United States has set the international pace for technological development in the realm of communication and information technologies. As described by one communication scholar:

> Regulated monopoly produced exceptional performance. Rapidly advancing technology, arising in part from AT&T's [American Telephone and Telegraph's] stellar research arm, Bell telephone laboratories, caused the real costs and prices of products and services to decline while, simultaneously, service was extended to virtually all the nation's rural communities, where costs were several times as high as in the larger cities. This was accomplished in part by direct federal subsidy through the Rural Electrification Administration, and in part by a system of price regulation that massively cross subsidized customers in high-cost areas. By the time the federal government began to question the desirability of and necessity of monopoly, virtually all households were connected to the network.[1]

However, in the late 1970s technological advances began to outstrip the pace of change within the public shared telecommunication network, leading ultimately to the divestiture of American Telephone and Telegraph (AT&T) and the emergence of a number of competing communication networks and service providers.

Competition has clearly contributed to growth and economic activity in the communication sector. According to a study conducted by the Computer Business Equipment Manufacturers Association (CBEMA), total service and equipment revenues in the U.S. telecommunication industry are likely to rise to $215.8 billion by 1990, as compared to $186 billion in 1987 and $196.6 billion in 1988.[2] Viewed from the perspective of shareholders, it is clear that. in the first 4 years following divestiture, the stock prices of the regional Bell operating companies (RBOCs) increased by more than 100 percent (if dividends are included in the analysis) and the total return on equity has averaged about 25 percent, which puts these companies in the same rank as the top third of the Standards and Poor 500.[3]

Notwithstanding these gains, the OTA analysis identified a number of factors that suggest that, in a global information-based environment, the United

[1]Roger Noll, "Telecommunications Regulation in the 1990,S,'" Center For Economic Policy Research, Stanford University, Stanford, CA, August 1988, p. 2.

[2]CBEMA, "The Information Technology Industry Data Book, 1960- 1998," 1989, p. 12.

[3]David W$_{erne}$r, "Management in the Tough 1990s: It'll Be a High Stakes, High Risk Challenge," *Telephony*, Jan. 2, 1989, p. 26.

States may find it increasingly difficult to adequately meet the multiplicity of demands placed on the communication infrastructure. These factors include:

Factor I: The extension of competition to the international arena and, with it, an increase in the requirements for technological advancement in the communication infrastructure.

The ability to keep pace with technological change becomes critical in a competitive environment. The recent history of telecommunication in the United States suggests that, with the introduction of competition, telephone companies are no longer able to time the introduction of new technologies to optimize the life-span of their capital resources. Instead, to retain old customers and capture new markets, they must be the first to adopt new technologies and offer new services.

Just as the introduction of competition in the domestic telecommunication market has increased the requirements for technological advancement in the U.S. domestic communication infrastructure, so, too, has the extension of competition to the international arena. In recognition of this growing need to be on the technological cutting edge, the European Community is pressing ahead to be first in the development of broadband integrated services digital network (ISDN) technology.[4] Thus, in a global economy, U.S. performance must compare favorably not only with its own past performance, but also with the performance of those countries that are its primary competitors.

Recent trade figures are not reassuring in this regard. They suggest that the United States is finding it increasingly difficult to retain its world technological leadership.[5] The declining performance in the area of communication and information technologies is particularly alarming because the United States has traditionally been a world leader in this area. As noted in figure 12-1, U.S. exports of computer, business, and telecommunication equipment decreased from 32.0 percent of the world total in 1982 to 26.5 percent in 1987, while at the same time U.S. imports of these products increased from 15.6 percent of the world total to 27.2 percent.[6]

The economic stakes in this sector are likely to be even higher in the future, given the growing importance of communication and information products and services as a factor in world trade. A recent study by Booz, Allen & Hamilton Inc., predicts, for example, that the world market for moving and managing information will grow 43 percent by 1991, from $390 billion in 1987 to a total of $560 billion.[7] The competition for this market is becoming increasingly intense, prompting many in the United States to view competitiveness in telecommunication trade as a priority issue. For those who do, it is essential to move quickly to modernize the communication infrastructure. As two observers have described the present international situation:

> As competition intensifies the stakes will increase rapidly. Winners will be amply rewarded and losers will be devastated. The big players are laying their wagers right now for a game in which coming in second means coming in last.[8]

Factor 2: The high capital costs of modernization and uncertainties with respect to how these capital requirements will be met.

Success in modernizing the U.S. communication infrastructure will depend, in part, on the Nation's ability to raise the capital required to develop and deploy new communication and information technologies. At present, it is difficult to determine where the United States stands in this regard. How much capital will be required will depend not only on what is entailed in modernization, but also on the

[4]See, for a discussion, Establishing *Advanced Communications in Europe,* IBC Strategic Audit, 1988, Chateau St. Anne, February 1989.

[5]As noted in a report by the Congressional Research Service: "The U.S. deficit in the balance of trade increased from $36.2 billion in 1980 to approximately $170 billion in 1986. . . . Until recently, the strength of U.S. advanced technology exports helped to compensate for declining trade in other manufactured goods. However, according to a report issued by the Joint Economic Committee, since 1982 U.S. advanced technology exports have not been able to keep manufactured trade out of a deficit position. The trade surpluses in these products began to decline and in 1986 ran a deficit." Wendy H. Schact, Library of Congress, Congressional Research Service, "Trade, Technology, and Competitiveness," Issue Brief 87053, updated Apr. 14, 1988, p. 2.

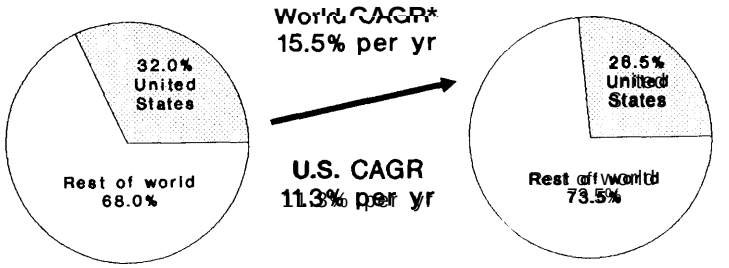
[6]*The Global Position of the United States in Computer Equipment, Business Equipment, and Telecommunication Equipment Markets,* A Global Market Analysis Project performed in conjunction with CBEMA Industry Marketing Statistics Committee, October 1987, p. 9.

[7]"A Scramble for Global Networks: Companies Are Spending Big On Worldwide Communication Systems, "Business *Week,* Mar. 21, 1988, p. 141.

[8]Larry Lannon and Czatdana Inan, "International Telecom Spending on the Rise," *Telephony,* Feb. 22, 1988, p. 36.

Figure 12-1-Comparison of U.S. Exports and Imports of Computer, Business, and Telecommunication Equipment, 1982 and 1987

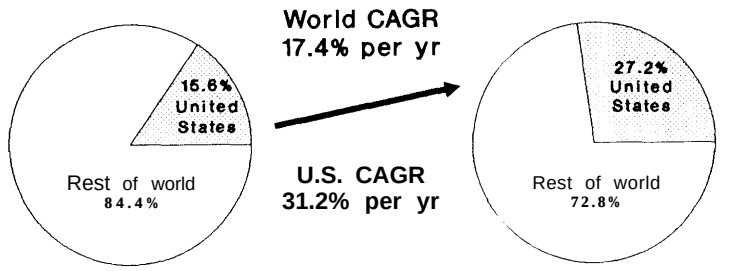
EXPORTS
Billions of U.S. dollars



Total world $37.2 billion
United States $22.9 billion
1982

Total world $76.5 billion
United States $20.3 billion
1987

IMPORTS
Billions of U.S. dollars



Total world $33.3 billion
United States $5.2 billion
1982

Total world $74.2 billion
United States $20.2 billion
1987

● **CAG R•C** o m p **ou** nd Average Growth Rate

SOURCE: "A Global Market Analysis Project," The Center for Economic Analysis, Inc , performed in conjunction with CBEMA Industry Marketing Statistics Committee, Oct. 20, 1987, p. 10. Reprinted with permission.

timeframe in which modernization is assumed to take place. For example, the capital costs of gradually developing narrowband ISDN services in response to market demand, and of moving in an evolutionary fashion to develop broadband ISDN, will be considerably less than those entailed in moving quickly and uniformly to deploy an integrated broadband network.[9]

One measure for assessing how far the United States needs to go in modernizing the communication infrastructure is to look at how equipped the communication network is, at present, to provide advanced communication services, Table 12-1, which depicts the deployment of equipped lines and digital switches, gives one rough estimation.

Another way to measure the extent of modernization is to consider U.S. progress in implementing the intelligent network. The intelligent network makes use of the technological advancement and convergence of telecommunication and computer systems, and especially the emergence of stored program control, digital telephone switching, and fast common-channel signaling systems, such as the Consultative Committee for International Telephone and Telegraph's (CCITT's) No. 7.[10] The research and development of this intelligent network architecture is being conducted at Bell Communications Research (Bellcore), with the assistance of interested vendors, as part of a phased-in process that will ultimately lead to the Advanced Intelligent Network. According to Bellcore, major technology releases—envisioning sophisticated intelligent network products—are scheduled for 1993 and 1995. The long-term network architecture is intended for completion around 1998.[11] Among the services that are presently available (or likely to be available in the near future) through the intelligent network are advanced 8(K) service, 911 public emergency service, automatic calling card, and televoting.

Even if there were agreement on what is entailed in modernization, and where the U.S. communication system stands with respect to it, it would be difficult to estimate the capital requirements. Historical data on the actual costs of providing communication services are very limited because of the problems entailed in identifying costs under the predivestiture telephone system. As Anthony Oettinger has described the problem:

> From an angle whence the very definitions of products and of services along with the definitions of their costs and of their prices all look discretionary, such questions as "what are the true costs?" and "what are the associated cost-based prices?" amount to hunting the unicorn.[12]

Moreover, as Bruce Egan and Lester Taylor have pointed out:

> The current decision to invest in digital fiber technology is unprecedented relative to decisions of the past, since it represents a major transformation of the network in a competitive environment. Every other major investment decision was made in a monopoly environment and the investment decision was therefore almost completely dominated by considerations of service quality, cost savings, and regulatory assurance of capital recovery.[13]

Nor is it easy to predict future costs, given rapid technological change and numerous uncertainties about the nature of the communication infrastructure. It is only recently, for example, that tariffs have

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[9]For efforts t. examine costs, see Bruce L. Egan and Lester D. Taylor, "Capital Budgeting for Technology Adoption in Telecommunications: The Case of Fiber," prepared for presentation at Bellcore/Bell Canada Industry Forum, "Telecommunications Costing in a Dynamic Environment," San Diego, CA, Apr. 5-7, 1989. See also the discussions on cost in William Lehr, "ISDN: An Economist's Primer for a New Telecommunications Technology," Department of Economics, Stanford university Technology and Progress Seminar, Feb. 14, 1989; and Robert Pepper, "Through the Looking Glass: Integrated Broadband Networks, Regulatory Policies, and Institutional Change," Office of Plans and Policy, Federal Communications Commission, Washington, DC, November 1988.

[10]By increasing network intelligence, network decisionmaking can be distributed outside of switching centers. This distributed kind of architecture is extremely flexible, allowing for much greater ease in introducing new services as well as for virtual private networks, and hence much greater user control. For descriptions and discussions, see Denis Gilhooly, "Towards the Intelligent Network," *Telecommunications*, December 1987, pp. 43-45, 48; John O. Boese and Richard B. Robrock, "Service Control Point: The Brains Behind the Intelligent Network," *Bellcore Exchange*, November-December 1987, pp. 13-17; Allen Adams and John Wade, "Looking Ahead to the Next Generation," *Telephony*, May 23, 1988, pp. 157-159; Art Beaty, Jr., "The Evolution to Intelligent Networks," *Telecommunications*, February 1989, pp. 29-36; and Paul Bloom and Patrick Miller, "Intelligent Network/2," *Telecommunications*, February 1987, pp. 57-65.

[11]"Perspective on the Advanced Intelligent Network," Bellcore Press Release, Mar. 27.1989.

[12]Anthony G. Oettinger, "The Formula is Everything Costing and Pricing in the Telecommunication Industry," Center fOr Information policy Research, Harvard University, Cambridge, MA, October 1988, p. 1.

[13]Egan and Taylor, op. Cit., footnote 9, p.1.

Table 12-1—The Regional Bell Operating Companies' Digital Status: Lines and Switches, June 30,1988

	Equipped lines[a]	Percent digital	Local switches	Percent digital
Nynex	16,392,000	38	1,292	56
Bell Atlantic	16,919,000	35	1,585	39
BellSouth	17,515,000	34	1,323	36
Ameritech	17,594,000	26	1,262	36
Pacific Telesis	13,900,000	23	744	33
us west	13,456,000	22	1,321	21
Southwestern Bell	13,017,000	18	1,706	20
Total	108,793,000		9,233	

● Total central office line capacity (access lines average 85 percent of equipped lines).
SOURCE: Reprinted with permission from *Telephony*, Jan. 9, 1989.

begun to be set for the first ISDN offerings.[14] Not surprisingly, therefore, the range of estimates is very broad. Looking only at the cost of deploying fiber technology to the local telephone loop, for example, estimates range from as low as $1,500 per subscriber to as high as about $20,000 per network subscriber. Considering these costs together, the total cost of a fiber network might be anywhere between $150 billion and $2 trillion.[15]

Estimates, of course, will depend on the indicators used. One analysis looks at the $5 million to $15 million per switch that would be required to replace approximately 12,000 central office switches with the latest digital switch.[16] Another uses the figure of $1,500 per subscriber to estimate the total network cost of installing fiber as $100 billion.[17] Another analysis, which looks only at the incremental cost to the local exchange companies of upgrading their networks for the provision of narrowband ISDN, concludes that the amount of money required for modernization will be approximately $17.6 billion.[18]

Another major factor affecting modernization costs is the rapid pace of technological change, and hence the likelihood that newly deployed technologies may have only a short lifespan. For example, developments in broadband ISDN technologies may soon make narrowband ISDN obsolete, even though the deployment of narrowband technologies has only just begun.[19] In fact, the cost of recently sunk investment may be high enough to significantly retard modernization.[20] It has been suggested, for example, that ISDN's slow rate of adoption has been due in part to the fact that so many new private branch exchanges (PBXs) have been installed over the past 5 years. Against this problem of obsolescence, however, one must weigh the fact that new technologies decline in cost as they mature. For example, there have recently been such declines in the costs of PBXs and T1 multiplexers.[21] And, of course, the extent to which technological change serves to retard modernization will depend, in part, on allowable depreciation rates.

The problem of determining whether the United States will be able to provide sufficient capital to modernize the Nation's communication infrastructure is not merely one of estimating the costs involved. It is also necessary to ascertain whether such a large amount of capital will be forthcoming, and, if so. from whom and through what processes. In the United States, there has been very little

14" Illinois Bell First With ISDN," *The ESC Monthly Report,* April 1988, vol.3, p. 13. Recently, AT&T has also released tariffs for some ISDN services.
15Egan and Taylor, Op. Cit., footnote 9, p.3.
16Lehr, op. cit., footnote 9, p. 57.
17Pepper, op. cit., footnote 9, p- 10.
18Lehr, op. cit., footnote 9, p. 56. This estimate is based on the $2 billion that Pacbell plans to spend to complete its digital switch upgrade program and the over $200 million that will be required to deploy signaling system 7 (SS7). To get the $17.6 billion figure, Lehr multiplies this total cost by seven regional holding companies plus GTE. He notes, moreover, that additional investments would need to be made by the interexchange carriers,
19See Loretta Anania and Richard J. Solomon, "The Beaut, and the Beast: Virtual Networking in B-ISDN," *Telecommunications*, September 1987, pp. 33-34.
20Clare Lee, "ISDN—User Doubt and Tariff Issues," *Telecommunications*, April 1988, p. 57.
21For example, see Neil Watson, "T1 Vendors Play 'Price is Right'," *CommunicationsWeek*, Dec. 26, 1988, pp. 1, 18.

discussion of this issue.[22] As Anthony Rutkowski has described the situation in reference to the open network architecture (ONA) process:

> The costs of openly providing the necessary network interfaces and BSEs [basic service elements], especially on a nation-wide scale and with older equipment, can be enormous. No guidelines presently exist as to how to separate the necessary from the frivolous, nor to decide what is funded out of the existing regulated rate base versus what is derived from other sources of revenue, nor how to separate those functionalities which are employed for interstate vs. intrastate service.[23]

The general operating assumption appears to be that where there is a demand for modernization there will be profit-making opportunities, and hence sufficient incentive to generate the necessary capital resources. However, notwithstanding impressive economic growth in the communication sector and the emergence of a vast array of new providers of communication goods and services, there are a number of reasons why policymakers might be concerned about the future prospects of capital accumulation for infrastructure development. Among these are:

Reason 1: The sheer magnitude of the costs involved.

Although there has been no detailed analysis of the costs of developing and deploying a fully modernized U.S. communication infrastructure, most people agree, on the basis of informal estimates, that these costs will be extremely high. Such estimates are corroborated by those of foreign governments. The Government of the Federal Republic of Germany, for example, assumes that the cost of converting their telecommunication system into an ISDN will be approximately $40 billion over the next 30 years.[24]

The increasing cost of R&D also suggests an increase in the costs of modernizing and keeping the U.S. communication infrastructure up to date. According to the National Science Foundation (NSF), for example:

> Over the next decade, the U.S. will have to more than double its annual expenditures on academic R&D merely to maintain its base level. One person-year of senior R&D effort will increase from $155,000 to $180,000-$205,000 by 1996 [in constant dollars].[25]

Increased R&D costs can have a major impact on the costs of modernizing the communication infrastructure because communication technology is so R&D-intensive.[26] As Karl Frensch, executive director of Siemen's public switching division in Munich, has pointed out with respect to the R&D required to develop a modern switching system:

> Developing a large public switching system requires an immense amount of R&D, let's say on the order of $2 billion for the whole system over its lifetime of about ten years . . . You can only make this investment if you have 10% to 15% of the world market.[27]

The cost of capital can also be expected to increase, insofar as it is unlikely that internally generated funds will be sufficient to meet future needs, and much of the cost will have to be financed through borrowing.[28] The cost of such funds maybe quite high, given the risks entailed in investing in an

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22 One of the few discussions of this issue is in Egan and Taylor, op. cit., footnote 9. According to their analysis: "The LECs [local exchange carriers] face a large capital shortfall in their efforts to aggressively pursue widespread deployment of fiber to homes and businesses. Under current market conditions and fiber cost levels, it appears that the LECs will require about $100 billion in new revenues beyond the internal cash flows over the construction horizon just to cover the costs of fiber for plain old telephone service (POTS) functionally. Advanced fiber systems providing for a wide range of new customer services would cost even more. "

23 Anthony M. Rutkowski, testimony before the House Committee on Energy and Commerce, Subcommittee on Telecommunications and Finance, July 30, 1987.

24 Rolf T. Wigand, "Integrated Services Digital Networks: Concepts, policies, and Emerging Issues, " *Journal of Communication*, vol. 38, No. 1, Winter 1988, p. 36.

25 National Science Foundation, "Future Costs of Research The Next Decade for Academe," Report PRA-87 by NSF's Division of policy Research and Analysis.

26 As noted b, Kenneth Flamm: "Only the aircraft and missile industry, with significant support from the Defense Department, spends a greater share (14 percent) of its sales on R&D." Kenneth Flamm, "Technological Advance and Costs: Computers Versus Communications," in Robert Crandall and Kenneth Flamm (eds.), *Changing the Rules: Technological Change, International Competition, and Regulation in Communications* (Washington, DC: The Brookings Institution, 1989), pp. 13-14 (footnote 2).

27 As cited in Jefferson Grigsby, "Global Report: Telecommunications," *Financial World*, Apr. 18, 1989, p. 34.

28 See Egan and Taylor, op. cit., fOOtnOte 9.

economic sector characterized by rapid technological advancement.[29]

Reason 2: The potential problems entailed in generating funds for research, development and deployment.

Capital for research, development, and the deployment of new communication and information technologies is derived from government funding, the reinvestment of profits, and borrowing in financial markets. Looking at these basic sources, it appears that obtaining capital for modernizing the U.S. communication infrastructure may be somewhat problematic in the future.

One factor suggesting such an outcome is the reduced levels of government funding in R&D, especially in relationship to the commercial applications of new technologies. For example, according to a report recently released by Battelle Memorial Institute:

> After adjusting for projected R&D inflation, real outlays will increase about 2% next year, down markedly from the 10-year average of 3.518% . . . Defense Department research spending will decline slightly next year because of pressures to reduce the federal deficit. Nonetheless, the Defense Department will account for 28% of total R&D expenditures next year, and will get 60% of federal research funds.[30]

Regulatory policies may also discourage investment in modernization. For example, some have suggested that rate-of-return regulation, by capping the potential payoffs at levels too low to offset the risks of failure, discourage private, equity investment in the public telecommunication network.[31] Others have argued that present methods of calculating depreciation rates provide inadequate incentives to attract investment for innovation.[32] Still others say that the uncertainty concerning the rules that govern communication companies' activities and operations is, in itself, enough to discourage investors.[33] As one market analyst has noted:

> Since the return on investment is not immediate and transition uncertainties loom large, telecommunication companies tend to be valued at some discount to their actual revenues. over the past **4 years** telecommunications has not been an attractive area to achieve investment return.[34]

An additional factor inhibiting investment might be increased political contention at the local level concerning the need for modernization and the manner in which it should be financed. In the face of growing pressure for modernization, State regulators, for example, want greater assurance that the capital required for modernizing the network is not paid for by ratepayers who will not benefit from new services .35 Many States now require that decisions to construct new plant be based on an economic analysis that can demonstrate that ratepayers' benefits exceed the cost of development.[36] Such decisions can be highly contentious. For, as Wheatley, Selwyn, and Kravtin have pointed out:

> . . . an assessment of specific capital decisions is rarely straightforward. The introduction of new technologies often brings with it the availability of new services along with cost efficiencies in the provision of existing services. There is seldom agreement among all parties as to the relative merits of the new services for different classes of customers

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[29]For a discussion, see Wenner, op. cit., footnote 3, pp. 24-38. See also discussion on raising capital that directly follows.

[30]As cited in, "Group Forecasts 3.4% Rise to $129.2 Billion Level After a 6% Jump in 1988," *The Wall Street Journal*, Dec. 21, 1988, Technology Section, p. 1. As Professor Lewis Branscomb has noted, the strong emphasis on military applications has drained critical resources from the commercial sector. Testifying before the House Committee on Science, Space, and Technology, Technology Policy Task Force, he pointed out, for example, that: "While recent federal budgets have permitted growth in some agency research programs-notably the NSF—the overall federal pattern is weak, primarily because of the failure of the Department of Defense to build its fundamental research base at the same time it extracts from the existing base with massive increases in applied research and development . Just as each corporation funds its share of industrial research, so too federal agencies must each re-invest in the knowledge base their program draws from. " Testimony, June 25, 1987.

[31]See, for one discussion, Loretta Anania and Richard Jay Solomon, "Capital Formation and Broadband Planning: Can We Get There From Here?" *Telecommunications*, November 1987, pp. 26, 28. See also discussion in Egan and Taylor, op.cit., footnote 9.

[32]See, for instance, T. Nousaine, S. Brant, and J. Murray. "Give Depreciation the Appreciation It Deserves," *Telephony*, July 18, 1988, pp. 52-58; and Larry F. Darby, "The ABCS of Telecommunication Depreciation . . . And Why They Matter," *Telematics*, vol. 4, No. 1, January 1987, pp. 3-9.

[33]See, for a discussion, "Progress On Hold? Telecommunication Needs Less Regulation, More Competition," *Barron's*, Oct. 5, 1987.

[34]Jon W. Bayless, "Telecommunications: A Venture Capital perspective," *Telecommunications*, January 1989, p. 25.

[35]For one discussion, see Leslie Albin, "Digital Tomorrowland: Who Will pay for the Gold Plated Network," *Telematics*, vol. 3, No. 10, October 1986. See also, Nancy J. Wheatley, Lee L. Selwyn, and Patricia D. Kravtin, "Telecommunications Modernization: Who Pays?" prepared for the National Regulatory Research Institute by Economics and Technology, Inc., September 1988.

[36]Ibid., p. 10.

or as to the benefits of the operating efficiencies that should be attributed to existing services.[37]

Raising capital for modernization may also become more difficult, given increased competition for funds among high technology firms (especially in the venture capital market) to finance new companies selling advanced products. There is also a growing disinclination on the part of financiers to fund communication or information-related technologies. For example, in a recent survey of the largest venture capital firms, it was found that of the 209 firms that responded, 70 percent planned to invest from $1 million to $10 million in high technology companies in 1988. Rating their preferences, they put software, computers, and communication second, seventh, and eighth on their lists. Only three firms expected to invest in fiber optics, and only one was interested in network management and/or networking systems.[38]

Reason 3: The shift of resources to privately owned communication systems.

As emphasized in chapter 5, the need for specialized, upgraded, and technologically advanced communication systems is particularly felt in the business community, where communication increasingly provides the leverage for competitive advantage. Dissatisfied with the technical limitations, lack of corporate control over, and high costs of publicly provided telecommunication services, many corporations have begun to establish their own private and/or competing systems. By 1986, more than one-third of all U.S. spending on capital facilities for telecommunication was accounted for by individuals and firms apart from communication common carriers.[39] And in 1987, sales of transmission lines and equipment for private networks were estimated to be $14 billion, an increase of 6 percent from 1986.[40] Most recently, expenditures on private networks have been estimated to be in the range of $16 billion.[41]

The development of these private networks has been facilitated by the emergence and availability of new technologies that allow users to purchase communication products and services in an unbundled fashion. They have also been encouraged by regulatory policies, such as open network architecture (ONA), that call for increased competition and the unbundling of network services. Commenting on the effect of these developments, one observer noted, for example, that:

> [After divestiture, the] transition from a monopolistic to a competitive environment, coupled with the availability of affordable alternative transmission media such as optical fiber, DTS microwave, and small aperture satellite communication terminals, witnessed mounting "bypass" activity. Protests about lost revenues were heard from the carriers. Competition would now come from two directions: private networks and alternative service providers .42

One way of looking at the extent to which communication systems may become privatized is to examine the rapid development and deployment of T1 technology in the corporate business environment. (See figure 12-2 for projected growth in communication networks.) Providing for the integrated transmission of voice, data, and image traffic, voice compression, the flexible use of bandwidth, as well as alternate routing, T1 offers users considerable cost savings and much greater network con-

[37] Ibid., p. i. As they note: "Regulatory commissions will be required to assess modernizing projects involving facilities that are used to furnish both regulated and unregulated services. A mismatch of costs and benefits from these projects can occur if costs and revenues are not consistently allocated between the ratepayers and the shareholders. A mismatch can also occur if there is a change in the regulatory status of one of the services furnished using upgraded plant subsequent to its acquisition. Finally, the cost of capital of a regulated firm may change as the firm takes on increasingly risky activities. Each of these potential cost/benefit matches arises because the telecommunications utility is no longer providing only regulated services. . the policy challenge is to devise a method to reduce or eliminate these potentially significant cost/benefit mismatches." Ibid., p. ii.

[38] Speech b, Henry J. Mayer, President, Mayer Frank& Co., Inc, as reported in *The ESC Monthly Report,* vol. 3, April 1988 Edition, PP. 4-6; see also Bayless, op. cit., footnote 34.

[39] Robert W. Crandall, "Fragmentation of the Telephone Network," The Markle Foundation, New *Directions* in *Telecommunications* Po/icy, vol. 1, *Regulatory Policy: Telephony and Mass Media* (Durham, NC: Duke University Press, June 1989), p. 49.

[40] *Business* Week, op. cit., footnote 7, p. 140.

41 William H. Davidson, "Trends in Telecommunications Networks: Regulatory Issues and the Outlook for the U.S. Information Economy," University of Southern California, Los Angeles, CA, April 1988, p. 44. A recent study by Coopers& Lybrand puts worldwide sales of equipment and transmission facilities for private networks at $52 billion in 1988, and projects that such sales will reach $147 billion by 1992. Coopers& Lybrand, "The Impact of Emerging intelligent Networks in New York State," February 1989, p. 2.

[42] Victoria A. Brown, "T1 Networking and open Systems," *Telecommunications*, January 1989, p. 56.

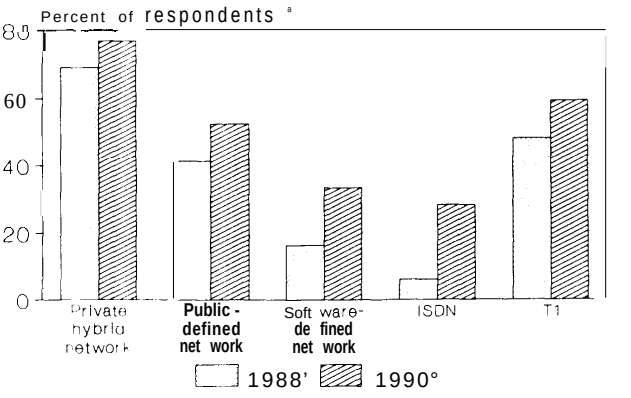
[43] T1 circuits operate at 1.544 megabits per second and Consist of 64 kilobits per second voice or data, plus a framing bit. For a description, see ibid.

trol.[43] Hence, it is appealing to the large-volume business user.

Although T1 services were originally provided by AT&T in the early 1960s, vendors of customer premises equipment (CPE)—responding to the growth in data traffic as well as to the entrepreneurial opportunities presented by the divestiture of AT&T—began in the early 1980s to provide high performance point-to-point T1 multiplexer specialized for business use.[44] The corporate demand for T1 services grew rapidly, at an annual rate averaging from 30 to 40 percent.[45] The growth of this market should continue steadily into the future. In fact, given an ever-increasing demand for data communication (estimated to have grown by 40 percent since 1970, and predicted to account for 40 percent of all communication services by the early 1990s), some large companies are now beginning to employ T3 circuits, which operate at 44.736 megabits per second (Mbps).[46] Moreover, because it is now becoming possible for vendors to offer fractional T1 services, smaller businesses may also enter the market, finding it economically more feasible to develop their own telecommunication systems.[47] Also driving the future demand for T1 and T3 services will be applications such as videoconferencing, computer-aided design/manufacturing (CAD/CAM), bit-mapped work stations, image transfer, high-speed local area network (LAN) bridges, and mainframe-to-mainframe links, which all exhibit appetites for bandwidth in the megabit range.[48]

How the use of such technologies in private networks will affect the public communication infrastructure is a matter of considerable debate, focusing heavily on the issue of bypass. Defined in a variety of ways, bypass generally refers to the act

Figure 12-2-Projected Growth in Communication Networks, 1988-90



[a] Base of 100 $100 million-plus companies surveyed

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of avoiding the local exchange carrier (LEC) in transmitting messages. The term, however, can refer specifically to the circumvention of LECs' facilities (known as facilities bypass) or to the circumvention of various services that the exchange carrier provides (known as service bypass). Moreover, the notion of bypass can be differentiated on the basis of whether it allows for the most efficient allocation and use of resources (known as economic bypass), or whether it is inefficient, resulting from distortions in price (known as uneconomic bypass).

How one measures the impact of bypass on the public communication infrastructure will depend in large measure on the type of bypass. For example, the extent of damage to the LEC due to bypass may be much less if it is only a number of services, and not the entire physical facility, that are circumvented. Or, in the case of economic bypass, it can be

[44] Ibid. See also Stephen Fleming, "The Evolution of T3 Networking," *Telecommunications*, December 1988, pp. 16-20. As the author notes: "BY the first half of the 1980s, three major events occurred to change the usage pattern of digital transmission links. First, telephone operating companies began converting major portions of their networks to digital transmission, making T1 pipes more accessible. Second, divestiture opened up competition in the telecommunications marketplace so that the time-to-market of new products and services became much shorter. Third, the continuing revolution in end-user computing power meant that a corporate telecommunications manager now had to administer complex data networks in addition to existing voice networks. Entrepreneurial companies such as Network Equipment Technologies, Cohesive, & Infotron, began adapting public network T1 technology for sophisticated private network requirements. T1 usage by end users began skyrocketing." p. 16.

[45] Tom Valovic, "Assessing the Complexities of the T1 Marketplace, " *Telecommunications*, December 1988, p. 16; see also M. Gawdun, "Future Directions in Transmission," *Telecommunications,* December 1987, pp. 48-49.

[46] A recent study by the Yankee Group reports that there are now about 25 corporations involved in T3 networking, including General Motors, Monsanto, McDonnell-Douglas, and American Airlines, Tom Valovic, "T1, T3, and the Never-Ending Bandwidth Argument," *Telecommunications*, December 1988, p. 6.

[47] For a discussion, see Neil Watson, "Mux Market Moves," *CommunicationsWeek*, Dec *26, 1988,* p. 17; Elizabeth Horwitt, "Data Seen Increasing On T1 Links," *Computerworld*, Jan. 9, 1989, p. 27; and Nathan J. Muller and David Hoist, "Customers and Carriers Can Benefit From Fractional T1 Services," *Telephony,* December 1988, pp. 33-37.

[48] Fleming, op. cit., footnote 44, p. 19.

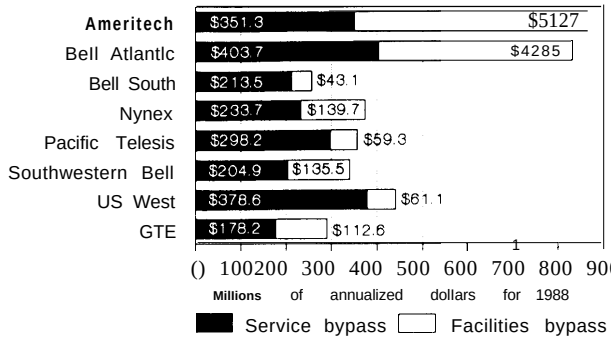
argued that, while LECs may suffer losses, society as a whole is better off, since resources are allocated most efficiently .49

Given these alternative ways of ascertaining bypass, it is not surprising that stakeholders strongly disagree about the actual extent to which bypass of the public telephone network has taken place and the impact it is having.[50] Telephone companies have claimed major losses. In their most recent assessment to the Federal Communications Commission (FCC), for example, the RBOCs claimed that they had lost $3.7 billion to bypass, as can be seen in figure 12-3.[51] On the other hand, telephone company competitors, together with local regulators and many consumer groups, have tended to minimize the damage due to bypass. As noted in a report prepared for the National Association of State Utility Consumer Advocates, many of these groups challenge FCC's conclusions about bypass on the grounds that they overemphasize price as the motivation for bypass and fail to consider bypass in the context of RBOCs overall growth. According to this perspective, FCC's analysis:

> ... largely ignore[s] the critical role of services considerations in the bypass decision. Bypass surveys performed by user groups have generally concluded that non price, service factors, including the unavailability of a service from the local telephone company, are more powerful bypass motivators than price.
>
> The case has not been made that bypass is now, or will be, of such magnitude as to have an impact on the revenues of the local operating companies. There is no evidence that companies currently employing bypass alternatives have generally reduced their uses of the local telephone company switched services.[52]

Measuring bypass is likely to be even more difficult in the future, given rapid technological advancement. For example, confusion will arise when greater intelligence is built into the network,

Figure 12-3-Telephone Company Revenue Lost to Bypass



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insofar as it becomes more and more difficult to distinguish between what constitutes facilities and what constitutes service. As Solomon and Anania have pointed out:

> These problems arise because the digital switch will be thoroughly integrated with digital transmission and with customer premise digital terminal equipment (voice, data, or hybrid). The seamless, digital integration creates paradoxes for regulators, service providers and customers. Since multiple computers will be accessing each other at the control levels of their central processors, how will each switch (computer) know the difference between lineside traffic and trunkside traffic? How will the computer switches handle contention for resources? How will each switch know what is public and what is private?[53]

Moreover, the problem of distinguishing between economic and uneconomic bypass will be compounded by the difficulties entailed in sorting out costs and prices in an integrated broadband network (IBN) environment. As Robert Pepper has noted:

> The inherent arbitrariness of old fashioned rate base rate-of-return ratemaking, where tariffs are cost

[49]For a discussion of these distinctions, see U.S. Congress, General Accounting Office, "Telephone Communications: Bypass of the Local Telephone Companies," GAO/RCED 86-88, August 1986.

[50]Government studies on bypass have included: "Bypass of the Public Switched Network." Common Carrier Bureau, Federat Communications Commission, Dee. 19, 1984; U.S. General Accounting office, op. cit., footnote 49; Gerald Brock, "Bypass of the Local Exchange: A Quantitative Assessment," OPP Working Paper #12, Federal Communications Commission, September 1984; Racster, Wong and Guldman, "The Bypass Issue: An Emerging Form of Competition in the Telephone Industry," No. 84-17, The National Regulatory Research Institute, Columbus, OH, December 1984; and Peter W. Huber, "The Geodesic Network: 1987 Report on Competition in the Telephone Industry," prepared for the Department of Justice in accordance with the Court's decision in *US, v. Western Electric Company,* Supp. 131, 194-5.

[51]Monitoring Report prepared by the Staff of the Federal-State Joint Board, CC Docket 80-286, p. 98, table 601. Telephone company bypass is monitored and assessments are made to the FCC on a quarterly basis.

[52]'' Bypass and the Subscriber Line Charge," prepared for the National Association of State Utility Consumer Advocates, Bethesda Research Institute, Ltd., Bethesda, MD, June 1987, pp. ii-ill.

[53]Richard J. Solomon and Loretta Anania, "Paradoxes and Puzzles of Digital Networks, Part 1," *Telecommunications,* January 1987, pp. 26-28.

supported by attempting to assign costs to "cost causers," will become even more apparent if such regulation is applied to tomorrow's IBNs. Traditional voice telephony and broadband video transmission are so different that any attempt to price them using the same procedures or measures will likely prove futile.[54]

The extent to which bypass will actually occur in the future will depend on a number of factors, including:

- how quickly the telephone companies can upgrade their networks and develop services that meet the needs of business users,
- the positive and negative experiences that large users have in developing and operating their own private communication systems, and
- the regulatory context that sets the ground rules for the provision of communication services.

Since these factors are, themselves, quite uncertain, the outcome with respect to privatization is very difficult to predict. (See box 12-A for a more detailed itemization of these factors.)

Traditional telephone companies have generally considered the development of broadband intelligent networks (moving in an evolutionary fashion from narrowband ISDN to broadband ISDN) as their primary strategy for competing to meet the communication needs of business.[55] However, as already noted, the full implementation of these systems is still a long way off. Thus, in the interim, telephone companies are undertaking a number of measures to forestall the migration of large users from their networks. To this end, they have moved to upgrade and enhance traditional Centrex services[56] and to develop hybrid network solutions that combine intelligent customer-premises equipment with telephone company transmission and multiplexing services, allowing customers much greater flexibility and control at reduced costs.[57] To meet the growing demand for data transmission services, for example. RBOCs are now offering CO-LANS, a central-office-based local area network service .58 These new offerings have proved quite successful, not only m terms of restraining the growth of the customer-premises market,[59] but also in terms of providing the telephone companies and their customers a solid transition path for moving toward and implementing ISDN.[60] To avoid the loss of business customers, the traditional telephone companies have also been more aggressive in their pricing and marketing strategies, offering much greater flexibility in the pricing and packaging of services. In a recent effort to generate interest in ISDN, AT&T, for example,

[54] Pepper, op. cit., footnote 9, p. 46.

[55] As noted by Tom Valovic: "Most especially, ISDN becomes important because it offered a universal scheme whereby significant new functionality for both voice and data (and possibly even higher bandwidth applications such as video) could be offered to corporate customers but controlled and managed via AT&T and the BOCs custody of the public networks. This was reinforced by the realization that unless they moved to create these new levels of both network intelligence and control for their customers, they would lose serious competitive advantages as corporate users plunged ahead with their private networking efforts . ." Tom Valovic, "Public and Private Networks: Who Will Manage and Control Them?" *Telecommunications*, February 1988, p. 42.

[56] Centrex is the general name for a switched business telecommunication service that is provided from the telephone company central office. An alternative way of achieving switching services is through the purchase of a PBX that is located on the customer's premises and is controlled and maintained by the customer. For a comparison of these two types of service, see John R. Abrahams, "Centrex Versus PBX: The Battle for Features and Functionality," *Telecommunications*, March 1989, pp. 27-28,31-32.

[57] For discussions of these strategies, see Martin H. Singer, "Hybrid Networks Move to Telecom's Center Stage," *Telephony*, Mar. 6, 1989, pp.4l-51; Bob Vinton, "Bells Eyeing MAN Market," *CommunicationsWeek*, Apr. 10, 1989, pp 34, 38-39; and Martin Pyykkonen, "Centrex Now, LSDN Later," *Telecommunications*, February 1987, pp. 53, 54, 84.

[58] For a discussion, see Anne-Marie Roussel, "Central Office Stepping Stones," *CommunicationsWeek, CLOSEUP*, June 27, 1988, p. C-6.

[59] Modern digital Centrex service has been gaining market share since it first became available in 1984, With the number of Centrex telephones in the United States growing at about 5 percent per year. However, over 50 percent of all Centrex lines in the United States are still provided from analog central offices. Abrahams, op. cit., footnote 56, pp. 27-28.

[60] As Pyykkonen has noted: "For the local operating Companies there is a trade-off to be made regarding the pace at which ISDN services are introduced versus the degree of graceful upgradability which can be implemented in the central office switch. . . . The commitment that has been made by carriers and equipment vendors to ISDN is sufficient to overcome these obstacles over the long term The question is, how quickly can the obstacles be overcome while being economically feasible for all parties concerned?" Op. cit., footnote 57, p. 54. For one discussion arguing in favor of an evolutionary strategy, see Ye-Sung Cho, "For ISDN, There's No Need to Dismantle the Network: A Smooth Transition is Possible," *Communications Week*, May 23, 1988, p. 17. Bellcore recently announced a technological breakthrough in internetworking that will facilitate an evolutionary strategy and thus might boost ISDN use. Currently, to offer ISDN services, LECs may have to invest between $3 million and $5 million in a new digital switch for each ISDN central office. However, with Bellcore's new breakthrough, telephone companies can interne t l A switches with modern digital switches, and thus protect some of their investment in embedded equipment. Sec Steven Titch, "Bellcore Breakthrough May Boost ISDN Use," *CommunicationsWeek*, Nov. 7, 1988, p. 1.

[61] Beth Schultz, "AT&T To Let Telcos offer Users Free ISDN," *Communications Week* Mar 20,1989, p. 2.

Box 12-A—Factors Affecting Control of Public and Private Networks

- Ongoing convergence of computers and telecommunications
- Development of ISDN and other intelligent network capabilities
- Increased use and deployment of T 1 networks in private networks
- The Be-Your-Own Bell phenomenon whereby companies can sell excess capacity
- Increasing utilization of central office switches as virtual PBXs
- BOC initiatives to create more "hands-on-control" for customers
- Acceptance of telecommunications as a corporate, strategic resource
- IXC/BOC success and lack of success in traditional data communication/computing markets
- The success of traditional data communication/computer equipment providers in traditional telecommunication markets
- ONA and the distribution of network control to "private" service providers

KEY: BOC=Bell operating company; ISDN=Integrated services digital network; IXC=Interexchange Carrier; ONA=Open network architecture; PBX=Private branch exchange

SOURCE: Tom Valovic, "Public and Private Networks: Who Will Manage and Control Them?" *Telecommunications*, February 1988, pp. 42-47.

has agreed to let its telephone customers offer their users free ISDN.[61]

What still needs to be determined, however, is how responsive the business community will be to these telephone company overtures. Today there are more than 50 organizations involved in ISDN trials. (See figure 12-4 for a breakdown based on organizational type.) However, many corporate executives continue to be unaware or quite skeptical about the promises of ISDN, questioning its value in meeting their needs.[62] As Travers Waltrip, Vice President of Travelers Co., has noted:

> In actuality, large corporations have built their own de facto ISDN. The environment . . . is a seamless, integrated data, voice and image all-digital network that has tremendous flexibility. Therefore I do not believe large corporations will benefit (at least initially) from commercial ISDN for intracorporate communications . . . At least through the early 1990s, most large corporations will follow their existing communications strategies.[63]

In addition to functionality, cost will also be a critical factor determining demand for ISDN in the corporate business community. According to a number of surveys, most users want cost savings above all, and thus would be unwilling to pay more for ISDN than they are presently paying for telecommunication services. Those most reluctant to spend a lot of money are businesses that have recently invested in new sophisticated telecommunication and switching systems based on pre-ISDN technologies, a sizable sector of the potential ISDN market by most accounts.[64] What ISDN will cost, however, remains uncertain. Until very recently there was no pricing information available to potential customers. Those who signed up early for ISDN trials did so on the basis of customized contracts, with many of the details kept under wraps.[65]

The time required to modernize the public communication infrastructure is also an important variable determining the future relationship between public and private communication networks; however, its effect can work in two contradictory ways. On the one hand, the longer it takes for ISDN and the intelligent network to be implemented, the greater the investment sunk in private systems. Moreover, the more established communication departments become within large corporations, the less willing

[61] Beth Schultz, "AT&T To Let Telcos Offer Users Free ISDN," *CommunicationsWeek*, Mar. 20, 1989, P. 2.

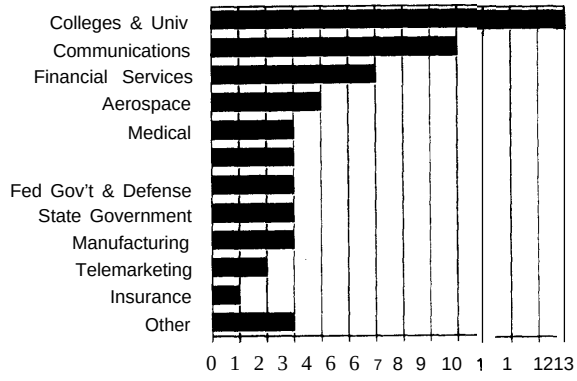
[62] As noted by Michael Hurwicz: "Primary Rate ISDN was designed to be used the same way as T1 circuits are currently used-to carry multiple data and voice charnels between private branch exchanges (PBX) or central office switches and, less frequently, to serve as a single high-speed data channel for applications requiring that kind of throughput. Although no single characteristic of ISDN makes it obviously superior to anything else around, the technology offers a number of incremental improvements over other digital transmission technologies." Michael Hurwicz, "Even Users Who See Promise Are Still Troubled By Questions," *Computerworld*, Dec. 12, 1988, p. 69. For additional discussions of user skepticism of ISDN, see "ISDN: Another Version of the Emperor's New Clothes?" *Data Communications*, December 1986, pp. 45-60; "ISDN on Trial," *Datamation*, Feb. 1, 1987, pp. 51-56.

[63] Travers Waltrip, "ISDN and the Large Corporation," *Telephony*, May 9, 1988, pp. 40-41.

[64] For example, it is estimated that, over the past 5 years, PBX replacement has taken place in the United States and Europe at a rate of over 60 percent. See Lee, op. cit., footnote 20, p. 57.

[65] See Kathleen Killette, "Controversial Costs: Though Two Tariffs Have Been Filed, Analysts Agree ISDN Pricing Remains Obscure," *CommunicationsWeek, CLOSEUP*, Sept. 19, 1988, pp. C-8, C-9.

Figure 12-4--Number of ISDN Users by Industry



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they may be to give up such control at some point in the future. As Tom Valovic has pointed out:

> Having painfully learned the joys of autonomously operating a network, and in large measure having succeeded in the task, it seems unlikely that network managers will hand control of their network operations back to the comforting but potentially smothering embrace of AT&T and the BOCs [Bell operating companies].[@]

On the other hand, time has also demonstrated some of the hidden costs entailed in developing private networks. Recently, for example, a number of companies, facing cost overruns and a scarcity of manpower and technical expertise, have decided to give up their efforts to develop their own networks and call for bids from telecommunication vendors.[67]

Given these uncertainties, it is difficult to predict how much privatization will take place within the communication infrastructure. However, it is clear that, to the extent that businesses continue to establish their own private communication networks at their present rate, fewer societal resources will be available to develop and modernize the publicly shared network.[68] Under such circumstances, a spiraling effect might take place, whereby the lack of investment in the public network would lead to greater bypass and unbundling. Moreover, such a two-tiered system might prove to be inefficient, especially to the extent that new technologies, such as fiber optics and common channel signaling could, over the long run, allow for greater flexibility within a single communication network.

Factor 3: The potential inefficiencies that might result from a lack of national coordination and planning.

The divestiture of AT&T, accompanied by a national policy of deregulation, has led to heightened competition among economic players in the communication infrastructure, as well as to the fragmentation and decentralization of the process by which major communication decisions are made. Some observers see these changes as being highly favorable for the modernization and development of the U.S. communication infrastructure.[69] Pointing to evidence such as AT&T's recent decision to write down $6.7 billion as part of its modernization effort,[70] they argue that competition has fostered innovation and hastened the deployment of new technologies. For example, in his analysis comparing the rapid rate of innovation in the computer industry with the slow rate in communication industries, Kenneth Flamm makes such a case.[71] And, in fact, as discussed in chapters 3 and 4, it was just such a perspective that served as part of the

[66] Valovic, op. cit., footnote 55, p. 45.

[67] For a discussion, see John Foley, "Merrill Shifts Gears: Solicits Network Bids," *CommunicationsWeek*, Oct. 21, 1988, pp. 1, 55; Kelly Jackson, "Red Ink Downs Net," *CommunicationsWeek*, *Nov. 21, 1988,* pp. 1, 43; and John Foley, "Problems Force Users to Retrench," *CommunicationsWeek, Nov. 7, 1988,* pp. 1,60.

[68] For example, it has been estimated that, in 1988, nearly $17 billion was spent on private networks in the United States. which is more than the total spent by all of the regional Bell holding companies on infrastructure development. Davidson, op. cit., footnote 41.

[69] See Gerald Faulhaber, *Telecommunications in Turmoil* (Cambridge, MA: Ballinger Publishing Company, 1987); and Robert W. Crandall, *'Telecommunications Policy in the Reagan Era," *Regulation*, *No. 3, 1988,* pp. 28-33, for two very positive evaluations of the post-divestiture period. See also, Kenneth Labich, "Was Breaking Up AT&T a Good Idea?" *Fortune,* Jan. 2.1989, pp. 82-87

[70] Peter Coy, "Modernization *Costs* Give AT&T First Annual Loss, " *The Washington Post,* Jan. 27, 1989, p. B-1. As noted, "AT&T took a $6.7 billion pretax charge in the fourth quarter of 1988 to cover costs of accelerating its transition to digital technology. The company is scrapping outdated analog phone equipment and moving, retiring or laying off 16,000 employees."

[71] Flamm, op. Cit., footnote 26, pp. 13-61. However, Flamm notes that, paradoxically: "The old market structure might actually have both increased basic research and slowed innovation. And deregulation and increased competition might step up the pace of innovation yet reduce spending on basic research." Ibid., p. 59. Flamm's argument would account for why, as already noted, the T1 multiplexer was developed under the old Bell system, but neither widely deployed nor perfected until after divestiture when, in a competitive environment, start-up high technology firms such as NET began to develop it.

rationale for the divestiture of the Bell System in 1984.[72]

Others, however, bemoan the destructive aspects of competition, pointing to the inefficiencies it might create.[73] They argue, moreover, that cooperation among government and industries, as has been the case in Japan, can lead to the most productive and efficient deployment of new communication technologies.[74] The possible negative impacts of competition on research and development have been of particular concern, even at the time of divestiture.[75] However, to date, the evidence on R&D is still inconclusive.[76] As is noted below, although the funding for research and development at Bell Labs and Bellcore has, in fact, increased since divestiture, it is not clear that these funds are being employed most efficiently, or that a commitment to joint research will survive in the future when the interests of the telephone companies diverge and/or the competition among them becomes more intense.[77]

Others claim that competition will retard the development of a national ISDN network. Instead, it will foster the emergence of separate, and incompatible, islands of technology .78 As evidence, they cite the difficulties entailed in establishing national standards in a highly fragmented organizational setting--difficulties that were noted and discussed in chapter 11. They point, moreover, to the problems involved in setting uniform prices for a basic set of nationwide services. They also question whether—under regulatory circumstances in which RBOCs are constrained from providing services beyond their own local access and transport areas (LATAs), and in which there are no guarantees that interexchange carriers will provide services equivalent to those provided by the RBOCs—the United States will ever be able to develop a truly national, communication infrastructure. As Rolf Wigand has pointed out:

> It is not too difficult to imagine the immense technical complications and fragmentations encountered by a customer trying to link ISDN services across several widely dispersed locations nationally. One might question if such conditions will then require special hardware and software for protocol conversion purposes, a condition that was by itself one of the key driving forces to develop ISDN in the first place. Have we then come full circle in this development to digitize information and data moving in the national networks?[79]

Whereas the procompetitive strategy is most highly favored among policymakers in the United States, the planned approach is more common in Europe and Japan (with the partial exception of

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[72]Kenneth Arrow provides the classic account of the relationship between technological development and regulated monopolies. In his 1962 analysis, he showed that, all other things being equal, monopolies have less incentive to renovate than firms that can gain some monopoly power through technological advancement. See Kenneth J. Arrow, "Economic Welfare and the Allocation of Resources for Invention, " National Bureau of Economic Research, Special Conference Series, *The Rate and Direction of Inventive Activity Economic and Social Factors* (Princeton, NJ: Princeton University Press, 1962). For a discussion that covers the recent theoretical literature, see Sanford V. Berg and John Tschirhart, "Technological Change Under Regulation," *Natural Monopoly Regulation Principles and Practice (New* York, NY: Cambridge University Press, 1988), ch. 10.

[73]For a general critique see, for instance, Robert Reich, *Tales of a New America* (New York, NY: Time Books, 1987). For a discussion focusing on communication technology, see John C. McDonald, "Deregulation's Impact on Technology, " *IEEE Communications Magazine*, January 1987.

[74]Michael Borrus, "Japanese Telecommunications: Reforms and Trade Implications, " *California Management Review, vol.* XXVIII, No. 3, Spring 1988; see also Jill Hartley, "The Japanese Approach to the Development of New Residenti alCommunication Services, " in Marjorie Ferguson (cd,), *New Communications Technologies and the Public interest* (London, England: Sage, 1986) ch 11, and Carla Rapaport, "The World's Most Valuable Company," *Fortune,* Oct. 10, 1988, pp. 92-104.

[75]The problems that competition might create for R&D was already a concern for some at the time of divestiture. See, fOr example, the testimonies of William Nordhaus (written testimony, in *U S v. AT&T*, 198 *1);* and Nathan Rosenberg, "Some Implications of H.R. 5158 for Technological Innovation in the Telecommunication Industry," testimony prepared for the House Committee on Energy and Commerce, Subcommittee on Telecommunications, May 7, 1982.

[76]Berg *and* Tschirhart, op. cit., footnote 72; see also David C. Mowery, "Assessing the Effects of Divestiture on Bell Telephone Laboratories," *Technovision, No. 7, 1988,* pp. 353-375. There have already been some moves to do more proprietary research. In the past year, both t-JS WEST and Nynex Corp. have set up their own independent research centers.

[77]Some of these problems, for example, have already been evidenced m other sectors

[78]See, for example, Wigand, op.cit., footnote 24, See also Tom Valovic, "ISDN in the United States: An Assessment," *Telecommunications*, December 1987, p. 7. As Valovic points out: "When it comes to ISDN, the timing of divestiture couldn't have been worse. As it turns out, ISDN was Just embryonic enough during the years preceding the "D" world not to have been a major concern for those contemplating how to slice the huge pie that was AT&T into manageable pieces. And yet, in retrospect, it appears that divestiture has had a serious impact on the development of ISDN in the United States and will continue to do so until the extreme fragmentation of our regulatory climate becomes resolved in some meaningful fashion. "

[79]Wigand, op. cit., footnote 24, p. 41

Great Britain) .80 These opposing points of view are clearly evident in the strategies that these countries are pursuing to implement ISDN. In the United States, ISDN is being introduced in a segmented fashion and in response to market demand. In Europe and Japan, ISDN implementation will be more technology-driven. Some provision is being made now to meet current demand for digital integrated services, but complete ISDN services will be held back until they can all be introduced uniformly.[81]

With our poor theoretical understanding of the processes of innovation, it is impossible, at present, to determine which of these approaches will prove to be the "best" for modernizing the communication infrastructure. Some of the advantages and disadvantages inherent in each approach can be illustrated by comparing the evolution of the intelligent network in Europe and the United States. The United States, having benefited from a highly competitive, economic environment, has moved much more quickly to develop new commercial products and services for niche markets than have the European countries. The Europeans, having designed their networks from the top down, are moving much faster than the United States to deploy the signaling system 7 (SS7) switches, which are required to distribute and market these new communication and information services .82

While acknowledging the untidiness of the U.S. approach, New York Public Service Commissioner, Eli Noam, casts recent U.S. developments in a positive light. As he has described the state of the future communication infrastructure:

> The future network is one of great institutional, technical, and legal complexity. It will be an untidy patchwork of dozens or even hundreds of players, serving different geographical regions, customer classes, software levels, and service types, with no neat classification or compartmentalization possible . . . The major characteristic of the open network environment is substantial lack of central control with no single entity being in charge. . . To leave this system to the vagaries of hundreds of uncoordinated and selfish actors seems to invite disaster. Can it work? Perhaps this is not the right way to frame the question. Can there be a stable alternative in economies that otherwise favor a market mechanism, and that want to stay on the leading edge of applications?[83]

Responding to his own question, Noam answers it in the affirmative. To create an alternative to central coordination and control, however, will require that government establish a system of open networking by structuring the ways in which interconnection is defined, policed, priced, and harmonized. As Noam notes, rules such as these are presently being negotiated and debated at the State and national levels under the heading of ONA. How well the United States telecommunication infrastructure adapts and deals with the chaos and competition of the postdivestiture era may very well depend, therefore, on the outcome of the ONA process.

Factor 4: The proactive role played by foreign governments in modernizing their communication systems.

Although a number of governments throughout the world are moving to privatize and/or deregulate sectors of their communication systems, many of them have retained a role for themselves in building and modernizing their communication infrastructures in support of their industrial policies or other national objectives.[84] Inspired by the Nora-Mine report, the Government of France, for example, assumed the leadership in developing and managing Minitel, supplying terminals free to all telephone subscribers, organizing a billing system, and providing basic services. It has also played an aggressive role in planning for and introducing a national ISDN

[80]For one example of this European perspective, s= European Parliament, Session Documents, Document a 2-0242/88, "Report Drawn Up On Behalf of the Committee on Economic and Monetary Affairs and Industrial Policy on the Need to Overcome the Fragmentation in Telecommunications, " Nov. 8, 1988.

81 For a discussion, seep. Slaa, *ISDN as Design Problem* (Leiden: The Hague, Ruud Philipsen, April 1988).

[82]Peter Purton, "Europe's Intelligent Networks: A Glimmering Start," *Telephony*, Aug 22, 1988, pp. 32, 36, 37. Just as some of the problems of a market-driven approach are coming to light in the United States, so the problems of a technology-driven approach are beginning to appear in a number of European countries. For one discussion of such problems in France, see Mark Hunter, "France' sGrand Computer Plan in Shambles: Consumers Reject Domestic Machines Despite $200 Million Purchase for National Schools," *The Washington Post*, Mar. 19, 1989, p. H-8.

[83]Eli M. Noam, "The Future of the Public Network: From the Star to the Matrix," *Telecommunications*, March 1988, pp. 58,60, 65,90. See also, "The Public Telecommunications Network: A Concept in Transition," *Journal of Communication, vol. 37, No. 1,* Winter 1987, pp. 30-47.

[84]For a discussion, see Wigand, op. Cit., footnote 24, pp. 48.

by 1990.[85] Similarly, the German Government, through the Deutsche Bundespost, has invested heavily in a network digitization program, which will lead to the availability of total ISDN by 1993.[86] Moreover, through the European Community, the countries of Europe have agreed to cooperate to build a "translational broadband backbone," and to conduct joint research and development in advanced communication technologies through both the Research for Advanced Communications in Europe (RACE) program (which focuses on telecommunication), and the European Strategic Programme for Research and Development in Information Technology (ESPRIT) (which focuses on information technologies).[87] In addition, through the Commercial Action Committee of the Conference of European Postal and Telecommunications Administrations (CEPT), the Europeans are planning to develop a pan-European-managed data network.[88]

The Government of Japan has also retained "strategic policy control over the process of change"[89] in telecommunication and the structure of the telecommunication infrastructure. It has been especially active in promoting new technologies, making a commitment to invest over $120 billion before 1995 for the development of a digital broadband infrastructure, the Information Network System (INS), and to provide $150 billion through the Technopolis Program for model programs and pilot projects targeted to both business and residential users.

Such national efforts are not confined to the advanced industrialized countries. The governments of Singapore and Brazil, for instance, view their communication infrastructures as springboards that will allow their countries to pass over the industrial phase of development and leap directly into the information age.[90] Given this perspective, it is not surprising that capital investment in Singapore, measured as a percentage of communication sales, is twice that of AT&T Long Lines and the seven RBOCs combined.[91]

A comparison of U.S. expenditures on communication with similar expenditures made in other countries can be seen in tables 12-2 and 12-3. As table 12-2 shows, based on the total amount of expenditures, the United States ranks at the top of the list. However, as evident from table 12-3, when a comparison is made based on the growth of total expenditures, the United States does not appear among the top 10 spending nations.

Factor 5: The fractionated decisionmaking process in the United States.

The national commitment and direction noted above is in sharp contrast to the situation in the United States, where the government has not exerted strong leadership in determining and planning for the Nation's future communication needs. Commenting on the U.S. approach to ISDN, Eli Noam observes, for example, that:

> ... virtually no public discussion of the ISDN concept and its investment needs has taken place. Instead decisions in favor of ISDN have been made outside of public view by engineering bureaucracies in government and equipment firms.[92]

Part of this lack of government leadership stems from the widespread belief among policymakers that the competitive marketplace is a more dynamic and appropriate force for innovation and change than the political arena. Equally important in explaining the lack of a comprehensive set of national communica-

85 "The ISDN Lead," *Communication International,* June 1987, pp. 30, 32.

86 "Integrating ISDN," *Communications International,* September 1988, pp. 44, 46.

87 ESPRIT is a $5.6 billion R&D program. According t. the European Economic Committee's 1987 report, 108 of the program's first 227 research projects (referred to as Esprit 1) have been successfully completed, and have generated results of industrial significance. In phase 2, 155 new projects will be undertaken. ESPRIT is supported by nearly all of the large European communication, computer, and information technology suppliers, as well as by most large European research institutes.

88 For a description, see Denis Gilhooly, "The CEPT MDNS Project—Work in Progress," *Telecommunications,* April 1988, pp. 47-54.

89 Michael Borrus and John Zysman, "The New Media, Telecommunications, and Development: The Choices for the United States and Japan," BRIE Working Paper #7 (originally prepared for a symposium organized by the Japanese Ministry of Finance and the Japan Center for International Finance, August 1984), p. 22.

90 See, for example, Debbie Shimman, "Asia Moves Into the Information Age," *Telecommunications,* January 1989, pp. 55 57; see also Edward J. Nickoloff and Randolf Yeh, "Maintaining International Transmission Circuits Through a National Center," *Telecommunications,* December 1988, pp. 52,57,58.

91 William H, Davidson, "Telecommunication Policy in Global Perspective," unpublished paper, Oct. 14, 1987.

92 See, for a discussion, Noam, op. cit., footnote 83. See also Anthony M. Rutkowski, "Toward a National Information Fabric: Organizing for Success," *Telecommunications,* September 1987, p. 8.

tion policy goals and strategies is the fact that, as detailed and discussed in chapter 13, the political decisionmaking structure is extremely fractionated, giving rise to a number of jurisdictional disputes. Because these conflicts allow, and even encourage, stakeholders to play agencies and jurisdictions off against one another, they serve to discourage attempts at cooperation and coordination. Moreover, by creating numerous uncertainties with respect to the outcomes of the policy process, they tend to exacerbate the problems that government and industry face in planning for the future.

STRATEGIES AND OPTIONS

To encourage the modernization and development of the U.S. communication infrastructure, Congress could pursue three basic strategies. It could:

- follow the lead of many foreign countries and become more directly involved in developing, planning, financing, and coordinating the development of the communication infrastructure;
- provide indirect incentives to encourage long-term investment and development; and/or
- remove regulatory barriers that presently serve to discourage modernization as a consequence of furthering some other goal.

A discussion of these strategies, and individual options for achieving them, follows. A summary appears in figure 12-5.

Strategy I: Direct government involvement in the development, planning, financing, and coordination of the communication infrastructure.

As discussed in chapter 4, policymakers in the United States, in contrast with their counterparts in many other countries, have traditionally been reluctant to intervene in economic affairs. Instead, they have preferred that economic decisions be made through the processes and mechanisms of the marketplace. In recent years, this general predisposition against government involvement has been strongly reinforced by the prevailing mood of the country in favor of deregulation. In such an environment, an exceptionally strong case would have to be made before adopting a strategy that goes against this trend.

There are, however, a number of arguments favoring a more direct Federal role in the realm of communication. Just as a Federal interest in national defense, economic development, and equity served to justify a Federal role in the development of highways and rural electrification, so too might communication networks be federally promoted as the highways of an information age. And just as the Federal Government provided over $109 billion for highway construction during the 20-year period from 1956 to 1976,[93] so it could be argued that, today, government should make a comparable commitment to the development of a communication infrastructure. While arguments of this sort have not received much support in the Federal arena, they have been given a more favorable reception at the State level. For example, economic development issues are now being factored more and more into the decisions made by State regulators.[94]

Policy options that Congress might adopt to execute such a strategy include the following:

Option A: Create a new legislative mandate for promoting the Nation's communication infrastructure that both updates the Nation's communication policy goals and clearly designates responsibility for implementing them.

Goals are statements of values that serve to guide decisionmakers. They signal a commitment, identify aspirations, clarify objectives, and integrate diverse elements through the establishment of a common bond. Thus, one step that Congress might take to promote the modernization of the Nation's communication infrastructure would be to declare modernization as a national goal, and both delegate the responsibility and provide the organizational resources and authority required for it to be effectively carried out. To be specific enough, and to be sufficiently emphatic in setting such a goal, Congress would probably need to revisit and revise the 1934 Communications Act.

[93] U.S. Department of Transportation, Federal Highway Administration, *America on the Move: The Story of the Federal Highway program and the Federal-State Relationship*, 1977.

[94] Recently, for example, the New York State Public Service Commission undertook an investigation to determine whether New York State and New York City are in danger of losing a competitive advantage due to the failure of the area to foster ISDN. For a discussion, see John Foley, "N.Y. Probes ISDN," *CommunicationsWeek*, Sept. 26, 1988, p. 1.

Table 12-2—Top 20 Countries: Comparison of Total Expenditures for Communication, 1987-1988

Country	1988 expenditures (U.s.$ooo,ooo)	1987 expenditures (U.s.$ooo,ooo)	Total increase	Total decrease	Percent increase	Percent decrease
United States	24,451.8	24,549.2		97.4		0.4
Japan	13,761.5	12,178.3	1,583.1		13.0	
West Germany	10,175.5	8,712.1	1,463.4		16.8	
France	6,219.8	5,714.4	505.4		8.8	
Italy	4,331.1	3,837.0	494.1		12.9	
United Kingdom	3,547.4	3,322.0	225.4		6.8	
Spain	3,148.2	2,341.0	807.2		34.5	
Canada	2,746.6	2,443.6	303.0		12.4	
Switzerland	1,859.3	1,623.2	236.1		14.5	
Korea	1,836.8	1,525.8	311.0		20.4	
Sweden	1,288.2	1,326.7		38.6		2.9
Brazil	1,263.3	1,050.4	212.9		20.3	
Australia	1,090.0	1,108.8		18.8		1.7
Austria	1,048.1	913.6	134.5		14.7	
Taiwan	902.5	702.7	199.8		28.4	
Netherlands	769.7	695.5	74.1		10.7	
South Africa	738.4	965.0		226.6		23.5
Norway	706.2	621.7	84.5		13.6	
Belgium	626.8	575.8	51.0		8.9	
India	608.8	598.8	10.0		1.7	

NOTE: Totals may not add due to rounding.

SOURCE: Reprinted with permission from Telephony, Feb. 22,1988, P.42.

Table 12-3--Top 1O Growth Budgets for Communication, 1987-88

Country	1988 expenditures (U.s.$ooo,ooo)	1987 expenditures (U.s.$ooo,ooo)	Total increase	Percent increase
Japan	13,761.5	12,178.3	1,563.1	13.0
West Germany	10,175.5	8,712.1	1,463.4	16.8
Spain	3,148.2	2,341.0	807.2	34.5
France	6,219.8	5,714.4	505.4	8.8
Italy	4,331.1	3,837.0	494.1	12.9
Korea	1,836.8	1,525.8	311.0	20.4
Canada	2,746.6	2,443.6	303.0	12.4
Switzerland	1,859.3	1,623.2	236.1	14.5
United Kingdom	3,547.4	3,322.0	225.4	6.8
Brazil	1,263.3	1,050.4	212.9	20.3

NOTE: Totals may not add due to rounding.

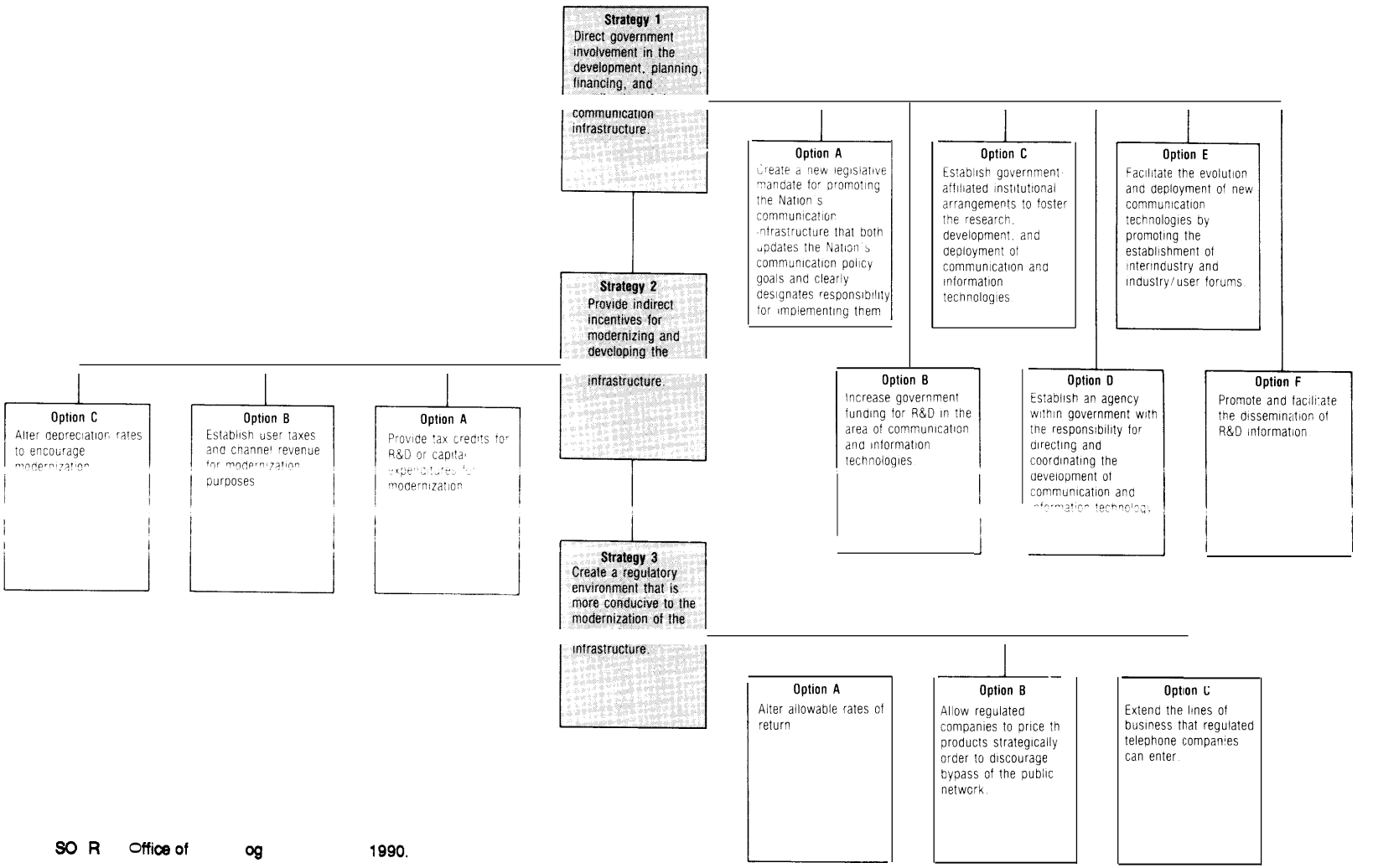
SOURCE: Reprinted with permission from *Telephony*, Feb. 22,1988, p. 43.

Many countries throughout the world have already made this kind of national commitment to developing a modern communication infrastructure. However, in the United States, establishing national goals on this order-especially in the realm of communication policy—has been much more rare.[95] The reluctance to set such goals reflects not only the pragmatic style of American politics in general, but also the highly contentious and politicized nature of most communication issues.

At the present time, however, reaching a new legislative consensus may not be as difficult as it has been in the past. The situation is very fluid; past alliances are in a state of flux, technology is rapidly advancing, and the nature of the future communica-

[95] As we have seen, basic U.S. communication policy was first established at the Constitutional Convention when the delegates agreed to include within the Constitution three clauses that provided for freedom of the press, the protection of intellectual property, and the establishment of postal roads. It took almost 150 years, however, for the legislature to debate and establish additional, national communication goals, first in 1912 and 1927 with the passage of the Radio Acts, and subsequently in 1934, with the passage of the Communications Act. Although Congress did re-evaluate communication goals again from 1976 to 1980, these efforts to revise the 1934 Communications Act failed for a lack of consensus. For a discussion, see Eric C. Krasnow, Lawrence D. Langley, and Herbert Terry, *The Politics of Broadcast Regulation (New* York, NY: St. Martin's Press, 1982).

Figure 12-5—Congressional Strategies and Options To Address Modernization of the Communication Infrastructure



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tion infrastructure is still quite uncertain. This situation may provide Congress with a window of opportunity. Requiring some resolution of the issues, many stakeholders agree that "something" must be done. Moreover, not knowing what the future entails and how their interests might fare in relationship to it, stakeholders may be much more willing to cooperate in updating and redefining the goals and rules of operation of the communication infrastructure. As John Rawls observes in *A Theory of Justice,* it is often easier for people to agree among themselves on rules of the game when the situation is uncertain-that is, when they do not know whether, as participants, they will start out from a position of advantage or disadvantage.[96]

Option B: Increase government funding for research and development in the area of communication and information technologies.

As described in chapter 4, the United States has a long tradition of funding scientific and technical research and development. Although the amount of funding has tended to fluctuate in accordance with perceived science crises, such as Sputnik, policymakers have generally been in agreement about the need for such support.[97] Most recently, there has been a decline in the amount of money the Federal Government allocates to R&D that is not defense-related. However, concerns about the ability of the United States to compete effectively in the global, high-technology marketplace have led to proposals calling for greater funding. Reflecting these concerns, over 200 R&D bills were introduced in Congress in the past 2 years, 12 of which were related to communication and information technologies.

One problem in providing government funding for R&D is determining what constitutes an appropriate amount of funding and how such a sum might be deployed effectively. This problem stems, in large measure, from our limited understanding of the relationships between R&D and innovation. Compounding this is the fact that, as economists Richard Nelson and Nathan Rosenberg have pointed out, choices about the type and amount of R&D support can only be determined on a case-by-case basis.[98]

In evaluating proposals to increase government funding of R&D, one key question is whether communication technology merits greater support than other technologies.[99] Recognizing the need to make such choices, a government panel (led by the presidents of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine) urged in a recently released report, "Federal Science and Technology," that the White House and Congress be much more systematic about setting priorities for Federal spending on science and technology.[100]

In the case of communication technologies, the argument could be made—as it has been in Europe and Japan—that they are unique, insofar as they constitute part of a nation's underlying economic and social infrastructure. In the United States, semiconductor technology has received R&D support on the grounds that this technology is critical to maintaining both a sound defense and a competitive national economy.[101] In fact, to support the super-

[96] John Rawls, *A Theory of Justice* (Cambridge, MA: Belknap Press, 1971).

[97] As pointed out in ch, 4, the role of government in supporting R&D has been based on the assumptions that: 1) new knowledge is a necessary condition for economic growth; 2) new knowledge originates in basic research; 3) the supply of knowledge is unlimited, and is not subject to diminishing returns; 4) the government should support basic research in support of national security, the economy, for reasons of health, etc.; and 5) industry lacks the economic incentive to conduct the socially optimum amount of research. William Leiss, "Industry, Technology and the Political Agenda in Canada: The Case of Government Support for R&D," *Science and Public Policy, vol. 15, No.* 1, pp. 57-65 For a discussion, see also Roger G. Nell and Linda Cohen, "Economics, Politics and Government Research and Development," Working Papers in Economics, E-87-55, The Hoover Institute/Stanford University, Stanford, CA, December 1987.

[98] For general discussions by Rosenberg of the problems entailed in technological change and innovation, see Nathan Rosenberg, *perspectives on Technology* (London, England: Cambridge University Press, 1976) and *Inside the Black Box– Technology and Economics* (Cambridge, IvIA: Cambridge University Press, 1982). See also, Richard Nelson, testimony, *Communications and Computers in the 21st Century,* hearings before the Technology Policy Task Force of the House Committee on Science, Space, and Technology, June 25, 1987 (Washington, DC: U.S. Government Printing Office, 1987).

[99] Nelson makes this point in his testimony. Ibid.

[100] OA, the report notes: "In a period of limited resources, there is an even greater premium on making the best-informed budget allocations possible," As cited in Colleen Cordes, "Panel of Top Scientists Urges White House and Congress To Set Research Priorities Before Deciding on Funds," *The Chronicle of Higher Education,* Jan. *4, 1989,* pp. Al, A22.

[101] A similar case has been made for superconductivity. See the Report of the Committee to Advise the President on High Temperature Superconductivity, *High Temperature Superconductivity: Perseverance and Cooperation on the Road to Commercialization,* The White House Science Council, January 1989.

conductor industry, the Department of Defense (DoD) has recently decided to undertake research on high definition television (HDTV), as described below. Advanced computer technology has also been suggested as an area requiring government support.[102] Concerned about the state of the U.S. economy, the National Research Council recently noted, for example, that:

> The U.S. position in this [the superconductor] field is threatened from without by external competition and from within by underappreciation of the need for basic research.[103]

In considering the amount of R&D funding, it is also necessary to address the question of how such government monies are to be employed. Public support for a government role in R&D has tended to decline as government programs have increasingly moved away from programs targeted to basic research towards programs in support of applied research.[104] However, in recent years, a number of economists have pointed out that, in terms of meeting the challenge of competition, it is perhaps in the area of applied research that the greatest efforts need to be made.[105] In this regard, a number of people have specifically cited telecommunication research as an area requiring a greater market perspective, given its long tradition of focusing on basic research.[106]

Alternative ways of using government R&D funding are discussed further in the options that follow. However, it should be noted that, as Roger Nell and Linda Cohen have emphasized, the political context in which R&D decisions are generally made and implemented is not particularly well--suited to making funding choices based on what has generally been considered to be the soundest criteria for supporting R&D. As they point out:

> . . . most programs are not clearly a waste of money, especially in early exploratory research. The problems arise because mid-project managerial decisions are directed from matters of economic efficiency by a host of political factors: impatience to show commercial progress, distributive politics, the inability to commit to long term, stable programs, and a mismatch between the types of industries that are most likely to underinvest in research and those that are most attractive politically to subsidize.[107]

Option C: Establish government- affiliated institutional arrangements to foster the research, development, and deployment of communication and information technologies.

Today, the governments of Europe and Japan are focusing their national research efforts on commercial development in high-technology areas such as electronics, biotechnology, material research, and informatics. In the area of HDTV, for example, the European Community is establishing a special company to foster the worldwide use of the Eureka HDTV standard, which has been developed by its leading electronic firms, including Philips, France's Thomson SA, West Germany's Bosch BMbh, and Finland's Nokia.[108]

In contrast to these countries, where there is general agreement that R&D should be conducted in support of general economic development, most industrial-related R&D in the United States is executed on behalf of Federal agencies, the most prominent being the (DoD).[109] Most recently, for example, DoD has decided to fund the development of an advanced high resolution video display, not only as a means of providing high-quality display technology for military purposes, but also as a way of fostering the revival of U.S. television manufac-

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[102] "Defense Department Wants in the HDTV Picture," *Broadcasting*, vol. 115, No. 26, Dec. 26, 1988, pp. 32-33; and "The U.S.'s Semiconductor Battle Plan," ibid., p. 33.

[103] As cited in, Mitch Betts, "Federal Panel: Aim High in R& D," *Computerworld*, Nov 28, 1988, p. 95.

[104] And, as Roger Noll and Linda Cohen have pointed out, political support is not necessarily equated with those projects that would benefit most from government intervention in support of R&D. For a discussion, see Nell and Cohen, op. cit., footnote 97.

[105] For one discussion, see Nathan Rosenberg and W. Edward Steinmueller, "Can Americans Learn to Become Better Imitators?" CEPR Publication No. 117, Center for Economic Policy Research, Stanford University, Stanford, CA, January 1988.

[106] For one discussion, see Michael Schrage, "Bell Labs Is Long on Genius But Short in the Marketplace," *The Washington Post*, Mar. 1, 1987. For another account of post-divestiture research at Bell Labs, see Denis Gilhooly, "A Mission From AT&T," *Telecommunications*, February 1988, pp. 26, 30,33.

[107] Noll and Cohen, op. Cit., footnote 97.

[108] For a discussion of national HDTV strategies, see Hugh Carter Donahue, "Choosing the TV of the Future," Technology Review, vol. 92, No. 3, April 1989, pp. 30-40; and Alan G. Stoddard and Mark D. Dibner, "Europe's HDTV: Timing Out Japan," *Technology Review*, April 1989, pp. 39-40.

[109] Leonard L. Lederman et al., "Research Policies and Strategies of Five Industrial Nat Ions, and Implications for the United States," *Science and Technology Studies*, vol. 4, No. 1, p. 25.

turing and semiconductor industries.[110] NASA has also been conducting R&D on HDTV, but on a much smaller scale than that proposed by DoD.[111]

Today, there are over 15,000 individual organizations in the United States associated with government labs. Given their number and variety, it is difficult to generalize about the pros and cons of this kind of government-affiliated research. However, as illustrated in box 12-B, [112] there are both benefits and costs associated with conducting research in government-affiliated research organizations. Any government decision to fund research in communication and information technologies would need to take these into account.

Option D: Establish an agency within government with the responsibility for directing and coordinating the development of communication and information technologies.

Given the divestiture of AT&T and the decentralized and fractionated nature of the U.S. communication policymaking process, it is not surprising that, in the United States today, there is no central, organizational focal point for conducting R&D in communication and information technologies.[113] Commenting on the lagging state of R&D in the United States, many of those involved in technology development and innovation processes have recently argued that if sufficient research is to take place, there needs to be an organizational focal point, and advocate, for it within government. Testifying in 1987 before the Technology Policy Task Force, Professor Lewis Branscomb of the John F. Kennedy School of Government, Harvard University, noted, for example, that:

> The Department of Commerce as currently constituted and as constituted in most of its history has no particular stomach for a more active role of this kind, notwithstanding the large number of scientific and technical agencies in the Department. Their missions are very neatly circumscribed and don't constitute in any sense an open-ended obligation to try to negotiate partnerships with the private sector that come to grips with these technology issues.[114]

One recent step to try to rectify this situation has been to enhance the role of technology development within the Department of Commerce by reconstituting the National Bureau of Standards (now the National Institute of Standards and Technology), providing it with more responsibilities in this area.[115] Another suggested alternative is to reconstitute the Office of Science and Technology Policy within the Office of the White House, connecting it in some formal way with the Council of Economic Advisors to give it the prominence and authority it would require.[116]

While such alternatives would address some of the more general problems of R&D in the United States, they would in no way assure that communication and information technologies would be targeted for R&D. In fact, such organizational arrangements would serve to enhance the competition among technologies for funds—a situation, it should be emphasized, that would be welcomed by most science policy experts. Thus, to promote R&D in communication technologies, per se, might require expanding the role of technology development within the Federal Communications Commission (FCC).[117]

Option E: Facilitate the evolution and deployment of new communication technologies by promoting the establishment of interindustry and industry/user @-urns.

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110 Evelyn Richards, "Pentagon Aims To Revive U.S. TV Industry," *The Washington Post*, Dec. 19, 1988, p. 1.

111 *Broadcasting*, Jan. 2, 1989, pp. 94. 98.

112 Barry Bozeman and Michael Crow, "U.S. R&D Laboratories and Their Environments: Public and Market Influence," final report to the National Science Foundation, Science Resource Studies, Mar. 1, 1988.

113 This lack of a coordinated R&D effort was noted, and its impact analyzed, even before divestiture. For such a discussion, see Glen O. Robinson, "Communications for the Future: An Overview of the Policy Agenda," *Communications for Tomorrow. Policy Perspectives for the 1980s (New* York, NY: Praeger, 1977), ch. 14. At that time, Robinson concluded that the lack of coordination in R&D planning and investment did not constitute a serious problem.

114 Lewis Branscomb, Cements, *Communications and Computers i, the 21st Century*, Hearing before the Technology Policy Task Force Of the House Committee on Science, Space, and Technology, June 25, 1987 (Washington, DC: U.S. Government Printing Office, 1987), p. 65.

115 These changes, as well as the change in name, were provided in Public Law 100-418. Subpart A.

116 Nelson, op. cit., footnote 98, p. 69

117 The of ffice of Plans and Policy, which would be expected to undertake such analysis, has often been forced by budgetary constraints into mOre routine agency affairs, to the neglect of long-range policy analysis and planning. Increased congressional funding, provided specifically for this task, might improve the situation. For a discussion, see Robinson, op. cit., footnote 113, p. 381.

Another mechanism for promoting and coordinating the development of R&D in the area of information and communication technologies would be to facilitate the establishment of interindustry, industry/university, and industry/user forums to conduct such activities. An approach that calls for cooperation among such groups could be aimed not only at reducing the total costs of conducting R&D, but also at improving the R&D process by more closely integrating its science, research, and developmental aspects. Such an approach has become increasingly popular in recent years among both innovation experts and stakeholder groups, especially in high-technology areas where the costs of R&D are exceptionally high. For example, the consortium approach was recommended by the Committee to Advise the President on High Temperature Superconductivity .[118] And, most recently, the American Electronics Association has proposed a government-industry consortium for the development of HDTV: [119]

One major law that has sought to foster such cooperative research agreements is the Stevenson-Wydler Technology Act of 1980,[120] which authorizes the provision of Federal seed money for a period of 3 years to help establish research joint ventures between industry and universities and other nonprofit institutions. As amended by the Federal Technology Transfer Act of 1986,[121] this act establishes an Office of Productivity, Technology, and Innovation within the Department of Commerce with responsibility, among other things, for identifying technological needs, problems, and opportunities; encouraging and assisting the creation of centers and other joint initiatives; encouraging technology transfer; stimulating innovation and promoting investment in technology-related industries; and publishing the results of studies and experiments. In accordance with that act, an Office of Industry Technology has been established within the Department of Commerce. [122]

This cooperative approach has been facilitated, moreover, by the enactment of the 1984 National Cooperative Research Act.[123] This act reduced the

Box 12-B--Summary of Market and Government Influence

Increased governmental influence implies:

- . More basic research
- • More cooperative research
- • More bureaucratization
- • Fast release of new knowledge
- • More technology transfer to the commercial sector
- • Heavy emphasis on technology transfer to the government
- . Moderate to high levels of applied research
- • Increased focus on scientific effectiveness
- • Heavy dependence on government funding
- • Stability for enhanced R&D productivity
- • More outmoded research equipment
- • Tendency to be policy and technology v. market driven research organizations (exception is the Public Market Laboratories)
- • Greater and more numerous barriers to R&D productivity
- • Generally larger research organization
- • General shortage in scientific personnel
- • Higher levels of interorganizational complexity
- • Knowledge outputs are variable and mixed including both proprietary and nonproprietary products

Increased market influence implies:

- • Almost total focus on applied research
- . Lower levels of cooperative research
- . Slower release time for new knowledge
- . General concentration in engineering and the traditional sciences
- • Less interdisciplinary research
- • Except for Public Market and Quasi-Public/Multi-Market laboratories, a generally smaller 12&D environment niche

SOURCE: Barry Bozeman and Michael Crow, *U S R&D Laboratories and Their Environments Public and Market Influence*, Final Report to the National Science Foundation, Science Resource Studies, Mar. 1, 1988, p. 18.

[118] See *High Temperature Superconductivity,* op. cit., footnote 101.

[119] "$1.35 Billion Sought for HDTV Consortium," *The Washington Post,* May 10, 1989, p F-1.

[120] Public Law 96-480.

[121] Public Law 96-480, 94 Stat. 2311, 15 U.S.C. 3701.

[122] 15 U.S.C. 3704 (c).

[123] Public Law 98-462.98 Stat 1815. 15 U.S.C.4301.

risk that companies face in entering such agreements with respect to antitrust liability.

Industry participants have generally favored the consortium approach, arguing that the cost of R&D is too high for anyone company to handle on its own. However, a number of people in the industry believe that Congress should focus its policies on a broad segment of the U.S. economy and not just on one technology. As the Electronics Industry Association has pointed out with respect to HDTV:

> HDTV is not the answer to all of America's problems in competitiveness . . . There is a danger connected with equating the competitiveness of a nation with that of a single industry. While a single industry may be symbolic of general, national problems of competitiveness, certain policies designed to promote the revival of such symbolic industries may be prejudicial to the solution of the wider problem of competitiveness.[124]

Option F: Promote and facilitate the dissemination of R&D information.

Another problem associated with R&D in the United States is that of technology transfer and the dissemination of R&D information.[125] Some efforts have been made to foster the dissemination of research information from Federal laboratories.[126] But the government has "no coherent, centrally organized, or systematically designed approach to deal with disseminating information created by the basic research community.''[127] Therefore, one option that Congress might adopt to foster the modernization of the communication infrastructure is to promote and facilitate the dissemination of R&D information in this area. In this regard, a number of computer scientists and government officials have urged Congress to create a "data superhighway," and legislation to this effect has recently been introduced into Congress.[128]

Although relevant to the issue of modernization, this option will not be discussed in detail here, since it is the subject of a subsequent OTA study.[129]

Strategy 2: Provide indirect incentives for modernizing and developing the communication infrastructure.

A second strategy that might be employed to encourage modernization of the communication infrastructure is that of providing indirect financial incentives to the private sector. Such incentives might take the form of tax credits or changes in allowable depreciation rates, for example. As discussed in chapter 4, in the past, such incentives were not required because the regulatory structure itself served to generate financing for R&D and capital expenses with what was, in effect, a user tax.[130] Today, however, such monies are no longer as readily available. While it appears that competition among providers for the business of large users has served as an effective incentive for investment in modernization,[131] it is questionable whether there will be enough incentive to bring about the modernization of the public communication infrastructure within a "suitable" timeframe. Public utility commissions (PUCs) have been reluctant to allow their local exchange carriers (LECs) to employ "excess" profits for modernization purposes, preferring instead to pass them back to ratepayers in the form of lower rates or rebates.[132]

If Congress wishes to implement this strategy, a number of options could be considered.

Option A: Provide tax credits for R&D or capital expenditures for modernization.

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[124] As cited in "Action Memos Offer HDTV Choices," *Broadcasting*, Feb. 6.1989, p.57.

[125] For a general discussion, see Tora K. Bikson, Barbara E. Quint, and Leland L. Johnson, "Scientific and Technical Information Transfer: Issues and Options, March 1984," The National Science Foundation, #N-213 l-NSF.

[126] See, for example, the Federal Technology Transfer Act of 1986, Public Law 99-502, Oct. 20, 1986.

[127] Bikson, Quint, and Johnson, op. cit., footnote 125.

128s.2918, the National High-Performance Computer Technology Act of 1988, was introduced by Senator Albert Gore in October 1988. See also John Markoff, "A Supercomputer in Every Pot: Network is Planned for Broader Access," *The New York Times, Dec. 29, 1988*, p. 1, and Business Section, p. 4.

[129] For a discussion, see OTA project proposal, "Information Technology and Research," m progress.

[130] For a discussion, see Loretta Anania and Richard Jay Solomon, "Capital Formation and Broadband Planning: Can We Get There From Here?" *Telecommunications*, November 1987, pp. 26,28.

[131] One recent example of the competitive incentive for modernization is AT&T's decision to take a "$6.7 billion pre-tax charge in the fourth quarter because exploding demand for high tech long-distance service is forcing it to speed up modernization of its phone network." Janet Guyon, "AT&T to Take a $6.7 Billion Charge in Period," *The Wall Street Journal*, Dec. 2, 1988, p. A-3.

[132] For one recent discussion of this issue, see Glen Abel, "Southwestern Bell upgrade, " *CommunicationsWeek*, Jan. 9, 1989, p. 6.

While the overall effect of the Tax Reform Act of 1986 was to significantly reduce the taxes owed by local exchange telephone companies—and hence their revenue requirements and rates—the repeal of the 10-percent regular investment tax credit has dampened the incentives of telephone companies to modernize the network. The regular investment tax credit had encouraged investments because it permitted telephone companies to retain a portion of the tax savings that it created. Thus, this tax credit benefited the telephone companies, their shareholders, and ratepayers, whose rates declined in the face of lower revenue requirements.

To encourage modernization, Congress could reinstate the investment tax credit for telephone companies, and it could be specifically targeted to new plant and equipment that serves to modernize the public network. A broader credit could also apply to any R&D that is directly related to such plant and equipment, although experience suggests it is not an easy task to allocate such costs. Such a tax would benefit telephone companies, ratepayers, and equipment suppliers. However, general ratepayers might actually end up paying more if the tax revenue foregone had to be made up through an increase in general tax rates.

Option B. Establish user taxes and channel revenue for modernization purposes.

The construction of the public infrastructure has often been financed by imposing special taxes on users and potential users of that infrastructure. For example, the construction and maintenance of public roads and highways have traditionally been financed in part from specifically earmarked gasoline taxes as well as from user-fee tolls.[133] A similar Airport and Airway Trust Fund—accumulated from taxes on airline tickets and airplane fuel—is available to fund the infrastructure needs of the air travel industry.[134] In like fashion, an option for generating additional capital for modernizing the Nation's communication infrastructure might be to impose user taxes that would be earmarked for infrastructure development.

It should be noted that there is already a special Federal communication tax imposed on telephone bills, which has historically ranged from 10 to 20 percent. However, the revenue collected to date (an estimated $2.5 billion in 1988)[135] has not been earmarked for telephone or other infrastructure development, but has been treated as undesignated revenues. There are also a number of miscellaneous State and local taxes, which totaled an estimated $2.5 billion in 1988.[136] In the future, these monies might be targeted to infrastructure development.

Assuming a genuine need for financial incentives and support, using revenues from user taxes to provide them would be preferable to using general purpose funds on the grounds of both equity and efficiency. As Alice Rivlin, former Director of the Congressional Budget Office, has noted:

> User charges represent a way of recapturing from the actual beneficiaries some of the costs to the general public. Levying user charges promotes economic efficiency because users pay, directly or indirectly, for the services they receive. Proper incentives are provided, since heavier use imposes greater costs on the user, and at the same time, generates revenues to expand facilities.[137]

There are, however, a number of general problems associated with providing financing from earmarked sources of funds. Once established, such a fund can take on a life of its own. Since revenue is obtained from earmarked taxes, such funds can circumvent the normal budgetary process. As a result, it is often difficult to evaluate spending decisions in the light of other social values. Moreover, in these circumstances, the allocation of funds may be inflexible in the face of changing societal needs.

User taxes to support the modernization of the communication infrastructure may be unpopular, insofar as users have communication needs that are

[133] For a discussion, see U.S. Congress, Office of Technology Assessment, *Changes in the Future Use and Characteristics of the Automobile Transportation System,* vol. II, (Springfield, VA: National Technical Information Service, 1979), pp. 253-261.

[134] U.S. Congress, Office of Technology Assessment, *Airport System Development,* OTA-STI-231 (Springfield, VA: National Technical Information Service, 1984), p. 139.

[135] A 3-percent Federal excise tax has been imposed on telephone usage for more than 50 years (26 U.S.C. 4251). Approximately $2.61 billion was collected through the Federal excise tax in 1988, and 1990 revenues are estimated at $2.95 billion. Staff, Joint Committee on Taxation, Schedule of Present Federal Excise Taxes (as of January 1989), p. 21.

[136] Data Provided by U.S. Advisory Commission on Intergovernmental Relations, March 1989. Interestingly, some of these taxes are earmarked for specific purposes unrelated to communication, such as a special New York City surcharge designated for the use of the transit authority.

[137] Statement of Alice M. Rivlin, Director, Congressional Budget Office, before U.S. Congress, Senate Committee on Public Works, Feb. 7, 1978, p. 8.

distinct from one another. Many residential consumers are strongly opposed to paying higher rates to finance modernization on behalf of other communication users.[138] In addition, shifting tax revenue from the general pool of tax revenue to support communication-related activities may increase the problems of the budgetary deficit, if the services that the general tax on telephone service previously supported are still considered to be essential. Furthermore, given the decentralized and pluralistic nature of the U.S. communication infrastructure, the political and administrative problems associated with collecting and allocating user taxes for the purposes of modernization would be extremely difficult to resolve.

Option C: Alter depreciation rates to encourage modernization.

Capital expenses are recovered over time according to depreciation schedules designed to reflect how fast capital assets are expended. The higher the rate of depreciation, the faster that capital is recovered, and the more quickly revenues are made available for additional investments. For regulated telephone companies, depreciation expenses constitute the primary internal means of generating funds for capital replacement. [139]

Given this relationship between depreciation rates and capital expenditures, one way in which Congress might seek to encourage investment in the modernization of the public communication infrastructure would be to increase the rates at which regulated companies could depreciate their equipment. Reconsideration of depreciation policy is most likely to be called for at times when the pace of technological change is accelerating rapidly. This would appear to be the case now, as the useful lifetimes of many communication technologies become shorter and shorter.

Depreciation rates for regulated telephone service providers are established by both the FCC and the State PUCs, with the former setting depreciation rates for capital expended on interstate communication, and the latter setting rates for intrastate communication services. Beginning in 1980, the FCC adopted a number of changes with respect to determining depreciation rates that were designed to take into account advances in technology. Disagreements still exist, however, as to which rates are appropriate, with many telephone companies arguing that higher depreciation rates are required if modernization is to proceed apace. Many States have also taken issue with Federal depreciation policies, but from an opposite perspective. Focusing on the costs of local service, they have been much less inclined to adjust their depreciation rates for the sake of modernization.*@ And the Supreme Court has supported the States' rights to an independent position, ruling-–in the case of *Louisiana Public Service Commission v. Federal Communications Commission--that* in the 1934 Communications Act, Congress did not want to preempt the States on depreciation issues generally.[141] Thus, if depreciation policy were to serve as an important component of a Federal strategy to modernize the Nation's communication infrastructure, Congress would need to specifically authorize the FCC to preempt State action in this area. [142]

Strategy 3: Create a regulatory environment that is more conducive to the modernization of the communication infrastructure.

Government regulatory policies can have a major impact on corporate planning and decisionmaking. Thus, one strategy that Congress might follow would be to configure the regulatory environment to create greater incentives for business to invest in modernizing the communication infrastructure. At

[138]The public 's reluctance to pay a user tax to finance a broad communication policy goal was, for example, clearly an important factor in Congress's decision not to follow the Carnegie Commission's recommendation to fund public television through an excise tax on television sets. For a discussion, see Stephen White, "Our Public Television Experiment," Current, Oct. 20, 1988, pp. 7, 10-11. For a discussion of public broadcasting's failure to achieve the vision of its founders, see Harry M. Shooshan 111 and Louise Arnheim, "Public Broadcasting," *Benton Foundation Project on Communications and Information Policy Options* (Washington, DC: Benton Foundation, 1989).

[139]According to Nousaine, Brant, and Murray: "For a typical Bell operating company, depreciation often supplies 75'% of the funds for capital spending and accounts for almost 25% of total expenses, excluding taxes. " Op. cit., footnote 32, p 52

[140]In fact, political pressure to keep local telephone rates low has led to substantial underdepreciation in the past; thus, the book value of telephone company investments far exceeds current market value, The most widely cited estimate of this excess is on the order of $25 billion, See Alfred E, Kahn and William B. Shew, "Current Issues in Telecommunications Regulation: Pricing," *Yale Journal on Regulation,* vol. 4, No. 2, Spring 1987, pp. 191, 222,243-246.

[141]For a discussion, see Roger M. Witten and Thomas F. Connell, "The Louisiana PSC Decision: Where the Federal-State Balance of Power Stands," *Telematics, vol. 3, No. 7,* July 1986.

[142]Such authorization would, of course, be subject to constitutional review.

present, there are three basic policy approaches being considered in this regard--one that would alter the permitted rate-of-return that regulated companies can earn; one that would allow for more flexible pricing policies; and one that would expand the lines of business that companies can enter.

To pursue this strategy, Congress has a number of options.

Option A: Alter allowable rates of return.

The option of adopting alternatives to rate-of-return regulation has already been discussed in considerable detail in chapter 9, which focuses on access issues. The discussion here describes only how this option relates to the issue of modernization.

Proponents of alternatives to rate-of-return regulation argue that it stifles modernization by discouraging investments in R&D and productivity-enhancing technologies. In their view, regulated companies will be unlikely to invest in upgrading or modernizing their networks because they cannot fully recover the outlays they incur.[143] It is argued that an alternative arrangement, such as a system of price caps, would allow communication providers to recoup these costs, thereby encouraging them to make investments in the network. In making this argument, it has been noted, for example, that the RBOCs commit only 1.4 percent of their total operating revenues to R&D-about 40 percent of the amount committed by other industry groups in the United States.[144] Moreover, since the price of services could be capped at some negotiated and agreed-upon level, such a system would buffer local ratepayers from higher prices and the risks entailed in modernization.[145] In addition, because providers alone would bear the cost of failure, they would have a strong incentive to think through their investment decisions very carefully.[146]

Some opponents challenge the basic assumption underlying this option. They contend that rate-of-return regulation has not discouraged modernization in the past, nor is it likely to do so in the future. As Mark Cooper, Director of Research for the Consumer Federation of America, has argued:

> This stellar performance was driven by a rate of growth in total factor productivity-the best measure of an industry performance-that was almost 3 times greater than the average for all nonresidential businesses. Pure technological progress—measured by what economists call the residual-appears to be higher too by about one-third. The manufacturing part of the industry, where technological progress takes place, has exhibited a much higher rate of investment in research and development than other manufacturing industries. At the same time, the industry has been making capital expenditures at a much faster rate than the Standards and Poor 400, while it earned a rate of return that was about a point and a half below that of the Standard and Poor 400.[147]

Others, while commending the goals of modernization, do not believe that the price-cap proposals as presently devised go far enough to protect the customer against excessive rates, or the telephone companies' competitors from cross-subsidies and predatory pricing. For example, testifying on S.2044 (a bill requiring further FCC review of its price-cap proceeding),[148] before the Subcommittee on Communications of the Senate Commerce, Science, and Transportation Committee, Gail Garfield Schwartz, Deputy Chairman, New York State Public Service Commission, challenged FCC's reliance on an indexed cap incorporating a productivity adjustment based on historical performance (2.5 percent).[149] As she points out:

> No historical productivity factor can guarantee fair treatment for ratepayers, because any factor based on historic performance is likely to diverge

[143] For this argument, see Robert T. Blau, "The Politics of Productivity: Reshaping Telecommunications Policy in the 1990s," *Telematics*, vol. 5, *No.* 10, October 1988, pp. 1-7.

[144] Ibid.; see also R. Harris, "The Implications of Divestiture and Regulatory Policies for Research, Development and Innovation in the U.S. Telecommunication Industry," Berkeley, CA, 1987.

[145] For this argument, see Leland L. Johnson, "Price Caps in Telecommunications Regulatory Reform," N-2894-MF/RC (Washington, DC: The Rand Corp., January 1989). See also Peter Huber, op. cit., footnote 50.

[146] Ibid.

[147] Mark N. Cooper, "Regulatory Reform in Telecommunications: A Solution in Search of a Problem," *Telematics*, *vol. 4, No.* 11, November 1987, pp. 1-7.

[148] CC Docket 87-313.

[149] Testimony of Gail Garfield Schwartz, Deputy Chairman, New York State Public Service Commission, before the Subcommittee on Communications, House Committee on Commerce, Science, and Transportation, on S.2044, Legislation to Require Further Review by the FCC of its So-Called Price Cap Proceeding (CC Docket 87-313), Aug. 2, 1988, p. 2.

> from actual future performance. Thus, it is especially ironic that the FCC defends so strongly as a consumer benefit a factor reflecting historical experience under rate-of-return regulation, which admittedly discourages efficiency. If the inefficiencies of the former regime were as great as claimed, surely the theoretically more efficient regime of price caps should result in a higher-than-historic productivity increase. [150]

Opponents of alternative regulatory approaches also point to the negative effects that such methods might have on modernization. They note that, although telephone companies would continue to have incentives to modernize their competitive services, price-cap regulations might encourage them to allow the deterioration of facilities that serve captive customers. Any new system, they argue, should require that telephone companies meet strict quality-of-service standards and establish the procedures necessary for enforcing such standards.

As noted in chapter 9, the FCC approved a revised price-cap plan for AT&T on March 16, 1989. Consideration is presently being given to extending such a plan to the RBOCs, although opposition to such an extension would be much greater in this case because competition is much weaker at the level of the local exchange. Responding to FCC price-cap initiatives, Edward J. Markey, Chairman of the House Telecommunications Subcommittee-with the co-sponsorship of 13 other subcommittee members-introduced the Telephone Rate Verification Act, which would require the FCC to submit reports to Congress comparing the current rate-of-return regulations with price caps, based on data supplied by AT&T.

Option B: Allow regulated companies to price their products strategically in order to discourage bypass of the public network.

If the public communication infrastructure is to be maintained and modernized, providers of communication services will need to operate at a sufficient level of scale and scope to make investments in their networks worthwhile, To assure such economies, providers will need to find ways to keep big-volume users, such as large businesses, from migrating to other networks. However, regulated providers have been limited in their ability to do so. While their unregulated competitors can discriminate among users in their offerings of communication services, regulated telephone companies cannot unless they have secured a special waiver from State or Federal regulators.

One way for Congress to encourage modernization, therefore, is to allow regulated providers more leeway in pricing and designing their services for large-volume users. AT&T recently gained some flexibility in this regard when the FCC tentatively approved Tariff 15 and the extension of Tariff 12.[151] Tariff 15, for example, permits AT&T to provide volume discounts, whereas Tariff 12 allows AT&T to customize and package a service offering to meet an individual user's needs. AT&T's competitors have strongly contested these decisions on tariffs, charging that the tariffs encourage anticompetitive behavior. Chiding the FCC for not having tried hard enough to promote competition, MCI Communications Corp. Chairman, William McGowan, stated that:

> Unfortunately, those pro-competitive decisions came a relatively long time ago, and it's probably fair to ask the FCC: What have you done for competition lately? The answer is: Not a whole heck of a lot. with the Tariff 15 decision . . . the FCC seems intent upon undoing what little pro-competitive record it has.[152]

Some opponents are concerned, moreover, that FCC approval of these tariffs will create a precedent that will be used by RBOCs to justify similar treatment, even though they face much less competition than AT&T.[153]

The FCC has recently been considering these charges, although the tariffs were not suspended in the interim. In March 1989, the Commission ruled on Tariff 12, calling for revisions that would increase the availability of the offering. To date, FCC has not acted on Tariff 15.

Option C: Extend the lines of business that regulated telephone companies can enter.

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[150] Ibid.

151 For a discussion, see Kathleen Killette, "AT&T Seeks to Assuage Critics in Custom Network Controversy," *CommunicationsWeek*, Feb. 29, 1988, p. 10; Kathleen Killette, "Industry Group Asks FCC to Scrutinize AT&T Tariff," *CommunicationsWeek*, Feb. 8, 1988, pp. 38-39; and Kathleen Killette, "Market Limbo: How Low Can You Go," *CommunicationsWeek, CLOSEUP*, Aug. 15, 1988, pp. C-10, C-11.

[152] William McGowan, "It's Like Deja Vu All Over Again," *Telematics*, vol. 5, No. 11, November 1988, p. 17.

[153] Tom Valovic, "Critical User Issues: ISDN, T1 Networking, and Tariff 12," *Telecommunications*, May 1988, P. 8.

Just as economies of scale can serve to promote modernization and investment in the communication infrastructure, so too can the presence of economies of scope. However, whereas economies of scale depend on the volume of demand, those of scope derive from the complementarities that exist among different business activities. Thus, another way of fostering modernization might be to extend the lines of business that regulated telephone companies can enter.

At present, regulated telephone companies are prohibited under the Modified Final Judgment (MFJ) from engaging in three activities—manufacturing, certain aspects of information services and interexchange services, and nontelecommunication businesses.[154] RBOCs are also limited in their activities by the 1984 Cable Communications Act, which precludes their involvement in the provision of video services.

Viewing these restrictions as impediments to the development and enhancement of the U.S. communication infrastructure, policy makers in a number of different Federal Government arenas have begun to call for their relaxation or elimination. For example, the FCC, in its 1986 Computer Inquiry III, took the position that RBOCs should be allowed to offer enhanced services without structurally separate subsidiaries as long as they developed acceptable plans for opening their network architectures.[155] In November 1988, the FCC, after having received extensive stakeholder comments, tentatively approved the RBOCs' basic model for an open network, contingent on a number of modifications.[156] More recently, FCC has opened an inquiry into whether telephone companies should be permitted to operate cable television systems.[157]

Similarly, the Department of Justice (DOJ), filing the first triennial report and recommendations on MFJ in February 1987,[158] called for a number of changes in MFJ line-of-business restrictions. In the case of interexchange services, DOJ recommended, for example, that RBOCs continue to be prohibited from providing interexchange services within their own regions, but be allowed to provide them outside of their local exchange monopolies. With respect to information services, DOJ recommended that RBOCs be allowed to provide information services, subject to FCC rules designed to protect competition and promote efficiency and innovation. In the case of telecommunication equipment, it recommended that all restrictions on manufacturing be removed.[159] DOJ based much of its case on the analysis done by Peter Huber in the report accompanying the recommendations, *The Geodesic Network: 1987 Report on Competition in the Telephone Industry,* which argued that new technology was leading to a network where control would be dispersed around the periphery, rather than concentrated at the center. Although acknowledging that a local exchange bottleneck still existed, DOJ claimed that, given ONA and the Joint Cost Rules, RBOCs would be deterred from using this bottleneck in an anticompetitive fashion.[160]

Arguing along similar lines, the National Telecommunications and Information Administration (NTIA) has also expressed strong support for removing the line-of-business restrictions. The

[154]The MFJ allowed for waivers from these restrictions, but left the rationale for them somewhat unclear. As one observer has described it, the lack of "coherent or consistent policy for deciding which lines of business were permissible meant that line of business waivers became a decisional quagmire." See Roger Noll and Bruce M. Owen, "*UnitedStates v. AT&T:* An Interim Assessment," Discussion Paper No. 139, presented to the Workshop on Applied Macroeconomics, Industrial Organization, and Regulation, Stanford University, Stanford, CA.

[155]Henry D. Levine, "The User's *State* in CEI and ONA," *Telematics, vol.* 3, No. 11, November 1986, pp. 3-7; *see* also Robert M. Frieden, "Computer III: Does FCC Theory Match Market Reality?" *Telematics*, vol. 3, No. 11, November 1986, pp. 7-14; A.M. Rutkowski, "Open Network Architectures: An Introduction," *Telecommunications,* January 1987, pp. 30-40.

[156]In its request for revisions, FCC required the RBOCs t. make all ONA-related offerings available under Federal tariffs, and asked them to try to develop more uniform plans. Kathleen Killette, "FCC Gives Bells Partial ONA Nod," Co*mmunicationsWeek*, *Nov. 21, 1988,* p. 1; see also Charles Mason, "FCC's ONA Vote Gets Generally Favorable Reviews," *Telephony, Nov.* 28, 1988, pp. 16-17.

[157]FCC Docket 87-266. In so doing, th, Commission suggested that the Computer III provisions might also serve as a regulatory framework under which the telephone companies could provide video services. For a discussion, see Melinda Gipson, "FCC Proposes Allowing Telcos To Provide Cable," *Cablevision,* vol. 12, No. 49, Aug. 1, 1988, pp. 12, 16.

[158]U.S. Department of Justice, "Report and Recommendations of the U.S. Justice Department concerning the Line of Business Restrictions Imposed on the Bell Operating Companies by the Modified Final Judgment," U.S. v. *Western Electric Co. inc. and American Telephon& Telegraph, No. 82-0192,* (D. D.C.), Feb. 2, 1987. For a discussion, see A.M. Rutkowski, "The Geodesic Network: Impact of the Huber Report," *Telecommun ications*, May *1987,* pp. *92,95-97, 103.*

[159]Ibid.

[160]See, for example, *Response of th, United States to Comments on its Report and Recommendations Concerning the Line-of-Business Restrictions Imposed on the Bell Operating Companies by the Modification of the Final Judgment,* Apr. 27, 1987.

agency has taken a favorable position, for example, with respect to permitting the telephone companies to provide information services[161] and offer video dial tone,[162] as well as to enter the interexchange market.[163] So adamant was NTIA, in fact, that when U.S. District Court Judge Harold Greene was unreceptive to these proposals, NTIA went so far as to petition the FCC to assert its jurisdiction and, on its own, deregulate the RBOCs.

Within Congress, the impact of the line-of-business restrictions on the development and modernization of the U.S. communication infrastructure has also been of concern. As early as 1985, for example, Congressmen Swift and Tauke introduced a bill in Congress that would have rescinded the curbs on RBOCs.[164] More recently, 205 representatives cosponsored House Congressional Resolution 339, which—noting that it is "essential to stimulate and encourage the use of information technology by the American people''--calls for congressional action to lift the restrictions against the manufacturing of telephone equipment and the provision of information services by RBOCs, subject to regulatory safeguards.

These proposals to alter MFJ have generated an intense public policy debate, with the advocates of change focusing on the need for modernizing and developing the communication infrastructure, and the opponents concentrating on the potential for anticompetitive effects. In the case of manufacturing, RBOCs have argued that, if the manufacturing restriction is interpreted narrowly so as to preclude them from software design and development, the development and deployment of the intelligent network will be retarded. Opposing this point of view, AT&T brought the issue before Judge Greene, charging that RBOCs' activities in this area would be anticompetitive.[165] RBOCs have also argued that they could speed up the introduction of fiber to the home if they were permitted to become involved in video services. Not surprisingly, the cable companies have protested against what they perceive to be unfair competition.[166]

U.S. District Judge Harold H. Greene, who is responsible for administering the consent decree that led to the divestiture of the Bell System, has been against relaxing MFJ restrictions. Although, in the light of the first triennial review, Judge Greene permitted RBOCs to provide low-level gateway services, he was adamant in his refusal to let them create or manipulate the information they carry over their networks.[167] Nor has the Judge been willing to change the prohibitions on manufacturing, going so far as to forbid RBOCs from engaging in any form of equipment design and development.[168] Justifying his position, Judge Greene has noted that the consent decree requires that the restrictions on RBOCs be maintained until they can no longer use their bottlenecks for anticompetitive purposes. At present, this precondition has not yet been met. As Judge Greene has pointed out, in 1987, 99.9 percent of all long-distance traffic had to travel through local bottlenecks to get to local consumers, with only one-tenth of one percent able to bypass the regional companies.[169]

Judge Greene has promised to vigorously resist attacks on his authority to enforce the terms of MFJ, and has taken issue with Dennis Patrick, FCC Chairman, for allegedly "exhorting" RBOCs not to comply with the court's orders.[170] Thus, barring any action on the part of Congress to change the terms of MFJ or to transfer the authority for its administration

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161 See U.S. Department of Commerce, National Telecommunications and Information Administration, *NTIA Telecom 2000: Charting the Course for a New Century,* NTIA Special Publication 88-21 (Washington, DC: U.S. Government Printing Office, October 1988), p. 214.

162 See U.S. Department of Commerce, National Telecommunications and information Administration, "Video Program Distribution and Cable Television: Current Policy Issues and Recommendations," NTIA Report 88-233, July 1988.

163 Ibid., p. 248.

164 This bill was reintroduced in 1986 and 1987.

165 "AT&T Comments on the Report and Recommendations of the U.S. Justice Department," Mar. 13, 1987.

166 This issue is discussed in considerable detail in ch. 9.

167 In making this concession, Judge Greene took into account the arguments having to do with modernization and the development of information services. He believed it was necessary for RBOCs to develop gateway services in order to stimulate the U.S. market for information services.

168 Judge Greene feared that the removal of the manufacturing prohibition would lead to an industry "dominated by a small number of muscle bound giants, possibly dominated by foreign conglomerates." Tim Race, "Judgment Day: Few New Freedoms for the BOCs," *Communications Week,* Sept. 14, 1987, p. 1.

169 Judge Harold H. Greene, "Day for Complete Deregulation Has Not Yet Arrived," *Telematics,* vol. 5, No. 10, October 1988, p. 17.

170 Charles Mason, "Greene Fights Back in Ruling on R& D," *Telephony,* Dec. 7, 1987.

from the first circuit court to some other Federal agency,[171] the Judge's evaluation of the situation is likely to prevail.

Many others, among them a number of the RBOCs' potential competitors, agree with Judge Greene's basic assessment.[172] Some think that modifying MFJ is inappropriate because it represents a negotiated settlement based on interindustry compromises,[173] while others think that it is too soon to make alterations in it.[174] From the perspective of many, RBOCs not only continue to maintain control over bottleneck facilities, but they also have the ability and the incentive to engage in anticompetitive behavior through cross-subsidization and/or discrimination.[175] In fact, in the view of some, relaxing MFJ restrictions will increase the opportunity and incentive of the telephone companies to cross-subsidize. Moreover, many minimize the competitive impact that private branch exchanges, shared tenant networks, digital termination systems, and cellular radio services have had, or will have, on the local exchange. And some note that the role of the local exchange, and hence RBOCs' monopoly powers, may be even greater in the future when they have converted to fiber and introduced common channel signaling and ISDN.

Challenging the notion that the FCC will find it easier to monitor the operations of the telephone companies in the future, given the possibility of comparing their cost allocations and tariffs, a number of people have suggested that, with deregulation, the FCC's job of protecting the public interest will become more, not less, difficult. Others take issue with the idea that MFJ imposes significant costs in terms of lost economies. As one economist has pointed out, the potential for economies of scale and scope are the greatest in precisely those areas where, if integration were to occur, it would be most difficult to identify anticompetitive behavior. Thus, the costs to consumers due to a lack of integration will probably be offset by the benefits they gain through enhanced competition.[176]

Because DOJ's recommendations assumed that the ONA process would be successfully carried out, stakeholders' reactions to RBOCs' initial ONA filings are also indicative of how they might assess the line-of-business restrictions at some later date. As CBEMA and many others pointed out in their statements to the Court, if and when ONA is effectively implemented to assure equal access, many of those who are presently opposed to altering the MFJ might look at the proposed changes in a much more favorable light.[177] However, in general, it can be said that RBOCs' initial filings did not allay the fears of most of those who have been opposed to relaxing the line-of-business restrictions.[178] One report, for example, which was commissioned on behalf of a number of companies—including ADAPSO, CBEMA, and Telenet Communications Corp.+ ailed the proposals inconsistent, inadequate, and unresponsive to industry needs.[179] Among their complaints was that RBOCs did not go

171 S.2565, a bill introduced in Congress by Senator Robert Dole in 1986, was one such attempt. If passed, it would have transferred the authority fOr administering the MFJ from the Court to the FCC.

172 See, for examples of these comments, "AT&T Comments on the Report and Recommendations of the United States," Mar. 13, 1987; affidavit of Nina W. Cornell, *United States of America v. Western Electric Corn., Inc., and American Telephone & Telegraph*, May 22, 1987; Kenneth Baseman and Stephen Silberman, "The Economics of Bell Operating Company Diversification in the Post-Divestiture Telecommunications Industry," ICF Incorporated, September 1986; "Comments of Computer and Business Equipment Manufacturers Association," *United States of America v. Western Electric Co., inc., and American Telephone & Telegraph Co.,* Mar. *13, 1987;* and "MCI's Reply in Opposition to Motions and Recommendations to Modify the Judgment's Line of Business Restrictions," *United States of America v. Western Electric Company, Inc & American Telephone and Telegraph Co.,* May 22, 1987.

173 AT&T has argued, for example, that DOJ's recommendations compromise the agreements made at the time of divestiture. Steve Coll, *'Still No Answer on American's Phones," *The Washington Post,* June 28, 1987, p. H-1.

174 Opposing any proposals to lift the restrictions on the regional companies, Gene Kimmelman, legislative director of the Consumer Federation of America, has said, for example: " . . . the American public is still very suspicious of what happened [with the breakup of AT&T] in the first place and would prefer to let things stabilize, rather than go through a second revolution in our telephone system in five years." Ibid.

175 See Cements cited above, footnote 172.

176 See Cornell, op. cit., footnote 172.

177 As CBEMA and many others pointed out in their statements to the Court, if, and when, ONA is effectively implemented so as to assure equal access, many of those who are presently opposed to altering the Modified Final Judgment might look at the proposed changes in a much more favorable light. See CBEMA comments, op. cit., footnote 172.

178 For a discussion of the response, see Anne-Marie Roussel, "Bells' ONA Proposals Deemed Unacceptable," *CommunicationsWeek*, May 23, 1988, p. 42.

179 Hatfield Associates, Inc., "Open Network Architecture: A Promise Not Realized," prepared for ADAPSO, CBEMA, CompuServe Inc., Dun & Bradstreet, Independent Data Communications Manufacturers Association, Inc., and Telenet Communications Corp., Apr. 4, 1988.

far enough in unbundling their services and opening up their networks.[180] The gap between the expectations and the outcome of this first effort to develop an ONA can be explained in part by the fact that the level of unbundling required from an antitrust perspective-and thus that would satisfy the court—is different from that called for by the FCC under Computer Inquiry III.

Not surprisingly, RBOCs have been the strongest advocates of altering MFJ. Their eagerness to enter into the lines of business that have hitherto been closed to them is clearly evidenced not only in their testimony to Congress and the court, but also by their active involvement in the ONA process, their more than 160 successful court appeals for waivers, and their growing interest in establishing joint ventures with foreign countries. [181]

While responding to the anticompetitive arguments made by their opponents, the RBOCs have focused much of their appeal on the issue of modernization, and on the requirement that the United States have a communication infrastructure that will allow it to compete successfully in the international arena. As John Clendenin, Chairman, BellSouth, has characterized the problem:

> . . . my concern is how slowly that evolution takes place, and how much deep damage we do to this nation if it's not quick enough. We've heard the restrictions are causing our nation's high tech strength to atrophy-and here we've seen disturbing corroborating evidence.
>
> This is not a special-interest concern, unless you consider America a special interest. This is a profound, broad-based concern for all American interests, large and small, telecommunications and otherwise.[182]

Such an infrastructure, RBOCs argue, can only be brought about if they are allowed to contribute their full measure to its development. With respect to manufacturing, they note that, if they were allowed to become more involved in this area, they would be better able to provide timely and higher quality products and services to their customers, and that the economy would benefit from greater investment in the research and development of advanced technology.[183] Comparing the development of information services in the United States to that of other countries, RBOCs attribute the relatively slow rate of growth in the United States to the restrictions of MFJ. As NyNEX has described it:

> It has resulted in some services being offered in an inefficient way and others not being offered at all, even though the technology to provide them, and demand for them, exist.[184]

Responding to the concerns of Judge Greene and others about competition, RBOCs point to how far they have gone in making equal access a reality with respect to interexchange services, CEI (Comparably Efficient Interconnection), and ONA. [185] In addition, they note that-given divestiture and the emergence of seven highly competitive operating companies—benchmark regulation and the Joint Cost Rules have become more feasible, thereby reducing the likelihood of cross-subsidies and discrimination. Moreover, they point out that RBOCs have a greater incentive than ever before to assure high quality, nondiscriminatory service; the more their networks are used, the more revenues they will enjoy.[186]

In sorting out the complicated issues raised by MFJ, it is important to consider three basic questions: [187]

1. Has the change in the U.S. telecommunication infrastructure since divestiture been sufficient to warrant the relaxation of RBOC restrictions?
2. What costs, if any—in terms of modernizing and developing the communication infrastructure—are entailed in making antitrust policy the linchpin of U.S. communication policy?

[180] Ibid.

[181] For a discussion, see Denis Gilhooly, "Unleashing the Baby Bells," *Telecommunications*, February 1988, pp. 48,57,58,60,62.

[182] John L. Clendenin, "The Paralysis of MFJ Analysis," *CommunicationsWeek*, Jan. 16, 1989, p. 15.

[183] See, for example, "Comments of Nynex Corporation on the Department of Justice's Report Concerning the Line of Business Restrictions Contained in the Modified Final Judgment," *United States of America v. Western Electric Co., Inc., and American Telephone & Telegraph Co.*, Mar. 13, 1987.

[184] Ibid.

[185] For one reply to the criticisms of the ONA process, see Shooshan and Jackson, Inc., *ONA: Keeping the Promise*, commissioned by Bell Atlantic, May 31, 1988.

[186] See, for example, Nynex comments, op. cit., footnote 183.

[187] For a discussion, see Robert Pepper and Stuart N. Brotman, "Restricted Monopolies or Regulated Competitors? The Case of the Bell Operating Companies," *Journal of Communication*, vol. 37, No. 1, Winter 1987, pp. 64-72.