being built in the United States, Canada, Europe, and Japan. Interconnection between these networks is planned. Packet switching has several advantages: (i) a very robust structure can be built that readily permits the building of systems whose operation is much more reliable than its elements (communications lines and packet switching centers); (ii) it provides the highest degree of statistical averaging to make most effective use of the basic resource; (iii) the standard format package simplifies full effective interconnection between completely different computer systems and terminals; and (iv) no better alternative is in sight for most user-to-computer and must computer network applications.

Future directions for digital networks. Packet switching, although important, is by no means the end of the development for future computer communications systems. The telephone plant itself is moving on to a mostly digital structure in order to achieve a number of economic advantages. In the process it looks more like a computer communications network but with tremendously greater data-handling capacity. One might argue that the two systems are really the same. However, the minor differences between the two systems are certainly of major significance. An argument can even be raised that the conventional telephone set is nothing more than a "terminal" which generates and accepts commands and which receives and generates data to other such instruments, with the "data" being digitalized voices. A single digital voice channel in today's digital telephone systems carries 64,000 bits per second without a conventional modem. Clearly this is a tremendous capacity. There are future needs that could well use some of these high-capacity trunks of the telephone plant. There is a need in the distributed processing area for large bandwidths. In the case of intercomputer file transfers or access, bandwidths on the order of two to three megabits are appropriate whereas for the interchange of high-fidelity pictorial information 10 to 50 megabits are necessary.

Broad bandwidths are not needed everywhere. The same situation prevails in the local versus long-distance distribution of data as in the local versus toll distribution of voice communication; namely, the cost of local circuits is much less than that of toll circuits. In the case of local distribution of high-speed data, new systems such as the Pierce loop developed at Bell Laboratories, the Irvine ring designed at the University of California, Irvine, and the Ethernet produced by the Xerox Palo Alto Research Center have been proposed and constructed to attack the problem. These systems are marginally applicable to the distribution of such capabilities over large distances. The interfacing of such local data networks to national and international networks represents one of the present edges of computer communications technology.

The Information Economy and Public Policy

Manley R. Irwin and Steven C. Johnson

If a single word summarizes U.S. telecommunication policy, that word is conflict. Telephone markets are vulnerable to competition from specialized carriers, the telephone industry is challenged by domestic satellites, telephone equipment is experiencing increased competition from outside manufacturers; the computer and communications industries are engaged in skirmishes for the lucrative market of data processing.

And this is only the beginning. Both state agencies and the FCC have squared off in a quarrel over their respective regulatory jurisdictions; controversy has erupted as to the proper policy mix between competition and regulation; both government and private antitrust suits have challenged the structure of the telephone carriers; and legislation has been introduced declaring a moratorium on competition in telecommunication.

In this article we attempt to provide the framework in our search for answers to questions concerning the cause of the conflict, the forces that contribute to it, the policy alternatives that are open for future consideration, and their effects on service markets.

U.S. Telecommunications

Conflict surfaces when two concepts, two ideas, or two philosophies find themselves juxtaposed. The telephone carrier industry, its services, its equipment, its organization—indeed the premise of regulation—is today subject to scrutiny and reappraisal. What has been the basis of the U.S. telecommunications industry for the past decades? The answer must begin with an examination of the telephone industry.

Service. Telephone companies have traditionally regarded their mandate as rendering a universal service to all subscribers (*1*, p. 4). Such universality, plain old telephone service, presumed carrier ownership of transmission, switching, terminals, and local loop plant. Local exchange services were priced at flat rates within specific areas and tariffs between customer classes rested on the concept of service value (*1*). Long distance tariffs were determined by the variables of time and distance.

Telephone companies were assigned exclusive service areas. Costs were aggregated or spread among the various types of equipment, vintages of plant, and density of population areas. Inevitably, subscribers in some areas subsidized customers in others.

The industry was capital-intensive. The investment required to establish a large telephone system was deemed to erect prohibitive barriers to entry. The industry was also said to enjoy economies of scale or size that gave monopoly a social advantage over competition (*2*). The results saw the industry evolve into a private monopoly—a development that laid the foundation for government regulation.

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Equipment. The concept of universal telephone service carried with it a corollary. Subscribers leased service rather than equipment (*3*). The carrier assumed full responsibility for a total, end-to-end concept, a concept that mandated control over equipment, its installation, its maintenance, its obsolesence, and, ultimately, its retirement (*2*). Subscribers, in fact, were precluded from attaching their own equipment to telephone lines under penalty of service loss or withdrawal. By definition, competition in supplying equipment to the telephone subscriber was deemed contrary to the public interest.

Organization. The telephone holding company became the organizational norm for the industry. The holding company did not render telephone service per se, but rather controlled firms that either supplied service or manufactured equipment. Holding company control of both manufacturer (seller of equipment) and the utility (the buyer of equipment) evolved into vertical integration (*2*). That ownership bond became the generic model for the structure of the entire telephone industry.

As the industry leader, the American Telephone & Telegraph Company (AT&T) controls 22 operating companies, a manufacturer (Western Electric), and Bell Telephone Laboratories. Bell's vertical integration eventually was replicated by non-Bell or independent telephone companies, including General Telephone, United Telecommunications, Continental, Mid-Continent, and others. Today more than 90 percent of the U.S. telephone service is rendered by companies owned or controlled through holding company ownership.

Holding company control was not merely paramount, it was functional as well. Research and development (R & D) laboratories designed equipment, manufacturers fabricated hardware, and utilities bought and incorporated equipment into their investment rate base. Central administrative control—the holding company—coordinated the components of finance, engineering, purchase, and service.

The results of the telephone holding company have been impressive by most standards. Telephone investment in the United States today exceeds $80 billion. Annual revenues exceed $35 billion. The industry's annual construction budget approaches $12 billion. Some $1 billion is allocated to R & D alone. The equipment market exceeds some $7 billion annually (*4*).

The Bell System accounts for most of the nation's telephone equipment and telephone service. Bell provides some 80 percent of all local exchange service and 90 percent of toll message telephone service. The rest is rendered by 1600 independent telephone companies, serving 50 percent of the geographical area of the United States. More than 94 percent of the homes in the country enjoy telephone service (*5*).

Under holding company control, each telephone system moved in the direction of self-sufficiency. Western Electric, Bell's manufacturing subsidiary, supplied the bulk of telephone hardware to the Bell operating companies. The manufacturing affiliate of General Telephone did likewise, a pattern repeated by other independent holding companies. In short, the holding company vertical integration and the systems concept evolved into closed, self-contained entities.

Challenge to U.S. Telecommunications

Service. The traditional triad of service, equipment, and organization has found itself challenged. Today, instead of universality, the telephone industry is experiencing competition, especially in private lease submarkets and in intercity facilities. Terrestrial microwave, digital satellites, and digital and packet switching obviously broaden the notion of service beyond the ordinary analog telephone. New subscribers, particularly those vesting interest in data communications, demand service that is tailored to their individual requirements. A number of firms have responded to the data communication market, a form of rivalry that has proved disconcerting to incumbent telephone carriers. In short, competition for intercity services represents a conflict between telephone carriers and new entrants in specialized services.

Equipment. Competition in telecommunications equipment represents a second area of contention. No longer are telephone handsets the only apparatus attached to the switched network. Today computers are interconnected to remote data bases, data terminals are linked by various networks, and point-of-sale devices are pervasive in their application. Some predict that tomorrow's office will tie copiers, dictaphones, word processing equipment, electronic files, and microprocessors to telephone lines (*6*). Thus, the telephone handset no longer stands alone, but is rather one part of a broadening spectrum of telecommunication hardware, a spectrum that is evolving into a wide range of information terminals.

The proliferation of telecommunications equipment is driven by the needs and requirements of the business user. Acting under the pressure of the marketplace, the business subscriber seeks equipment that yields lower costs, greater flexibility, and increased productivity. That search, sprung loose by regulatory action in the late 1960's, has created market opportunities for equipment suppliers, manufacturers outside the holding company family. These manufacturers sell private branch exchanges, data modems, key telephone systems, and automatic call distributors—to mention but a few.

The business subscriber has accordingly been exposed to a broad selection of equipment. In fact, some subscribers prefer hardware not manufactured by the telephone carrier suppliers. Once the user avails himself of that choice, however, the investment rate base of the carrier is eroded. Telephone utilities strenuously oppose rate base diminution on grounds that revenues lost in one market must be compensated through higher rates from other markets (*1*, p. 21). Inevitably equipment interconnection represents a second dimension of controversy in the telecommunications industry.

Organization. A third area of conflict is organizational. Given vertical ownership of buyer and seller, telephone carriers traditionally buy the bulk of their hardware from in-house suppliers, a practice that has limited the market opportunities for nonintegrated firms. But these practices, long unchallenged, have suddenly been criticized as independent manufacturers seek, solicit, and demand an outlet for their own products. The result has been a rash of antitrust suits filed by companies which allege that vertical integration forecloses market entry and extends monopoly from telephone service to equipment manufacturing. Plaintiff suits against AT&T and General Telephone seek corporate divestiture between utility and supplier as relief to what they allege as market foreclosure (*7*).

Antitrust exposes the structure and conduct of the industry to public reassessment. It places the question of vertical integration on the policy front line. Telephone companies, of course, defend the structure, conduct, and performance of their industry with vigor and persistence. Nonetheless, the organizational philosophy, the way the industry has been put together, is experiencing unprecedented criticism. Accessibility to equipment markets thus represents a third area of conflict within the industry.

Causes of Conflict

What is behind this series of events described above? Why, after all these years, does the telephone industry find itself on the defensive? Why, after decades does an industry subject to public regulation find itself exposed to market competition? In a search for some answers, it is essential to reexamine the implicit assumption of the nation's telephone industry.

Telephone service, its equipment and organization rested on a presumption of technological exclusivity. That exclusivity originated with the patent right in 1876. It was subsequently extended by R & D and augmented by patent accumulation. It was later reinforced by policies that forestalled entry into equipment or telephone services.

Given technological exclusivity, it followed that market rivalry was deemed inappropriate. Rather, it was argued, the industry was endowed with what economists term "natural monopoly" characteristics. This meant the industry experienced declining unit costs as scale or size of plant increased (*2*, p. 973). "Natural monopoly" also suggested that the industry exhibited high capital spending that automatically precluded easy access or easy entry. Finally, telephone service was endowed with dimensions of public convenience and necessity. It followed, then, that exclusive supply, rather than market competition, would yield the benefits of efficiency, innovation, quality, and responsiveness.

Private monopoly inevitably issued the call for some form of accountability. Regulation evolved first at the state level and subsequently at the federal level (*1*, p. 5). Regulation as an institution was erected to assure that monopoly power translated into reasonable rates and adequate service. Regulation accepted the premise that competition was wasteful and inefficient. At the same time, regulation ensured that the monopoly firm should generate sufficient revenue to enable the firm to compete in the capital market. Technological exclusivity, in short, erected two institutions: the institution of private monopoly and the institution of public regulation.

It is that premise and those institutions that are now subject to question. The telephone industry, in the middle of technological explosion, finds that its expertise has migrated with a vengeance. Technological expertise in switching, transmission, equipment, manufacturing, and research and development no longer reside as the exclusive province of incumbent telephone carriers. The telephone industry is but part of the broad revolution besetting the electronics industry, a revolution that has spawned market competition.

Competition is a hallowed institution in the American scene. Antitrust laws governing corporate structure and conduct are long established. In the past, competition consisted of intraindustry firms competing for the consumers' dollar. Product substitutes added an element of competition to the market process.

But telecommunications technology is provoking a new economic phenomenon in the marketplace. Today, one can detect five industries, once separate and distinct, now moving on a collision course. These include the telephone industry, computer industry, semiconductor industry, terminal industry, and aerospace industry. This economic dimension goes beyond the competition of product substitutes, beyond competition within an industry. The telecommunications industry is experiencing *multiple interindustry competition*. This is a new species of market rivalry that is clearly unsettling to firms in a regulated environment.

The content of this multidimensional rivalry is the complexity and interaction of these five industries; the merging of markets represents a marked divergence from our past experience. Semiconductor firms compete with computer firms, telephone manufacturing firms compete with aerospace firms, and aerospace firms compete with data terminals. The permutations and combinations of this intense rivalry are indeed "mind boggling."

As a consequence of this technological turbulence, the technological diversity is seen to challenge the concept of universal telephone service, to challenge telephone manufactured equipment, and to challenge holding company determination of R & D and investment. Technological migration is a fundamental challenge to the premise of scale economies, to the concept of wasteful duplication, to the notion of lower per unit costs, and to the very presumption of so-called natural monopoly.

Some assert, in fact, that technology challenges the very rationale of public regulation itself. Little wonder that the industry finds itself on the defensive. Little wonder that public policy now resides in the eye of a hurricane. Clearly two institutions, private telephone monopoly and public telephone regulation, are subject to change, reassessment, and reevaluation.

The strategic role of technological change is emphasized by the following illustration. Telephone companies find themselves attracted to the growing market of data communications. The question arises as to how carriers should diversify into these markets, whether they should file tariffs as regulated entities, or whether they should establish subsidiaries and enter the market as unregulated affiliates. Since 1971, the Federal Communications Commission (FCC) has ruled that non-Bell common carriers must establish separate affiliates for the purpose of selling data processing services on the premise that such services are competitive in nature and can sustain vigorous market rivalry (*8*).

In contrast, AT&T has filed tariffs on a data terminal that incorporates memory components (*9*). More questions arise: does memory constitute data processing? Is data processing appropriate for regulation? Do tariffs set a precedent for the extension of monopoly into markets previously regarded as competitive? That the FCC has presumably accepted the Bell tariff will undoubtedly precipitate a policy controversy over what are data communications, what constitutes data processing, what is the demarcation line between each, and whether such a line can be determined.

Finally, competition is intensifying in the domestic satellite market. A consortium under the aegis of IBM has received FCC approval to offer a digital satellite service within the United States. The system incorporating new microwave, satellite, and antenna innovations will undoubtedly compete with private line service offerings of common carriers.

But IBM's entry into data communications via a holding company raises a number of complex issues. Will such a consortium give IBM competitive advantages in software, hardware, protocols, data processing, and equipment compatibility not available to its competitors? And will IBM's entry into data communications eventually envelop the corporation with federal regulation as suggested by AT&T (*10*)? The fact that the Federal Trade Commission and the Department of Justice have called for further examination of these issues suggests that public policy remains unsettled and unresolved.

Public Policy Debate

The public policy debate focuses essentially on the service, equipment, and organization of the telephone industry. The issue has been joined with proponents advocating competition versus proponents advocating monopoly in this industry.

Service. First, there is the monopoly argument. Those supporting the monopoly approach assert that telecommunications is best secured through the vehicle of the regulated firms. Specifically, this position argues that exchange telephone service, intracity facilities, and even communication processing service is best rendered through a franchised utility with end-to-end system responsibility (*11*). This position is backed by several contentions. (i) Telephone service requires coordination and planning and must be rendered accountable to someone. That responsibility has traditionally fallen to communication carriers exclusively. The record of carriers in telephone service quality is eminently reassuring. Telephone service or quality in the United States broaches few rivals. (ii) Telephone subscribers gain through a policy of nationwide price averaging. Under this policy high profit subscribers subsidize low profit subscribers, low cost subscribers contribute to high cost subscribers. Both gain through the application of an overall averaging concept according to natural monopoly proponents.

Proponents for monopoly assert that rivalry, entry, and competition contradict the concept of system coordination. Competitive services result in wasteful duplication, cream skimming, and plant inefficiency. Technological imperatives and economic realities dictate that a single firm—the telephone carrier—be accountable to achieve the goals of efficiency, responsiveness, innovation, and quality to the subscribing public (*12*).

Let us consider ancillary services, such as value-added services or communication processing services. According to the telephone industry, such services pose a legitimate extension of traditional telephone service. Communication technology and transmission in switching and other service offerings lead inexorably to digital technology. The industry is on the forefront of that technology and has contributed to the non-voice as well as the voice state of the art. To deny the telephone industry an opportunity to grow in these new services would be arbitrary and capricious, and would flaunt the imperatives of technological change. Given the fact that communication processing services are regulated, the consumer is guaranteed that services to him are rendered at equitable and nondiscriminatory rates.

Second, there is the competitive argument. Proponents of competition assert that the "natural monopoly" argument is confined essentially to exchange telephone service. Here duplication or rivalry in central office exchanges can be wasteful, and no one advocates a policy of market entry. But natural monopoly has its limits; it is no longer applicable to intercity facilities and obviously is misplaced for data processing services.

In these new services, advocates of competition assert that market rivalry creates incentives that spur new services, new investment, lower costs, lower prices, and a broader array of consumer choice (*13*). Proponents argue that the marketplace best achieves the goals of efficiency and innovation, and that unfettered rivalry encourages the flow of resources into an industry and provides an impetus for the development of new markets.

Some proponents of competition insist that regulated carriers should be precluded altogether from markets congenial to entry, diversity, and rivalry. Movement by carriers into unregulated markets, they argue, carries with it an illegitimate extension of "natural monopoly." More important, diversification carries with it the illegitimate extension of government regulation. Once that regulation grows beyond the bounds of economies of scale, the pivotal barrier to entry thus becomes the very regulatory process itself.

Equipment. With respect to monopoly, telephone carriers consider themselves as the proper entities charged with equipment responsibility. Customer ownership of terminal devices can compromise a highly technical network, erode investment, dampen technological innovation, introduce cost inefficiencies, and degrade telephone quality (*1*). Only the carrier bears the continuing burden of equipment maintenance and repair. In the past, consumer benefits have resided in the concept of end-to-end service, and the telephone network must be protected from harm or "pollution" or it will be rendered useless to over a hundred million subscribers.

As to competition, its proponents assert that telephone technology has experienced a dramatic change. New equipment, new apparatus, and new hardware are spawned in a competitive marketplace. That process is aided and abetted by the incentives of technological rivalry. Competition and entry, in terminal apparatus, will alleviate capital shortage of equipment, reduce the construction burdens of the carriers, spur new equipment features, prompt lower prices, and enhance product innovation (*14*). Proponents of competition argue that standard interface requirements can protect the quality of the telephone network, that terminal apparatus exhibits none of the characteristics of "natural monopoly," and that the proliferation of data and computer terminals best proceed unfettered by regulation and unrestrained by restrictive tariffs.

Organization. Proponents of monopoly or advocates of holding company control of manufacture and supply believe that vertical integration must be judged on its performance. In their view performance has been outstanding. Integrated suppliers enjoy economies of scale, impressive productivity, low price, and innovation track records that redound ultimately to the subscribing public.

They say that equipment manufacturing must be coordinated and planned and be consistent with the objectives of overall system quality. Fragmentation of holding company control of buyer and seller increases cost, lowers quality, and compromises a nationwide telephone system. Holding company control of manufacture assures operating carriers that suppliers pursue profits not as an end in itself, but rather that integrated suppliers provide the right product at the right place and at the right time (*12*, pp. 9–29). Control of the manufacturing affiliates merely secures that end.

Proponents of competition argue that technological diversity has broadened R & D, broadened investment, broadened products, and broadened marketing expertise. Technology has also increased the number of firms capable of making contributions to the telephone equipment industry. Critics of vertical integration believe that the equipment market is not a natural monopoly, that it is not a regulated market, that suppliers are not public utilities. All manufacturers, they say, must meet the crucible of the market test in terms of equipment price, features, technology, and availability.

Proponents emphasizing the advantages of competition submit that market entry is the acid test of alleged economies of scale, that entry carries the virtue of economies of specialization and the economies of diversification. They argue that sole source manufacturing is a legacy of a bygone era, and that vertical integration compromises the nation's interest in R & D, in telephone equipment, in resource allocation, and in the incentives placed upon corporate efficiency and innovation.

Proponents insist finally that the equipment market has been foreclosed, and that the foreclosed market must be reopened so that the virtues and benefits of market forces can accrue to both the telephone operating companies and the telephone customers. In short, they imply that structural reform of vertical in-

tegration under holding company control is long overdue.

The reality of the policy debate. The debate on the pros and cons of service, equipment, and organization is no mere academic exercise. The telephone industry has found itself resisting and opposing service equipment ownership and the proposed changes in its organizational structure. In fact, the industry has introduced to the Congress legislation, titled the "Consumer Communications Reform Act" which marks a return to monopoly control of telephone service, telephone equipment, and of the telephone industry. This legislation, which would immunize the industry from competition, from antitrust, and from market rivalry, is controversial.

By contrast, competitors have challenged the carriers' position and contend that the carrier-sponsored legislation is merely an attempt to return an industry to operational methods of a bygone era. The public policy debate, monopoly versus competition, is thus very real. It is likely to gain intensity as technological migration continues to assault and question the premise of telephone carriers, its industry, and its regulation. Indeed, the debate and dialog are subjecting the very process of regulation to increased scrutiny and evaluation. The unprecedented rate of change in the telephone industry has resulted in a major debate as to the direction and content of public policy.

The Stakes of the Battle

It is clear from the turmoil in public policy that the stakes are enormous. To assess them requires an examination of certain trends in the economy and a determination of where these trends are driving us.

Consider first the trends in services. In recent years we have seen a proliferation of new services and new markets. Businesses can send mail electronically. Bills can be paid from the home over the telephone. Consumers can transfer money electronically, thus moving us toward a cashless economy. Important phone calls can be automatically forwarded. These new services are but the tip of the iceberg. Development and introduction of new services have become the hallmark of the industry. Marketing with emphasis on the specialized requirements of the customer has become a critical factor to corporate profits and organizational structure.

The second trend is the development of terminals. New services require the development of new terminals incorporating increased intelligence and memory. Already these terminals are becoming commonplace for such applications as remote banking, travel reservations, and point-of-sale devices for retail stores and supermarkets. Even the common typewriter is being replaced by word processing machines in business offices. By 1980 the annual number of terminals shipped is expected to increase from a present rate of 325,000 to 574,000 (*15*).

A third trend is the evolution of computer networks. New information services and remote intelligent terminals form the basis for growth in distributed computer networks. Thus, computing power is becoming more commonplace and is particularly important to such distribution oriented industries as warehouses and to branch facilities such as banks, retail stores, and supermarkets.

The trends in new services served by intelligent terminals and linked together with distributed computer networks are creating an exponential growth in data communications. For example, AT&T has estimated that data communications revenues will quadruple from $5.5 billion in 1975 to $22 billion in 1980 (*16*).

New services, new markets, and multi-industry competition are symptoms of a basic shift in the economic infrastructure of the United States. It represents a shift to an information economy. That we are in transition to an information economy there is no doubt; the evidence is abundant. Already some 50 percent of the U.S. work force is employed by the information sector of the economy, and U.S. service exports now exceed the exports of goods (*17*).

Just as the shift from agriculture to industry was in the last century, the shift to an information economy will be pervasive. The impact of this shift can be seen in how we produce, what we produce, how we transact business, how we pay, how we shop, how news is gathered and spread, where we work, what kind of work we do, and how we communicate. Information, its formation and transmittal, will play a key role in this new era. What we are witnessing is an information explosion covering the entire spectrum of our economy. It is not restricted to the computer or the communications industry. At the very least, it embraces banking, insurance, transportation, health, education communications, entertaining, and manufacturing.

Our dependence on information and its transmittal will be critical to the growth and prosperity of our economy. Policy decisions as to what information services are provided, who provides them and at what prices go to the heart of tomorrow's economic infrastructure. The stakes, markets, and investment are incalculable. It is in this context that the public policy issues surrounding telecommunications should be considered. And it is in this context that the merits of a policy of competition and monopoly in telecommunications should be debated and resolved. At issue is not merely the fortune of a single industry, but the thrust, content, and direction of our economy (*18*).

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