ENTRY RESTRAINTS IN THE COMMUNICATION EQUIPMENT INDUSTRY

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY

Manley R. Irwin

1963

THESIS

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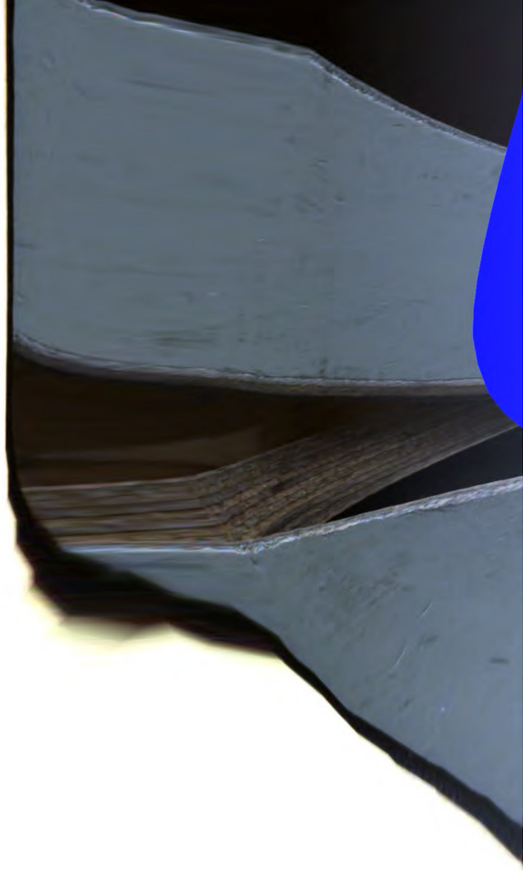

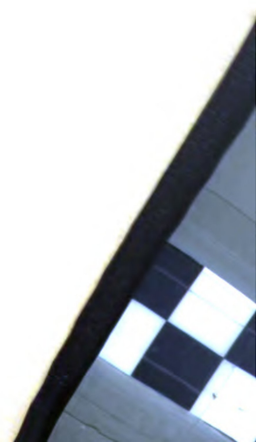

ABSTRACT

ENTRY RESTRAINTS IN THE COMMUNICATION EQUIPMENT INDUSTRY

by Manley R. Irwin

This study seeks to evaluate the factors contributing to entry restraints in both the domestic and international segments of the communication equipment industry. The problem of market entry assumes two levels. First, vertical integration exists as the predominant market structure in both domestic and international aspects of the industry; and the problem of entry is centered around the attempt by the nonintegrated supplier to gain market access. A second factor is concerned with two competing modes of rendering communication service, metallic circuits and microwave radio circuits. In general, the nonintegrated firms have a vested interest associated with the latter, while the integrated manufacturers and their common carriers have substantial investments in the former.

Given the problem of entry, this study cites three factors that historically have tended to inhibit market entry. First, the legal and technical factors of patented knowledge, capital requirements, and the frequency spectrum; second, the market structural traits associated with the pricing and interconnection policies of the common carrier; and third, policy decisions within the public sector.

This classification of restraints is applied to both the domestic and international equipment markets.

The study suggests that while most of the legal and technical deterrants have eroded with time, the structural barrier of vertical integration remains as a formidable restraint to market entry and hence competition. The study concludes that public policy must address itself to this issue and require vertical disintegration as a means of restoring a competitive environment to the communication equipment industry.

Much of the research for this study was obtained directly while working with the Senate Small Business Committee during the summer of 1961. In addition, the author has conducted interviews with the Department of Justice, the staff of the Federal Communications Commission, and the National Aeronautics and Space Administration. Non-government sources include interviews with American Telephone and Telegraph Company, Bell Laboratories and Western Electric, Western Union, Motorola, General Electric, Radio Corporation of America, and Chrysler Corporation. In addition, conversations with private utility consultants, private microwave consultants, and the Washington law firm, Smith and Pepper, have been most useful.

The direct interview has supplemented such sources as Congressional hearings, FCC dockets, and a host of books, periodicals, journal articles, etc. relating to the problem under consideration.

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By

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CHAPTER I

INTRODUCTION

This study is concerned with the communication equipment industry. The specific problem under analysis is the problem of market entry. An assessment of the entry problem will be organized under the following topics. First, what is the nature of market entry; second, what are the potential or actual deterrants to market entry; and finally, what policy recommendations emerged from this study.

The second topic, the deterrants to market entry, will receive the major emphasis in this study. Specifically, these barriers are classified as:

1. Legal and technological barriers--including patents, absolute capital cost, and the nature of the frequency spectrum.

2. Market structural barriers--including the interconnection policy and the pricing policy of the common carriers.

3. Finally, government policy--including an assessment of decisions undertaken by the Federal Communications Commission, the Justice Department, and the National Aeronautics and Space Administration.

The markets under consideration will be segregated into the domestic equipment and the international equipment market.

The specific purpose of this chapter is to segregate market structure as a potential deterrant to entry. The salient structural trait of the communication equipment industry is that of vertical integration--a characteristic that appears to be common to both domestic and international markets. Furthermore, vertical integration exists between common carriers as suppliers of communication service and equipment manufacturers as suppliers of communication apparatus. Thus, a survey of previous thinking on the subject of vertical integration will serve as a convenient prelude to the general discussion of market entry.

Market integration assumes three general forms: horizontal, vertical, and conglomerate integration. Horizontal integration is said to occur when like products are subject to common ownership; conglomerate integration exists when unlike or unrelated products are subject to common ownership; and vertical integration occurs when successive stages of production and/or distribution are subject to common ownership. Typically, vertical integration occurs when the raw material-final product sequence is absorbed into one operation; and sometimes the classification is further refined into forward or backward integration, depending upon whether the source of the movement originated in the product or factor market.

Although these definitions are general, the essence of vertical integration is that the market as a criteria

of performance is displaced by the internal decision of the firm.[1]

Most commentators appear to agree that vertical integration in and of itself is a neutral term and its existence in varying degrees is almost universal.[2] This attempt to survey the literature will examine the relationship between vertical integration and market efficiency, market power, market entry, and finally, policy alternatives.

The problem of efficiency arises when vertical integration induces either a fall or a rise in the firm's per unit production costs. The former would result from economies of integration, the latter from diseconomies.

Several factors can contribute to economies of vertical combinations. A new technology may shift and redefine the technological process in which several independent steps are combined into one.[3]

---

[1]Arthur R. Burns, The Decline of Competition (New York: McGraw Hill Book Co., 1936), pp. 431-2, 461; also: M. A. Adelman, "Integration and Antitrust Policy," Harvard Law Review, Vol. 63, 1949, pp. 27, 33.

[2]Corwin Edwards, "Vertical Integration and the Monopoly Problem," Journal of Marketing, Vol. 17 (July 1952-April 1953), pp. 404-5.

[3]See E. A. G. Robinson, Structure of Industry, pp. 25-6. New technology can also result in what Robinson terms technical disintegration "where some given process requires a scale of production considerably greater than the smaller firms in an industry can achieve, this process tends to be separated off from the main stream. . . . Thus the industry becomes broken up into two or more industries and each is enabled to work at its most convenient scale of production." See George Stigler, "The Extent and Basis of Monopoly," American Economic Review, 32:2 (1942), p. 22.

A second economy may be induced by the elimination of transactions or savings in the "cost of transfer."[1] Such economies may include the avoidance of selling costs, the elimination of advertising, and perhaps greater economies of scale. Research laboratories are often justified as a result of scale economies.[2]

Other economies may result from a continuous flow of resources as a consequence of greater vertical control.[3] Designated as a "rationalization" of the production process lower costs may be the result of the elimination of plant shut downs, the elimination of unnecessary inventories, and a dampening of wide output fluctuations.[4] The importance of the last factor may rest upon the nature of the average cost curve, i.e., if it is flat over a large span of the firm's output, fluctuations may not exact a high cost. Nevertheless, the coordination of resource input and production appears to have some importance in reducing operating costs--as Wallace notes in the case of the aluminum industry.[5]

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[1]M. A. Adelman, "Integration and the Antitrust Laws," op. cit., p. 29.

[2]G. E. Hale, "Vertical Integration: Impact of the Antitrust Laws upon Combinations of Successive Stages of Production and Distribution," Columbia Law Review, XLIX (1949), pp. 950-1.

[3]Edwards, op. cit., pp. 405-6; also Maintaining Competition (New York: McGraw Hill Book Co., 1949), p. 98.

[4]Donald H. Wallace, Market Control in the Aluminum Industry (Cambridge: Harvard University Press, 1932), p. 182.

[5]Ibid., p. 174.

Firms that integrate forward into the product market may induce lower costs as a result of better distribution, more coordinated merchandising, greater quality control, etc.

In addition, Wallace cites other factors as important cost advantages accruing to integrated firms:

1. Closer and less wasteful coordination of requirements between successive stages.

2. The location of plants at points which are, for the particular industry, more favorable (because of transportation or production advantages) than the locations already used or likely to be used in the given economic conjuncture.

3. The imposition at one or more stages of a more effective scale of investment, or more efficient technique.

4. The promotion of rationalization at one or more stages.

5. The initial extension of able business management of the control of more than one stage, or the imposition of more able management than that already in control.[1]

Several observers have suggested that vertical integration possesses the virtue of permitting the firm to circumvent certain market imperfections. Spengler, for example, points out that a firm facing a monopolist supplier and confronted with monopoly prices can avoid monopoly rent by integrating backward and supplying itself.[2] The

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[1] Ibid., p. 182.

[2] Joseph J. Spengler, "Vertical Integration and Antitrust Policy," Journal of Political Economy, Vol. 58 (1950), p. 351. "For our vertically integrated producer has been enabled, through vertical integration, to evade the rent-

lower cost of production as a consequence of this circumvention will ultimately benefit the consumer in the form of lower prices. Arthur Burns cites an example of this phenomenon when farm machinery producers were able to boycott the steel and iron monopolies by providing their own steel needs.[1] However, Dirlam and Kahn have cautioned that if a firm is granted the power to remove monopoly profits, no assurance exists that the integrated firm will resist the temptation to insert monopoly profits itself.[2]

Spengler's thesis of the cost advantages attendant vertical integration extends beyond mere market imperfections, however. He asserts that an integrated firm can avoid a host of Federal and state taxes that accompany all market transactions as well as permit the firm to dodge fair trade pricing and farm supported prices.[3] These are cost advantages that the nonintegrated firm cannot avail itself of.

In short, as a source of functional efficiency, vertical integration can result in advantages if, by combining

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like 'monopolistic' surcharges being imposed by sellers situated in earlier stages of production." Also Burns, op. cit., p. 439.

[1]Burns, op. cit., p. 422.

[2]Joel B. Dirlam and Alfred E. Kahn, Fair Competition: The Law and Economics of Antitrust Policy (Ithaca: Cornell University Press, 1959), p. 148.

[3]Spengler, op. cit., p. 351.

operations, the firm finds that its costs are lower than if the operations are performed independently.

Just as the efficiency of a plant has limits imposed by diseconomies associated with size, the same diseconomics confront vertical combinations. That is, a point is reached where the cost advantages associated with vertical integration are cancelled by cost disadvantages. The first is associated with the limitations of management. As a plant includes more successive operations under its jurisdiction, it is possible that the technical optimum size may be greater or lesser than managerial optimum.[1] Thus, even with the computer, managerial efficiency has its limits and

> . . . there is no reason to suppose that all the different functions of management and of manufacture will reach their optimum size at one and the same total output of the product.[2]

There is further the problem of synchronizing various plant scales in a production chain.[3] Burns has observed:

> The most economical scale of production at some stages of production is larger than at others; the longer the chain of processes integrated the greater the probability that it will include one which will induce large-scale organization of that process and, therefore, also in the preceding and succeeding processes.[4]

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[1]E. A. G. Robinson, The Structure of Industry (Nisbet and Co., Ltd., Cambridge at the University Press, 1947), pp. 108, 112.

[2]Ibid., p. 108.

[3]George W. Stocking and Myron W. Watkins, Monopoly and Free Enterprise (New York: The Twentieth Century Fund, 1951), p. 65.

[4]Burns, op. cit., p. 432.

Thus, it becomes increasingly difficult for each stage to operate at optimum output.

Again, the diseconomies of vertical integration may tend to elicit a bias toward managerial inflexibility.

> Vertical integration may diminish the responsiveness of the firm to changes in knowledge of methods of production.[1]

In addition to the insulation effects of excessive vertical combination, a firm may be so committed to an investment inherent in a given process or product that it will resist alternative means of reducing costs.

> The vertically integrated firm is tempted to continue using the former raw material in order to secure as great a return as possible from investment in prior processes which have now become partly obsolete.[2]

In sum, vertical integration induces market efficiency if the cost advantages of combination outweight the cost disadvantages. However, there exists the problem that market size may blur the area where diseconomies supersede cost economies and this leads to the second problem--the relationship of market power to vertical integration.

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[1] Ibid., p. 432. Also, p. 42, "The integration of the manufacture of automobile parts with the assembly of automobiles, probably delayed the abandonment of the 'Model T Ford.'"

[2] Ibid. Also: Stocking and Watkins, op. cit., pp. 341-3; also Edwards, op. cit., pp. 98, 171-5. See Carl Kayser and Donald F. Turner, Anti Trust Policy--An Economic and Legal Analysis (Cambridge: Harvard University Press, 1959), p. 122. For an opposite view see: G. E. Hale, "Impact of the Antitrust Laws upon Combinations of Successive Stages of Production and Distribution," 49 Columbia Law Review (1949), p. 952.

Corwin Edwards suggests that the problem of market power arises when a firm assumes a disproportionate share of the industry's total output. Given the absolute size of the firm:

> . . . the fact that a single business unit extends over several successive levels becomes the source of special opportunities for the exercise of business power.[1]

This power or market "leverage" becomes apparent if the non-integrated firm resides in the product market or in the factor market.

The nonintegrated firm, facing high factor costs from the integrated firm's manufacturing subsidiary and confronted with low product prices imposed by the integrated firm's retail subsidiary may be subjected to low profit margins which dampened the nonintegrated firm's ability to invest and expand. The aluminum industry experienced the "double squeeze" from integrated Alcoa.[2]

Under conditions where demand increases in the product market putting pressure on the supply of factor resources, it is conceivable that under conditions of supply inelasticity, the integrated supplier will favor its own retail outlet at the expense of the nonintegrated firm. On occasion, some nonintegrated firms have been "starved" into bankruptcy.

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[1]Edwards, "Vertical Integration and the Monopoly Problem," op. cit., pp. 405-6; also Maintaining Competition, p. 98.

[2]Dirlam and Kahn, op. cit., p. 167.

A second problem of market control occurs when the nonintegrated firm resides in the factor market. The firm that operates in both retail and manufacturing market is able to enjoy the option of make or buy on the manufacturing level. Again, this option can be employed to exact price discounts (discounts not accorded nonintegrated buyers) by threatening to undertake in-house manufacturing. If the integrated firm purchases supplies in sufficient quantities, then the exercise of the make or buy option becomes an effective strategic device.

Thus, A & P, in threatening to undertake the manufacture of certain products, obtained price discounts from some of its suppliers. Adelman argues that such price concessions ultimately benefited the consumer in this particular instance.[1]

The A & P case is also illustrative of the strategic advantages associated with disproportionate combinations. The government charged that the company was subsidizing its low prices on the retail level from the high profits in the manufacturing level, and cases exist where a multi-market firm has "bought into" a market by underwriting the losses from other markets. Furthermore, Corwin Edwards observes

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[1]M. A. Adelman, "The A & P Case: A Study in Applied Economic Theory," Quarterly Journal of Economics, 1949, p. 255. "However, it may be that some of the abuses condemned by the government and the courts are not clearly an exercise of coercive bargaining power but are rather policies that vertically integrated concerns should be encouraged to follow. Should not a vertically integrated grocery store be encouraged to bargain with its suppliers for lower prices on the basis of what its own manufacturing costs would be?"

that the nonintegrated supplier may be forced to absorb industry output fluctuations.[1] As a hypothetical example, if a firm's vertical subsidiary operates at an optimum level in supplying 80 per cent of the firm's manufactured product, the remaining 20 per cent is supplemented by independent subcontractors. During a contraction in demand, the 20 per cent is cut off while the firm's own subsidiary continues to operate at optimum levels. A practice that appears common in the automobile industry, the nonintegrated supplier virtually assumes the risk of demand fluctuations.[2]

Vertical integration raises some problems of market entry. The problem arises when the existence of vertical integration prompts nonintegrated firms to integrate in self-defense. Chamberlin remarks that this phenomenon of parallel integration

> . . . erects barriers in the way of competitors securing distribution except by integrating themselves.[3]

Another apprehension leading to compulsive integration is the fear of high factor prices.

> Frequently, a potential entrant to an industry in which the major established firms are integrated

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[1]Edwards, C. "Vertical Integration and the Monopoly Problem," op. cit., p. 408.

[2]Donald A. Moore, The Automobile Industry in the Structure of American Industry, Walter Adams, ed. (New York: Macmillan, 1954), p. 298. The automobile practice was called "tapered vertical integration."

[3]Edward H. Chamberlin, The Theory of Monopolistic Competition (Cambridge: Harvard University Press, 1958), p. 123.

> through several production stages will find that if it enters in nonintegrated status for production in some later stages it will have to purchase materials from established integrated firms and thus perhaps pay premium material prices.[1]

Together, the potential of high factor prices and the possibility of inadequate access to resources prompt the entering firm to match integration for integration (witness the aluminum industry). The result is that in the presence of vertical integration variable costs to the firm are converted into fixed costs.[2] This, in turn, raises the capital requirements for entry into the industry, as well as increases the scale of plant necessitated by the greater fixed investment. Chamberlin asserts that parallel integration promotes duplication of plant and equipment, leading to undercapacity and possible redundant plant. But the crucial impact of parallel integration is its effect on potential competition. As Kaysen and Turner summarized:

> In general, entry into a vertically integrated industry is more difficult than would be entry into one of its component horizontal stages, at least by the amount of the extra capital cost.[3]

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[1]Joe S. Bain, Barriers to New Competition (Cambridge: Harvard University Press, 1962), p. 145.

[2]Carl Kaysen and Donald F. Turner, Anti Trust Policy--An Economic and Legal Analysis (Cambridge: Harvard University Press, 1959), p. 121.

[3]Ibid., p. 120. See: Bain, op. cit., p. 145; also: E. A. G. Robinson, Monopoly, p. 64, "but quite obviously, the larger the capital requirement, and the larger the addition of output in relation to the existing output of the industry the less likely is any competitor to think it profitable to attempt to force his way into the industry and the more enduring is the quasi-monopoly likely to be." Robert Bork, "Vertical Integration and the Sherman Act: The

Finally, what policy suggestions have been advanced in dealing with the market control aspects of vertical integration? Much of the answer to this question is dependent upon what is regarded as the source of market power. Spengler and others have suggested that vertical integration per se is not at fault.[1] The real cause exists in horizontal concentration and to this problem all policy considerations should be directed.

Others insist that disproportionate market power associated with vertical integration should be subject to divestiture action if such action is consistent with market efficiencies.[2]

Still others advocated a market performance criteria

Legal History of an Economic Misconception," 22 University of Chicago Law Review, pp. 195-6. Thus, monopoly power depends upon the percentage of the market occupied by the firm, and the ease of entry into that market. Vertical integration does not increase the percentage of the market controlled by a firm. It should be equally apparent that such integration does not impede entry into a market.

[1]Spengler, op. cit., p. 352. "It follows that vertical integration if unaccompanied by a competition-suppressing amount of horizontal integration and if conducive to cost and price reductions, should be looked upon with favor by a court interested in lower prices and a better allocation of resources." Further, if restraint of trade exists, ". . . it is the horizontal elements that need be singled out for remedial treatment." See also: E. A. G. Robinson, The Structure of Competitive Industry, pp. 132-3; and Erich Schneider, "Real Economies of Integration and Large-scale Production Versus Advantages of Domination" in Monopoly and Competition and Their Regulations, Edward H. Chamberlain, editor, p. 212. Also: G. E. Hale, op. cit., p. 952.

[2]Walter Adams, "Public Policy in a Free Enterprise Economy," Structure of American Industry (New York: Macmillan Co., 1961), p. 557. Also: Edwards, "Vertical Integration and the Monopoly Problem," p. 407.

in evaluating vertical combinations in a case by case basis.[1]

In its concern with competitive entry, this study will attempt to evaluate the relevance of the Spengler thesis against the existence of vertical integration in the communication equipment industry.

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[1]Adelman, op. cit., p. 49. "What we need, therefore, is a painstaking examination of the economic facts of the individual case."

CHAPTER II

THE PROBLEM

Given this brief survey of the literature on vertical integration, the discussion will now concentrate on the first of the three broad issues cited in Chapter I, namely, what is the nature of the market entry problem.

It is the thesis of this study that market entry in the communications hardware industry assumes three levels. Its technological level takes the form of competing alternative means of conveying information, metallic circuits vs. radio or microwave circuits. Its market level assumes the form of nonintegrated suppliers seeking entry into a market previously regarded as the province of captive suppliers of common carriers, i.e., integrated equipment suppliers. Finally, while somewhat oversimplified, it is fair to observe that the integrated firms tend to represent a vested interest in metallic circuits, while the nonintegrated firms tend to represent a vested interest in microwave radio relay. In short, the integrated equipment firms are being challenged by nonintegrated firms who, in the main, represent a competitive technical alternative to the conventional means and equipment used in rendering communication services.

We turn first to the domestic market, to be followed by the international market.

The problem of entry in the domestic equipment market will include first, a survey of conventional communication technology and its attendant market structure; second, a survey of new communication technology and its market structure; and finally, the problem of market entry as a consequence of competing technologies.

Domestic Market

Conventional Technology

The raw material in the transmission of intelligence, be it record, voice, or data, is the electromagnetic signal. Information is relayed by a process of pressing an intelligence signal on a carrier signal and removing it at its destination--a process known as modulation and demodulation. Each signal, depending upon the information carried, exhibits the property of oscillating so many cycles per second. The number of oscillations or range of frequencies required by a specific signal is known as bandwidth, and the bands of frequencies required vary from small to increasingly large requirements as illustrated in Table 1. For example, the band of frequencies required to convey one television signal is equivalent to 600 telephone voice signals or channels. In general, the amount of information carried by a signal is proportional to its frequency of oscillation.

TABLE I

BAND WIDTHS REQUIRED FOR VARIOUS RADIO-COMMUNICATION SERVICES

Kind of Service	Typical Band Widths, cps
Keyed telegraphy--manual (25 wds/min)	0-100
Frequency shift telegraphy	0-1,800
Tone-modulated telegraphy (25 wds/min, 1,000 cps tone)	0-2,100
Telephony, commercial (ssb)	0-3,000
Facsimile, 8 x 10 in., 100 lines/in. transmitted with 1,000 cps tone	0-4,000
Telephony, commercial (DSB)	0-6,000
Telephony, high quality SSB	0-5,000
FM Facsimile, 8 x 10 in. pix, transmitted with 1,000 cps tone	0-14,000
Telephony, exceptionally high quality SSB	0-20,000
Telephony, frequency modulated	0-36,000
Telephone broadcasting, FM, high quality	0-200,000
Television, commercial (525 lines, 30 frames/sec)	30-4,350,000
High-definition television (1,029 lines, 30 frames/sec)	30-16,650,000

Source: The Electronic Spectrum, Electronic Industries, Chilton Company, 1962, Philadelphia; also Philco, Lansdale Division, Lansdale, Pennsylvania.

Frequencies are usually measured as either kilocycles or megacycles. A kilocycle is a thousand oscillations or cycles per second, a megacycle is equivalent to a 1000 kilocycles.

The communications industry is erected upon the property of electromagnetic signals. Sending equipment or station equipment converts sound waves into electric impulses, the impulses carried via metallic circuits, the electromagnetic signal is then reconverted to sound waves by receiving

apparatus. The signal could be a voice message (telephone) or a record message (telegraph). In either case, subscribers are interconnected to each other by central exchanges known as switchboards and the whole complex laced together with wires and cables.

Reference to technology as conventional by no means minimizes the complexity of a modern communications network, but rather the description is directed to the traditional medium through which intelligence is transmitted in the domestic market, namely, metallic circuits.

Originating as open copper wires, lines were strung on glass insulators mounted on pole-crossarms. As the state of the art progressed and as an interference known as crosstalk was diagnosed and solved, wires were strung closer together in the form of cables, enabling the transmission of more messages. The epitome of the metallic circuit was the coaxial cable developed by the Bell Telephone Company. The capacity of the coaxial cable permitted the rendition of signals of wide bandwidth, such as frequency modulation radio (FM) and television, as well as hundreds of telephone channels (not simultaneous with video, however.

The technique of multiplexing and the development of carrier systems expanded the capacity of metallic circuits. Carrier systems, by generating a wider frequency band, expanded and permitted simultaneous relaying of voice messages, in some cases doubling capacity of cables.

Figure 1 illustrates the adaptation of carrier systems to open wire conductors, conductors in paired and quadded cable, and coaxial cable.

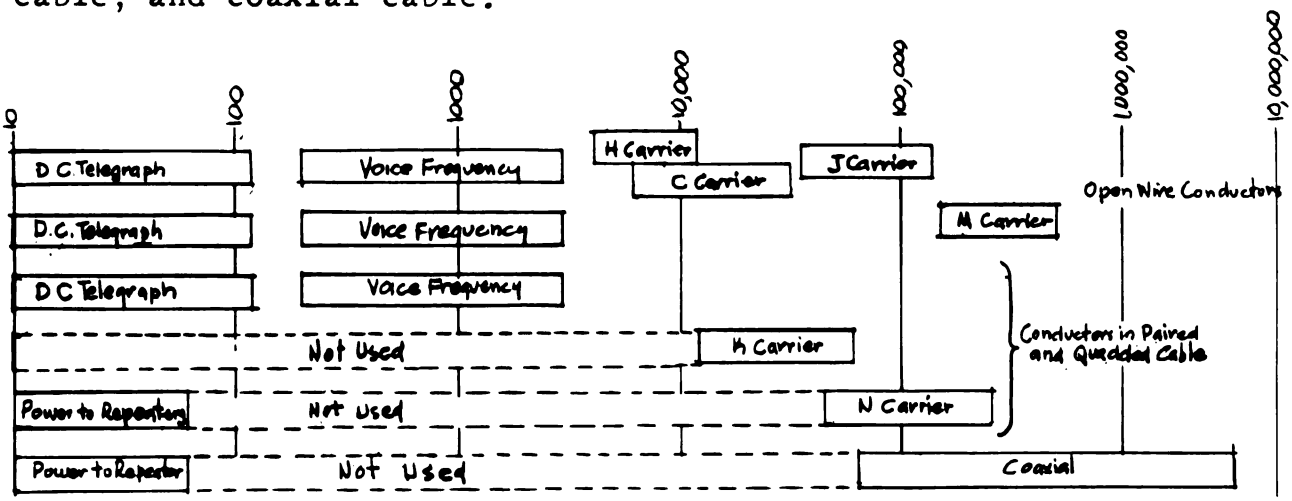

Figure 1. The frequency bands used in the Bell System's wire communication system.
Source: Charles Mapes, "Carrier is King," Bell Telephone Magazine, XXVIII:4 (Winter, 1949-50), p. 198.

Firms engaged in rendering domestic communication services are known as common carriers. Subject to regulation under the Communication Act of 1934, these public utilities are granted licenses to engage in the rendition of interstate communication service. A certificate of convenience and necessity represents a monopoly grant by the government to the common carrier, and in return for this grant, the tariffs, service, and profits are under

surveillance by the FCC. The carriers must grant service to all consumers and are assured of reasonable rates of return.

Message record service is provided by Western Union and message voice service rendered by some 3,000 plus telephone companies. However, in both markets, record and voice, the American Telephone and Telegraph Company is of central influence. Hence, the Bell System will be described in closer detail.

The organizational structure of the Bell System is depicted in Figure 2.

Supporting the Bell System are twenty-two operating subsidiaries. Nineteen operating companies are almost wholly owned by the parent firm, American Telephone and Telegraph Company, and two subsidiaries partially or substantially owned. The operating companies are divided into regional territories or states and provide local exchange telephone service. Long distance service is provided by the Long Lines Department of AT&T, whose lines and facilities interconnect each of the operating companies. Table 2 and Figure 3 depict the Bell Telephone associated companies and the territories in which service is conducted.

In addition to the Long Lines Department, AT&T's General Department performs much of the administrative work of the whole system by financing the operating companies, supplying them construction funds, and providing cash for day-to-day operations. The operating companies are granted licenses under Bell patents to render service in their

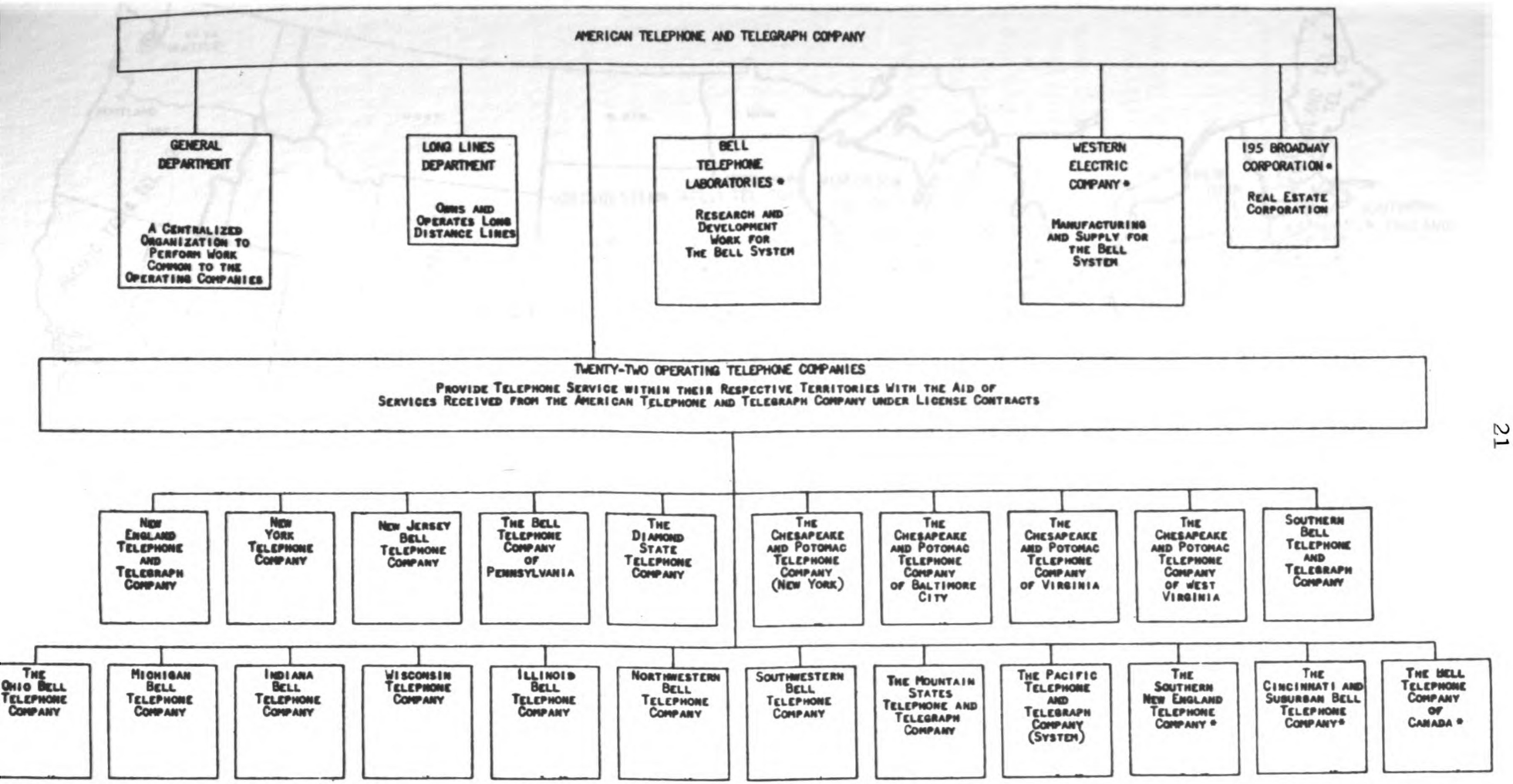

Figure 2. The Bell Telephone system.
Source: Report on Preliminary Survey and Investigation of Western Electric Company, Inc. Prepared by members of the Joint Subcommittee of State Commissions and Federal Communications Commission reporting to NARUC-FCC Staff Committee on Telephone Regulatory Problems, New York, N. Y., July 15, 1948, p. 11 (cited as NARUC-FCC 1948 Study).

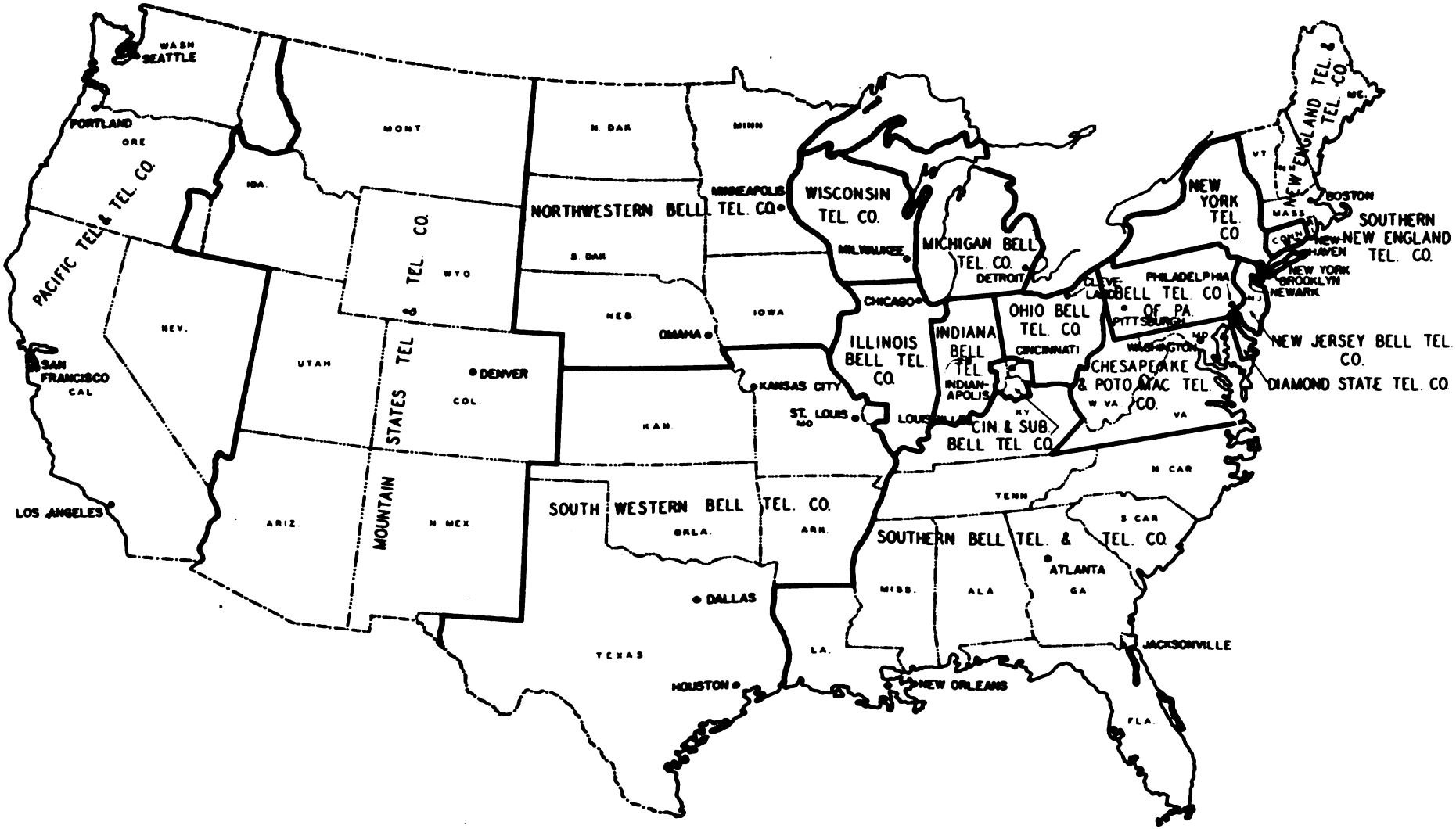

Figure 3. Territorial divisions of the Bell System and location of Western Electric distributing houses.
Source: NARUC-FCC, 1948 Study, p. 21.

TABLE 2

AMERICAN TELEPHONE AND TELEGRAPH COMPANY INVESTMENTS IN SUBSIDIARIES AND IN OTHER COMPANIES
December 31, 1960

PRINCIPAL TELEPHONE SUBSIDIARIES	Capital Stocks owned by AT&T Co.		Advances from AT&T Co.
	Per cent owned	Cost (thous. of $)	(thous. of $)
New England Tel.&Tel. Co.	69.33	$310,641	$84,000
New York Tel. Co.	100.00	1,424,280	--
New Jersey Bell Tel. Co.	100.00	523,667	18,400
Bell Tel. Co. of Pa.	100.00	666,316	15,500
Diamond State Tel. Co.	100.00	41,700	4,175
Chesapeake & Potomac Tel. Co.	100.00	101,000	22,200
Chesapeake & Potomac Tel. Co. of Md.	100.00	226,468	28,800
Chesapeake & Potomac Tel. Co. of Va.	100.00	250,000	28,000
Chesapeake & Potomac Tel. Co. of West Va.	100.00	97,000	7,700
Southern Bell Tel. & Tel. Co.	100.00	1,266,817	29,000
Ohio Bell Tel. Co.	100.00	532,042	17,500
Michigan Bell Tel. Co.	99.00	409,399	18,000
Indiana Bell Tel. Co., Inc.	100.00	206,587	6,200
Wisconsin Tel. Co.	100.00	218,224	5,900
Illinois Bell Tel. Co.	99.32	671,422	39,000
Northwestern Bell Tel. Co.	100.00	411,040	17,900
Southwestern Bell Tel. Co.	99.99	1,243,243	25,000
Mountain States Tel. & Tel. Co.	86.75	439,195	18,200
Pacific Tel. & Tel. Co.	89.62	1,402,360	134,000
Total		$10,441,301	$519,475
OTHER SUBSIDIARIES			
Bell Telephone Laboratories	50.00	$27,500	--
Western Electric Co., Inc.	99.82	739,361	--
195 Broadway Corporation	100.00	26,015	$4,600
Other	--	31,068	3,650
Total		$823,944	$8,250
OTHER COMPANIES			
Southern New England Tel.	19.06	$36,990	$4,600
Cincinati & Suburban Bell Tel. Co.	29.83	21,065	8,100
Bell Tel. Co. of Canada	3.51	18,855	--
Miscellaneous Investments	--	28,304	--
Total		$105,214	$12,700

Source: AT&T Annual Report, 1960, p. 21.

respective areas; in return, AT&T receives stock dividends and a 1 per cent management assessment on the subsidiaries' gross revenue.

Western Electric, the manufacturing and supply arm of the system, is owned wholly by AT&T. In addition, Western Electric and AT&T each own 50 per cent of the stock in Bell Telephone Laboratories, Inc, the non-profit research facility of the system. The Bell Laboratory conducts fundamental research and determines equipment specifications of telephone apparatus. It bills both Western Electric and AT&T, depending on the ratio of work performed for each. Finally, the 195 Broadway Corporation performs the real estate functions in New York. Figure 2, then, depicts what has become known as the Bell System. In a sense, the System exhibits trilevel vertical integration in that Bell Laboratories designs communication equipment and apparatus; Western Electric manufactures the equipment; and the operating companies purchase the equipment in order to render service to the end user, the consumer. Overseeing these activities stands AT&T. Its Long Lines Department functions as operator of the long distance facilities, and its General Department functions as a holding company--controlling the stock and operations of the Bell subsidiary companies, Bell Laboratory and Western Electric.

Although no written contract exists between Western Electric and the Bell operating companies, the fact that each is subject to common ownership means that the Bell

subsidiaries purchase practically all of their equipment from Western Electric. Western Electric, in turn, procures some 35 per cent of its equipment means from outside suppliers.[1]

Total operating revenues for the communication industry are shown in Table 3. Figure 4 includes the revenue breakdown between Western Union, the independent telephone companies, as well as the Bell System. The preeminence of Bell's 8 billion dollar receipts is amplified by the fact that the 2 billion dollar receipts of the independents is shared by some 3,000 separate independent companies.

The market for communication services can be separated into the public message market and the private line market. The former includes service rendered to the general consumer including voice and record service. The latter includes equipment and channel leased to private business for specific purposes and exclusive connections.

Table 3 contrasts the percentage share of local message and toll exchange service rendered by the Bell System and the independents. The Bell System accounts for some 85 per cent of local exchange service and 98 per cent of toll exchange (long distance) service.

While Bell's predominance in telephone message service is generally recognized, perhaps less well known are the market shares in the public message record field--the Telegraph and Teletypewriter Exchange Service (TWX). Figure 5 illustrates this market with about a 50-50 split between Western Union and Bell's TWX service.

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[1]Letter from AT&T to author, May 6, 1963

TABLE 3

BELL SYSTEM OPERATING REVENUES

Bell System
Operating Revenues (before Uncollectibles)
(In Thousands)

Year	Local Service	Toll Service	Miscellaneous	Total
1951	$2,146,439	$1,342,914	$159,605	$3,648,958
1952	2,397,552	1,470,267	182,900	4,050,719
1953	2,642,905	1,571,088	214,956	4,428,949
1954	2,836,958	1,720,742	241,677	4,799,377
1955	3,086,455	1,959,667	264,967	5,311,089
1956	3,368,608	2,176,241	297,243	5,842,092
1957	3,647,596	2,357,650	331,375	6,336,621
1958	3,944,443	2,490,649	360,590	6,795,682
1959	4,250,778	2,786,144	381,033	7,417,955
1960	4,547,409	2,996,436	414,280	7,958,125
1961	4,797,528	3,217,300	440,101	8,454,929

Reporting Companies of U. S. Independent Telephone Association
Operating Revenues (before Uncollectibles)
(In Thousands)

Year	Local Service	Toll Service	Miscellaneous	Total
1957	$411,704	$198,618	$26,626	$636,948
1958	459,906	217,470	30,336	707,712
1959	519,394	254,147	31,855	805,396
1960	585,004	289,400	36,398	910,802
1961	640,202	320,193	39,370	999,765

Source: FCC letter to author, January 23, 1963.

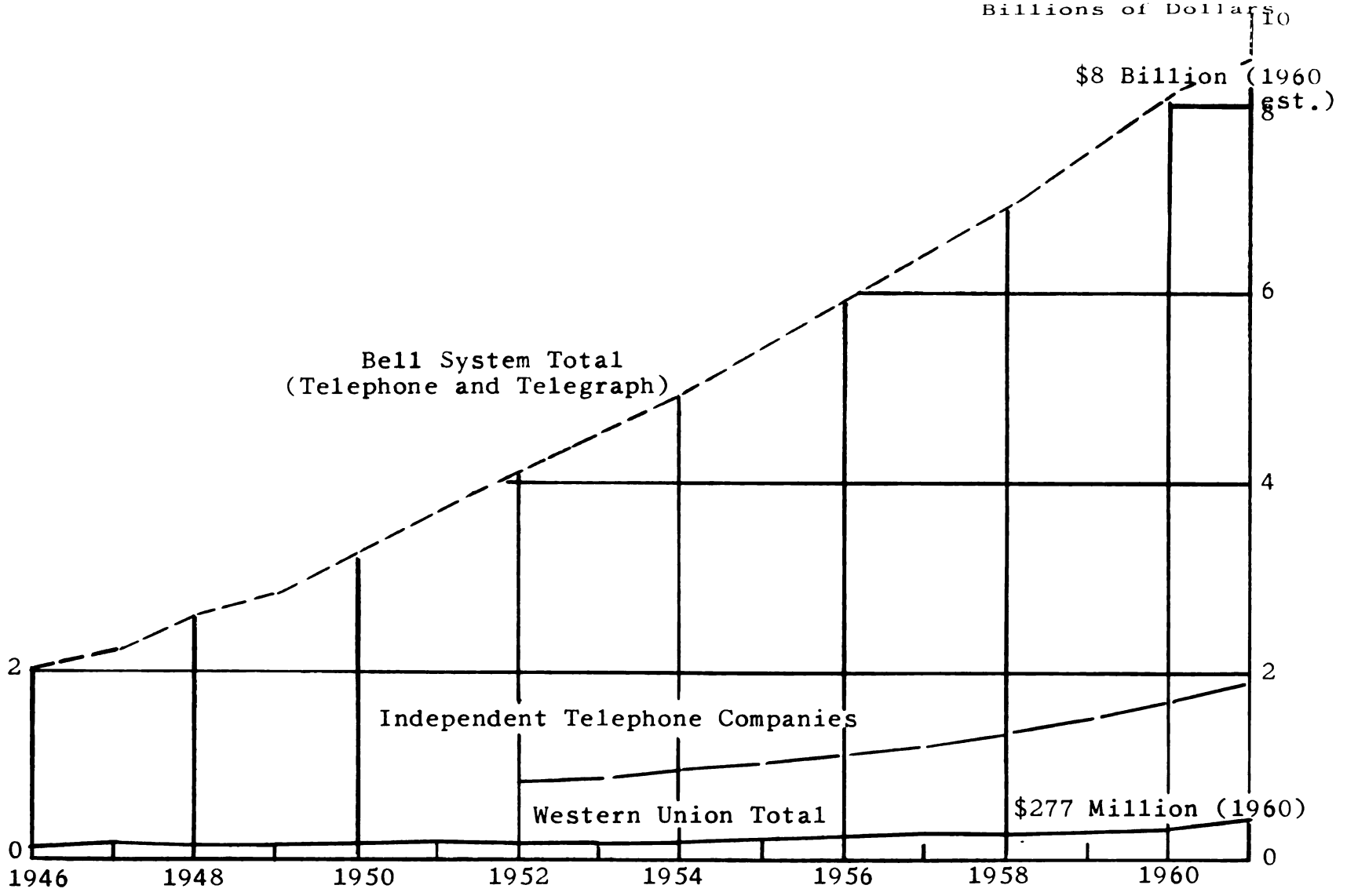

Figure 4. Total Revenues Western Union-Bell System-Independents.
Source: A review of Western Union today as summarized before the FCC on March 9, 1961, by President Walter P. Marshall, Attachment 8; also 1962 Annual Statistical Volume, United States Independent Telephone Association by Courtney Snyder.

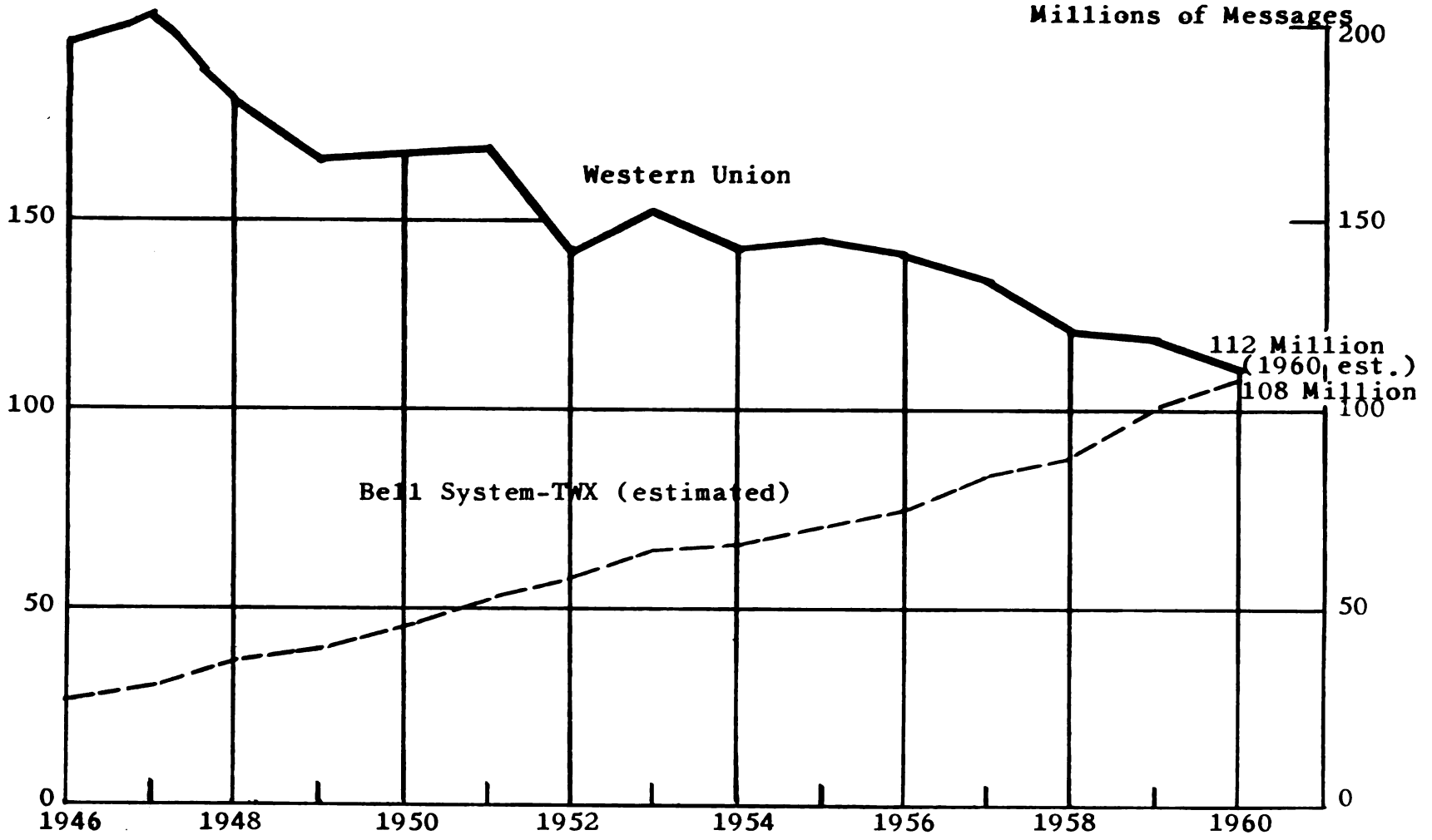

Figure 5. Domestic public telegraph message services, Western Union-Bell System. Source: A Review of Western Union Today, op. cit.

As opposed to the public message market, the private line market varies in importance to the Bell System and Western Union--accounting for some 2 per cent of Bell's total revenues, but 20 per cent of Western Union's total revenues.[1] As noted earlier, circuits in this market are leased to business firms, at a flat monthly fee, for rendering service to specific points. The services include the following:

a. Telephone service consists of furnishing channels terminating at customer locations in telephone instruments or PBX (private branch exchange) board furnished by telephone companies. The service is furnished by the Bell System companies and their connecting carriers.

b. Telegraph service consists of furnishing both channels and station equipment, or the channels only with the customer providing his own station equipment. This service includes what is termed teletypewriter service by AT&T and teleprinter service by Western Union.

c. Telephotograph (facsimile) service consists of telephone grade channels specially adapted for transmission of picture material. AT&T furnishes the channels only and the customer provides the station equipment. In Western Union's service, station equipment may be furnished either by the customer or the carrier.

d. Data transmission service consists of telephone and telegraph grade channels for the transmission of signals generated by customer-provided data processing equipment.

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[1]Initial Decision, adopted July 6, 1961. Before the Federal Communications Commission, in the matter of American Telephone and Telegraph Company charges, classification, regulations, and practices for and in connection with Private Line Services and Channels, Docket No. 11645. In the matter of the Western Union Telegraph Company changes, classifications, regulations and practices for and in connection with Domestic Leased Facility Service, Docket No. 11646. (Hereafter cited as the Private Line Docket.)

e. Remote metering, supervisory control and miscellaneous signaling services. Telephone and telegraph grade channels are furnished for such purposes as indicating readings of customers' meters at distant locations and remote control of customer-provided switches and signals.

f. Multiple channel service consists of certain groupings of telephone grade channels and of telegraph grade channels for charging purposes. A customer leasing a requisite amount of such service is afforded a discount increasing with the quantum of channels between designated points.

g. Government extension service consists of the furnishing of facilities to customers for interconnection with a private line telephone, telegraph or telephotograph service furnished to an agency of the United States Government for the collection and dissemination of information relating to matters of public interest such as weather conditions and aircraft flight information. The facilities furnished such customers by the carriers are channels with or without station equipment, subject to the variations described above.[1]

Total revenues (Figure 6) are shared between AT&T and Western Union with Bell accounting for nearly all private line telephone (recently Western Union was permitted to render private line voice). Private line telegraphy is split between Bell and Western Union in a 2:1 ratio (Table 4 and Figure 7).

Recently, one-third of the private line market[2] has been further segregated into the bulk communications market (Figure 8). Equivalent to about 1 per cent of the Bell

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[1] Ibid., p. 60.

[2] Before the Federal Communications Commission in the matter of American Telephone and Telegraph Company Regulations and charges for Telpak services and channels (Docket No. 14251, testimony of Curtiss M. Bushnell, Motorola Exhibit No. 13, p. 7 (herein cited as the Telpak Docket)).

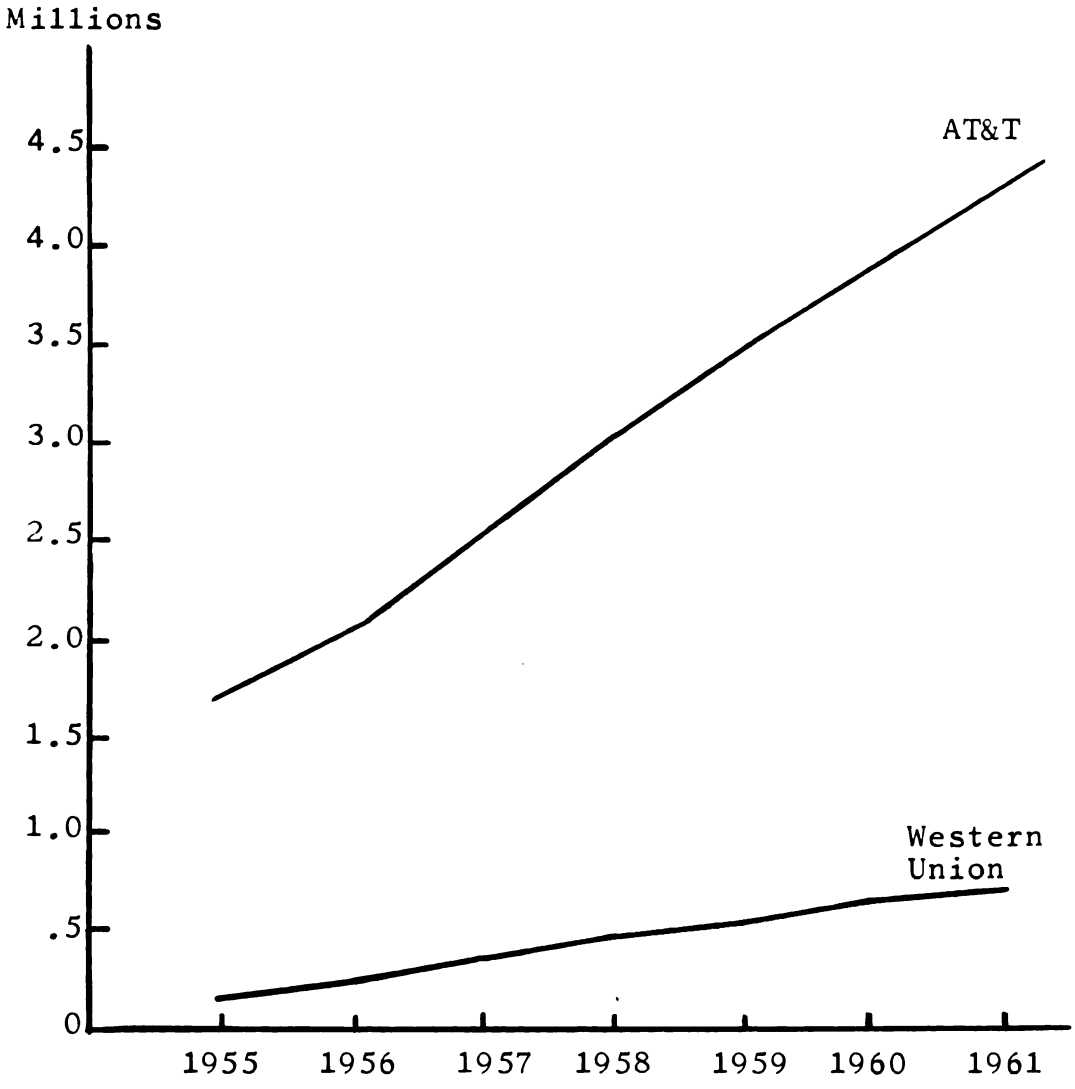


Figure 6. Total private line market--AT&T and Western Union.
Source: FCC letter to author, January 23, 1963.

TABLE 4

PRIVATE LINE SERVICE REVENUES
AT&T and Western Union
(In Thousands)

	Revenues			
	Private Line Telegraph		AT&T Private Line	
Year	W.U.	AT&T	Telephone	Program and Other
1951	$15,202	$35,920	$43,526	$30,228
1952	17,679	40,254	52,801	35,802
1953	19,924	44,034	60,581	41,138
1954	22,347	48,138	63,388	55,030
1955	26,486	54,664	82,576	58,558
1956	31,700	65,154	101,822	63,170
1957	36,131	76,627	119,906	65,951
1958	40,757	84,651	141,031	70,315
1959	51,423	107,389	170,185	75,656
1960	56,578	116,479	201,225	86,158
1961	61,140	121,071	210,591	93,364
1962	56,444[a]	115,617[b]	186,934[b]	95,583[b]
		TELPAK Service not included above:		
1961		$17,315		
1962		58,459[b]		

[a] 11 months estimated
[b] 11 months actual

Source: FCC letter to author, January 23, 1963.

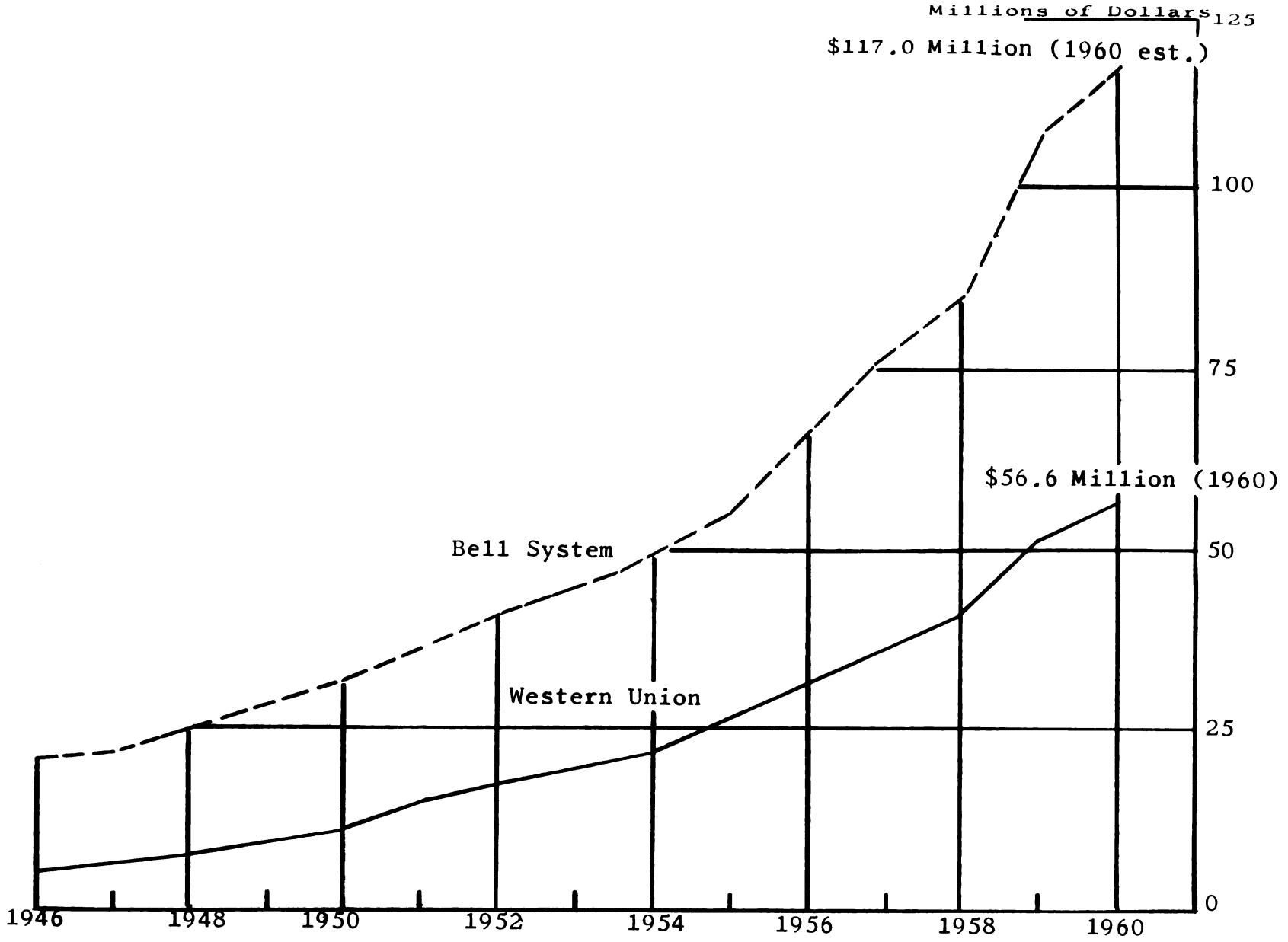
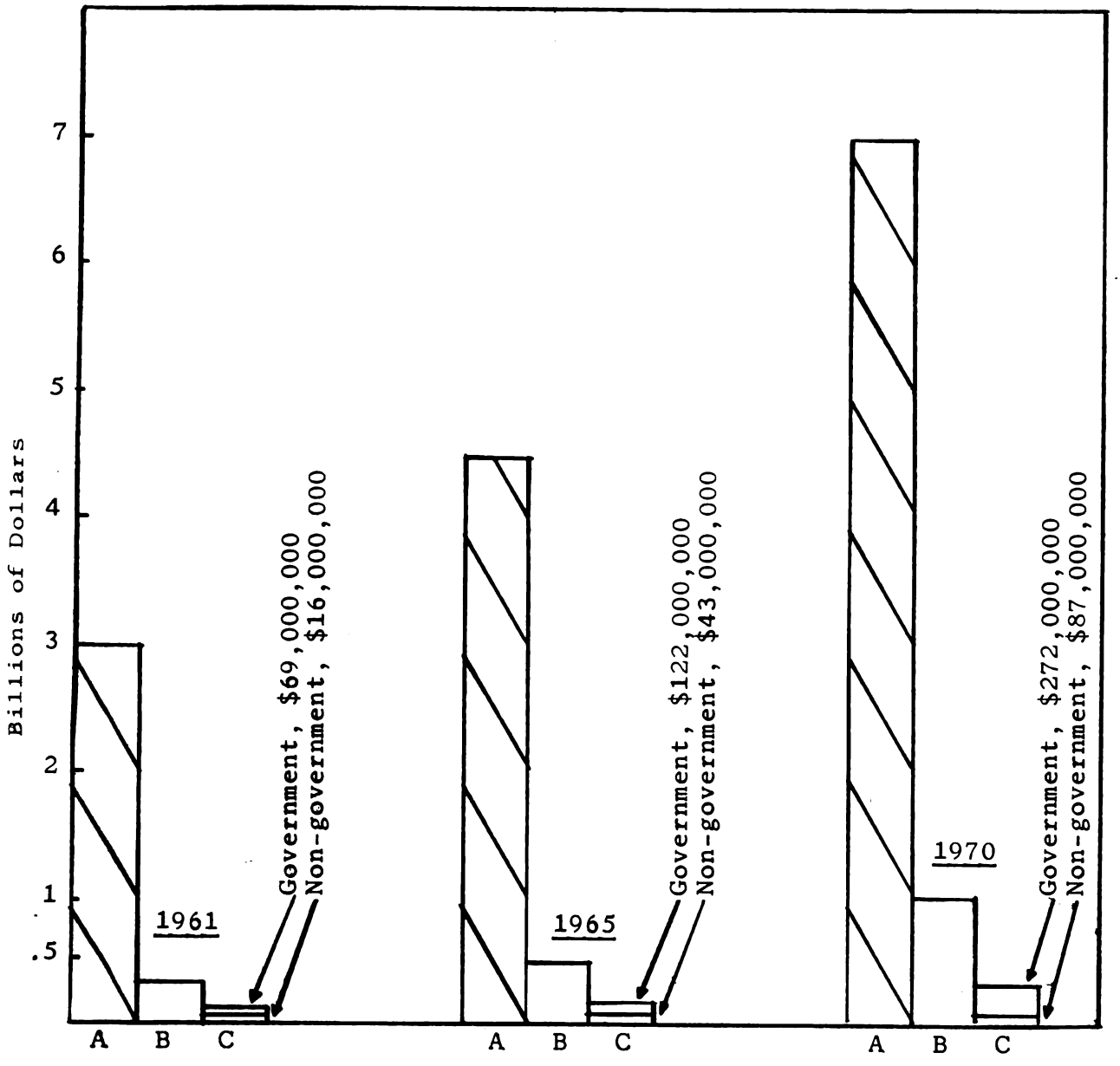


Figure 7. Domestic Telegraph private wire revenues, Western Union-Bell System. Source: A review of Western Union today as summarized before the FCC commissioners on March 9, 1961, by President W. P. Marshall.



A Bell System's total toll business
B Bell System's toll private line business
C Total bulk communications market

Figure 8. Relationship of bulk communications market to Bell System's toll business.
Source: Telpak hearings, proposed findings and conclusions of Motorola, Inc., p. 67.

System's total operating revenue, this market is generated by the growth of automatic data processing techniques (hence the need for broadband channels) and the trend toward business decentralization of operations while centralizing administrative locations. The bulk market has been defined by Bell as those users whose demand exceeds six voice channels--a market consisting of government agencies and very large firms (Western Union estimates that 55 per cent of its revenue comes from 5 per cent of its customers).[1] As opposed to an 8 per cent growth rate in public message service, the private line market is growing at 20 per cent. Table 5 projects the growth of this market relative to Bell System's total toll business and toll private line business; the dollar and channel equivalents are shown in Table 6.

TABLE 5

DEMAND COMPONENTS OF BULK COMMUNICATION MARKET

	Millions of Dollars Annually	
	Calendar Years	
	1965	1970
Total Government	$128	$192
Transportation Industries	11	34
Other Industries	26	46
Total	$165	$272

[1]Western Union Presentation, op. cit., p. 44.

TABLE 6

CHANNEL REVENUE PROJECTIONS OF BULK COMMUNICATION MARKET

	Millions of Dollars Annually	
	Calendar Years	
	1965	1970
6-12 voice channels or equivalent	$80	$123
13-24 voice channels or equivalent	28	47
25-60 voice channels or equivalent	21	37
61-240 voice channels or equivalent	36	65
Total	$165	$272

Source: Telpak Hearings, testimony of John F. Magee, Bell System, Exhibit No. 1, p. 5.

Reference to Table 4, column 4, captioned "Program and others" reveals Bell's revenues from transmitting video and AM programs through its facilities. Of the total broadcast and video transmission channels furnished, Bell supplies some 93,660 channel miles, whereas, the independents account for some 150 channel miles.[1] Thus, AT&T's position in the public message voice, public message record, the private line market, its rendition of program channels is attested by the following statistics; the Bell System accounts for 85 per cent of local exchange service, 98 per cent of long distance facilities, 50 per cent of message record service, about 70 per cent of the private line

[1]FCC letter to author, September 17, 1962.

telegraph field, almost 100 per cent of private line telephone and intercity program channels, and approximately 85 per cent of the total private line market.

The communication equipment market includes an array of equipment ranging from telephone sets to cable terminals.

Some indication of the magnitude of the market is recorded in Table 7, showing sales from 1953 to 1962.

TABLE 7

U. S. COMMUNICATION EQUIPMENT SALES

Year	Total sales (billion dollars, constant 1958)	GNP (billion dollars, constant 1958)	Population (millions)
1953	1.77	$408.7	$159.64
1954	1.78	402.1	162.42
1955	2.16	434.9	165.27
1956	2.70	443.6	168.17
1957	2.73	452.0	171.23
1958	2.48	441.7	174.17
1959	2.65	475.1	177.14
1960	2.93	487.8	180.13
1961 est.	3.20	--	--
1962 est.	3.33	--	--

Source: United States Department of Commerce, Communication Industries Division, Business and Defense Services Administration, December 21, 1961.

The Bell System's manufacturing subsidiary, Western Electric, is the central factor in the equipment market accounting for 73 per cent of all telephone apparatus and equipment, insulating wire and cable in the country in 1954, and some 60 per cent in 1961.[1] In relative terms Western

[1]Private Line Docket, Initial Decision, op. cit., p. 37.

Electric ranks sixteenth in size among all U. S. corporations, and in terms of sales, ranks ninth.[1]

Over a period of twenty-five years, Western Electric's sales to the Bell companies have amounted to 95 per cent of its total sales. Necessarily, this has meant that Western Electric's share of the total equipment has averaged around 90 per cent. Some concept of Western's historical market predominance is revealed in the annual sales for an eight-year period beginning in 1926 (Table 8).

TABLE 8

AVERAGE ANNUAL SALES OF TELEPHONE APPARATUS AND EQUIPMENT AND PERCENTAGES OF TOTAL, WESTERN ELECTRIC COMPANY AND FIVE LEADING INDEPENDENT PRODUCERS, 1926-1934

Company	Average Annual Sales	Per Cent of Total
Western Electric	$115,079,000	87.6
Automatic Electric	8,637,898	6.6
Kellogg Switchboard and Supply	4,471,670	3.4
Stromberg-Carlson	2,626,498	2.0
North Electric	443,536	.3
Leich Electric	173,920	.1

Source: John B. Sheahan, "Competition vs. Regulation as a Policy Aim for the Telephone Equipment Industry." Unpublished Ph.D. thesis, Harvard University, August 1951, p. 55.

[1]H. R. Bickett and T. W. Spicer, "Indirect Regulation of Western Electric" (notes from which informal talk was given December 20, 1962, to Amherst group, American Telephone and Telegraph Company), p. 1.

Over 90 per cent of the Bell System's communication apparatus and equipment is secured from Western Electric. This investment in plant and equipment influences the cost of telephone service since as one component in the rate base the Bell operating companies are entitled to earn a reasonable rate of return. In 1957, for example, about 50 to 60 per cent of Bell's gross investment in telephone plant[1] (18 billion) was Western Electric equipment. Remaining investment includes property (buildings and land), installation costs, and local supply purchases.

Figure 9 outlines the corporate structure of Western Electric. The Teletype Corporation manufacturers and sells printing telegraph equipment, not only to Bell System companies, but also to Western Union. Some indication as to the investments of Western Electric is depicted in Table 9. Table 10 outlines the breakdown of Western's customers, and Table 11 her income. Figure 10 depicts the general distribution of Western's output over time. Most of the government contracts involve defense work.

The domestic equipment market also includes the subsidiaries of the General Telephone and Electronic Company (Sylvania, Automatic Electric, etc.). On a smaller scale, the General System represents a market structure integrating manufacturing units with the operating companies.

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[1]Private Line Docket, op. cit., p. 37.

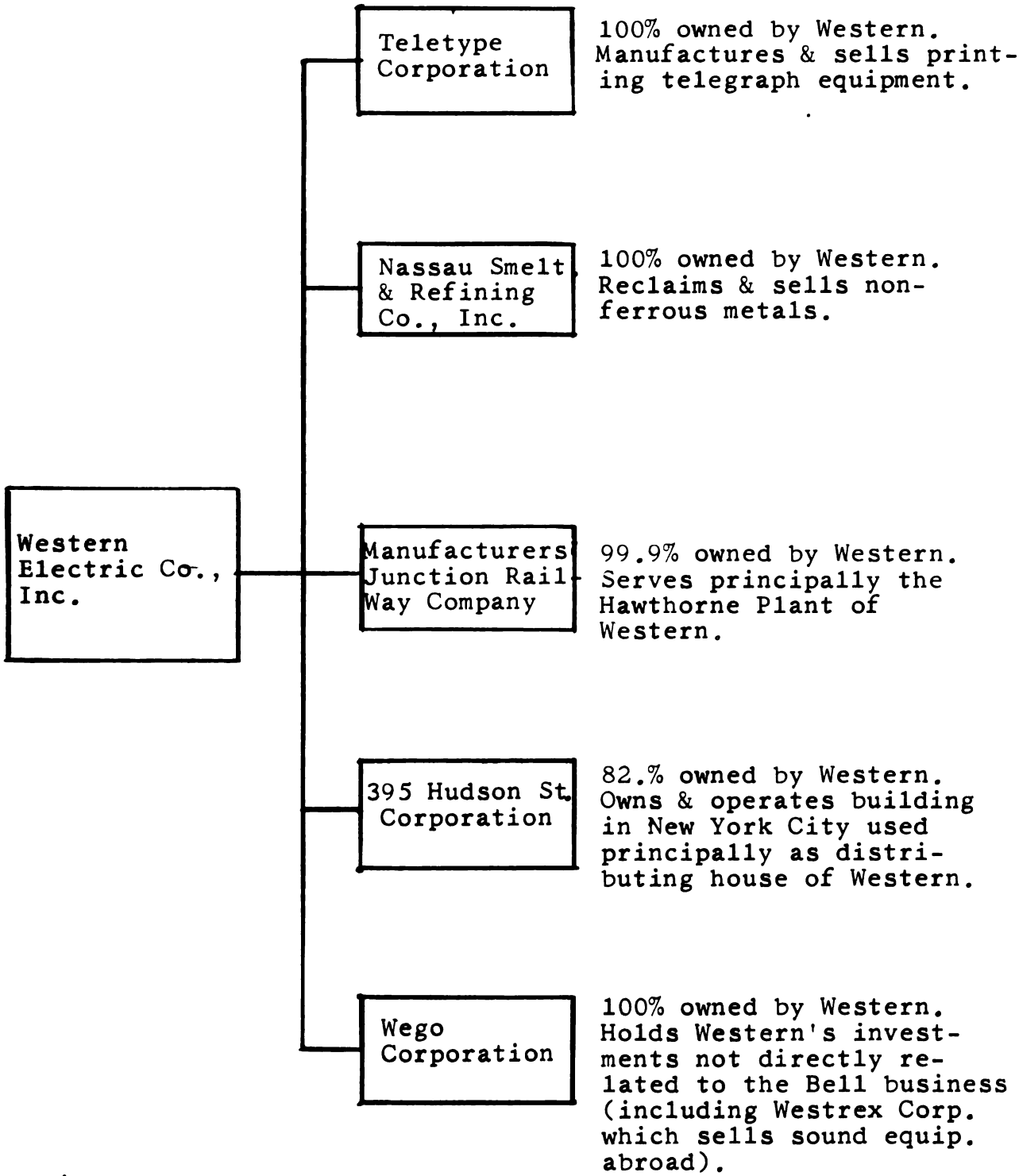

Figure 9. Western Electric Co., Inc. and principal subsidiaries.
Source: NARUC-FCC 1948 Study, p. 13.

TABLE 9

WESTERN ELECTRIC COMPANY, INC. INVESTMENTS
As at December 31, 1960 and 1961
(Dollars in Thousands)

	December 31, 1961	December 31, 1960
Subsidiary Companies at Equity Value		
Teletype Corporation (100% owned)		
Capital stock (No par value - 1,350,000 shares)	$50,500	$45,000
Revaluation	428	6,316
Reserve for intercompany items	(6,556)	(6,439)
Total	44,372	44,877
Nassau Smelting and Refining Company, Inc. (100% owned)		
Capital stock (No par value - 75,000 shares)	3,419	3,419
Demand loans	0	1,150
Revaluation	1,652	1,515
Reserve for intercompany items	(159)	(418)
Total	4,912	5,666
Manufacturers' Junction Railway Company (99.9% owned)		
Capital stock ($100 par value - 3,795 shares)	404	404
Revaluation	93	96
Reserve for intercompany items	(271)	(271)
Total	226	229
Western Electric Company, Ltd. (London) (100% owned)		
Capital stock (£ 1 par value - 100 shares)	-	-
Advances	35	35
Revaluation	12	10
Total	47	45

TABLE 9 (continued)

	December 31, 1961	December 31, 1960
Sandia Corporation (100% owned)		
Capital stock (No par value - 100 shares)	1	1
Western Electric Company, Ltd. (Canada) (100% owned)		
Capital stock (C$100 par value - 100 shares)	10	10
Advances	29	29
Revaluation	(39)	(39)
Total	0	0
Total Subsidiary Companies	49,558	50,818
Bell Telephone Laboratories, Inc. (50% owned) (A)		
Capital stock ($100 Par - 275,000 shares)	$27,500	$27,500
Demand loans	13,600	4,300
	41,100	31,800
Other Investments at or Below Cost		
Realty investments	8,033	7,401
Miscellaneous investments	1,751	1,876
Total	9,784	9,277
Grand total	$100,442	$91,895

Parenthesis denote reductions

(A) Balance owned by American Telephone and Telegraph Company

Source: NARUC-FCC, 1962, p. 19.

TABLE 10

WESTERN ELECTRIC COMPANY, INC. SALES
Years 1960 and 1961
(Dollars in Thousands)

	1961	1960
By Customer Classes		
Bell Telephone Companies	$1,916,805	$1,850,248
Non-Bell customers:		
United States Government	608,950	702,669
Subsidiary and associated companies	12,001	7,560
Graybar Electric Company, Inc.	17,018	17,399
Other customers	8,365	19,539
Total non-Bell customers	646,334	747,167
Grand Total	2,573,139	2,597,415
By Product Classes		
Apparatus and equipment:		
Switchboards	1,023,312	929,706
Station apparatus	160,045	148,144
Protection and outside plant	56,762	58,935
Repairs and services	112,930	102,648
Non-telephone products	580,936	683,375
Total apparatus and equipment	1,933,985	1,922,808
Cable and wire:		
Exchange and toll cable	176,079	219,980
Rubber covered wire	27,519	31,391
Total cable and wire	203,598	251,371
Supplies	425,556	423,236
Grand total	$2,563,139	$2,597,415

Source: NARUC-FCC, 1962, p. 20.

TABLE 11

DIVISION OF OTHER INCOME BETWEEN BELL AND NON-BELL BUSINESS
Years 1960 and 1961

	(Dollars in Thousands) Gross	Expenses incl. Federal Income Taxes	Total	Bell	Non-Bell
		1961			
Income from Subsidiaries:[a]					
Teletype Corporation	$9,519	$453	$9,066	$5,192	$3,874
Nassau Smelting & Refining Co.	720	54	666	491	175
Manufacturers' Junction Ry. Co.	92	2	90	72	18
Western Electric Co. Ltd.(London)	3		3		3
Total	10,334	509	9,825	5,755	4,070
Royalties, Compensation and License Fees	5,134	5,134[b]			
Dividends, Interest & Other	553	129	424	14	410
	$16,021[c]	$5,772	$10,249	$5,769	$4,480
		1960			
Income from Subsidiaries:[a]					
Teletype Corporation	$9,176	$461	$8,715	$5,030	$3,685
Nassau Smelting & Refining Co.	196	12	184	(86)	270
Manufacturers' Junction Ry. Co.	25	3	22	19	3
Western Electric Co.Ltd.(London)	3		3		3
Total	9,400	476	8,924	4,963	3,961
Royalties, Compensation and Licence Fees	4,442	4,442[b]			
Dividends, Interest & Other	609	160	449	19	430
	$14,451[c]	$5,078	$9,373	$4,982	$4,391

[a] Includes effect of change in reserve for intercompany profits; [b] includes amount by which telephone products development and related engineering expense is reduced for the excess of royalties, copensation and license fees receipts over applicable other expenses; [c] excludes $1,240 in 1961 and $2,018 in 1960 representing principally income from temporary cash investments, which is included in results from operations. (Parentheses denote reductions.)
Source: NARUC-FCC, 1962, p. 21.

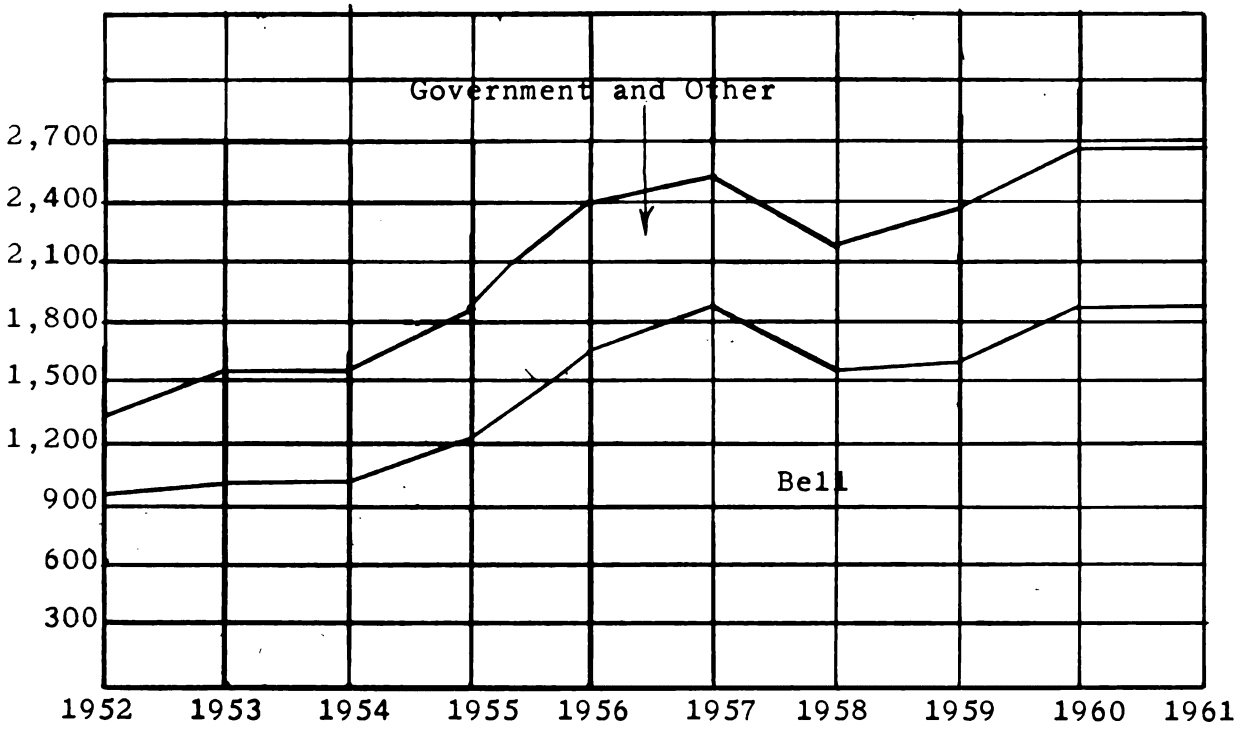

Figure 10. Western Electric sales (in millions of dollars). Source: Western Electric 1961 Annual Report, p. 5.

The non-affiliated or non-integrated equipment firms supply the independent telephone market. The latter market, however, has been declining proportionately since 1920 from 15,000 to 3,000 companies,[1] particularly under the impetus of mergers. General Telephone, in particular, has grown largely by merger, thus providing a market for its manufacturing

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[1]U. S. Congress, Senate, Space Satellite Communications, Hearings before the Subcommittee on Monopoly of the Select Committee on Small Business, 87th Congress, 1st Session, 1961, p. 318 (hereafter cited as Senate Small Business Hearings).

subsidiary[1] (60 per cent of General's revenues come from its manufacturing activities). Together, the Bell System and GT&E account for 92 per cent of the U. S. telephone operating companies.[2]

A general summation of the communications industry reveals that the Bell System is paramount, both in the rendering of communication services and in the supplying of communication equipment. More important is the salient feature of vertical integration--a market pattern that assures Western Electric of virtually a captive market for its goods and services. The Bell operating companies as monopsonists, and Western Electric as monopolist approximates the bilateral monopoly model in economic theory.

Furthermore, competition in both service market and equipment market is further diluted by Western Union's dependence upon Bell's circuits. In the early 1950's, for example, Western Union leased some 70 per cent of its circuits from the Bell System[3]--a situation in which Western Union is attempting to alleviate. Furthermore, as noted earlier, Western Union's teleprinter equipment is supplied to no small

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[1]Ibid., p. 171. Statement by General Telephone and Electronic Corporation.

[2]Senate Small Business Hearings, testimony of North Electric Company, op. cit., p. 318.

[3]"Electronics Puts Young Blood in Old Company," Business Week (August 27, 1960), p. 90.

extent by Western Electric's teletype subsidiary.[1]

New Technology

The preceding discussion of both product (communication services) and factor (communication equipment) markets rests upon the assumption of conventional technology. That is, the industry owes much of its origin and subsequent growth to the metallic circuits of wire and cable. We have seen that this technology requires poles, rights-of-way, certificates of convenience and necessity and, as a public utilities, are subject to regulation by both federal and state commissions. We turn now to radio circuits as opposed to metallic circuits, and will examine the nature of this new technology and the market structure associated with it.

As a carrier signal, radio waves exist as an alternative media to metallic circuits in the transmission of intelligence. The physical properties of various radio signals are determined by their position in what physicists label the electromagnetic spectrum. First postulated by Maxwell and verified by Hertz, the electromagnetic spectrum is a continuum of signals possessing the common property of similar velocity--the velocity of light (Figure 11).

The continuum ranges signals from very low to increasingly higher frequencies, or alternately from long wave lengths to increasingly shorter wave lengths.

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[1]Richard Elliott, Jr., "A New Era in Data Communication is Opening Up," Barrons, XLI:16 (April 17, 1961), p. 21.

Figure 11. Radiation spectrum.
Source: Dulany Territt, U. S. Army in World War II, The Technical Service, The Signal Corps: The Emergency (to December 1941), Office of Military History, Department of the Army, Washington, D.C., 1956, p. 7.

The spectrum is divided into the radio spectrum and the quantum or molecular and atomic radiation spectrum. The latter includes infrared rays, light rays, ultraviolet, x-rays, gamma rays, and cosmic rays. The radio spectrum is bound on the bottom level by oscillations of less than 30 kilocycles per second (very low frequencies) to frequencies oscillating as high as 3,000 megacycles. The spectrum is ranged and classified into bands classified below as to frequency range and wave length (Table 12).

At any given point in time, the spectrum utilization is limited by equipment that transmits and receives the radio signals. Thus, the state of the art imposes a limit to the availability of the spectrum, and since the demand for spectrum use generally exceeds its availability, the spectrum is a scarce resource subject to rationing and allocation.

Radio signals are classified as ground waves, sky waves, and direct waves. Ground waves include the frequency bands from UF (less than 30 Kc/s) to medium frequencies (MF, 300 Kc/s). The ground wave exhibits the property of following the curvature of the earth. Long distance transmission via this signal is rather expensive because of the power needed to generate the signal. The sky wave includes the high frequencies (HF) to very high frequencies (VHF). The sky wave travels in straight lines, but is reflected from a ceiling of ionized particles 300 miles above the atmosphere, called the ionosphere. High frequency use of the sky wave

TABLE 12

RADIO FREQUENCY CLASSIFICATION

Frequency Classification		Frequency Range		
Abbreviation	Name	Kilocycles per second	Megacycles per second	Wavelength (in meters and centimeters)
VLF	Very low frequency	Less than 30	--	Over 10,000 m.
LF	Low frequency	30-300	--	10,000-1,000 m
MF	Medium frequency	300-3,000	.3-3.0	1,000-100 m.
HF	High frequency	--	3-30	100-10 m.
VHF	Very high frequency	--	30-300	10-1 m.
UHF	Ultra high frequency	--	300-3,000	1 m. (100 cm)
SHF	Super high frequency	--	3,000-30,000	10-1 cm.
EHF	Extremely high frequency	--	30,000-300,000	1-0.1 cm.

Source: "Radio--Nature of Radio Communication," The Encyclopedia Americana, Vol. XXIII (Americana Corporation, 1961), p. 121a.

permits long distance radio communication since the signals are transmitted by ricocheting between the earth and the ionosphere. Beginning at the UHF band and continuing to the top of the radio spectrum at EHF is the direct wave. As higher frequencies are generated and as the position on the electromagnetic spectrum approaches light, the radio waves of very short wavelength (microwaves) assume quasi optical properties, that is, they tend to travel in straight lines.

Figure 12 illustrates the optical qualities of microwave signals. The figure is an anterior view of a typical microwave antennae shaped as a paraboloid. The waves are reflected, focused, and beamed to adjacent towers.

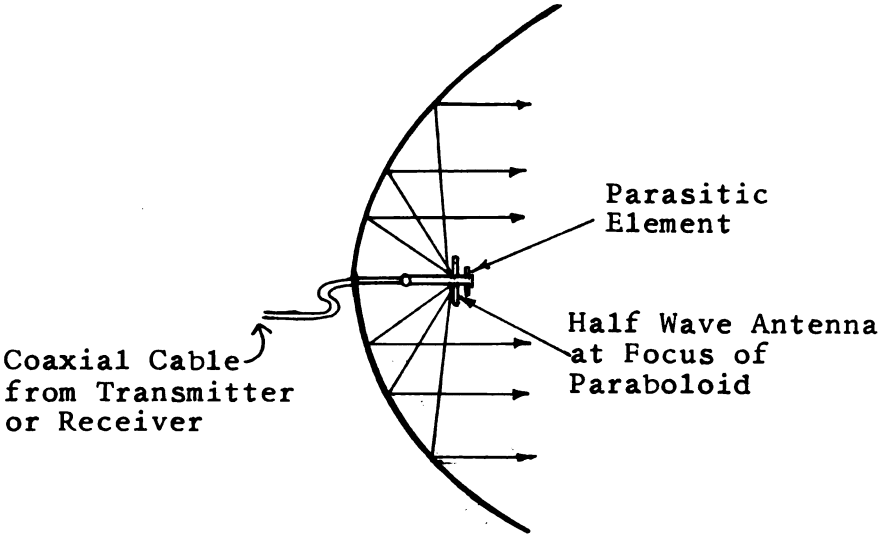

Figure 12. Anterior view of a microwave antenna. Source: Andrew R. Boone, "The Army's Radio Relay Equipment," Radio News, 35:1 (January, 1946), p. 152.

Distinguished from the sky wave by the property of traveling in straight lines and penetrating the ionosphere, the microwave or direct wave is relayed by constructing a series of towers in tandem spaced at intervals of twenty to thirty miles apart within line-of-sight of each other. In this manner the signal is caught by repeater stations before it leaves the earth and is redirected to another repeater station. Thus, the signal is received and "bent" around the earth's curvature, permitting long distance terrestrial communication (Figure 13).

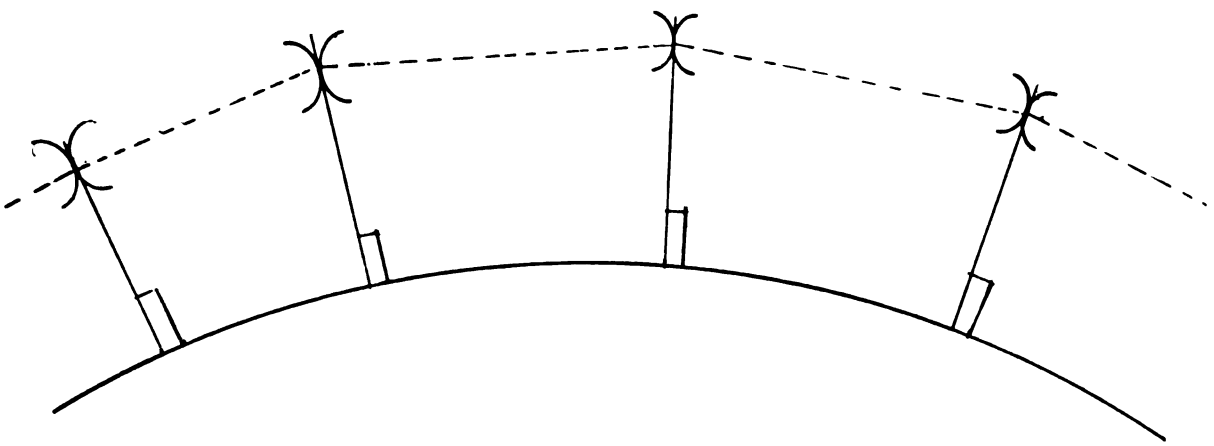

Figure 13. Terrestrial microwave link.
Source: Adapted from "A Report in the First Relay Communications Satellite," NASA Facts (January 14, 1963), p. 3.

Microwave confers advantages not available in metallic circuits. First, it possesses greater channel capacity. As higher frequencies are generated, the spectrum size needed to convey a voice signal becomes a smaller percentage of

total spectrum available; hence, more channels can be sent over one microwave beam. In this sense, microwave has been described as a wide-band multi-channel signal.

A microwave beam can simultaneously transmit voice channels, channels for data, telegraph, as well as the wide band frequencies of television (Figure 14).

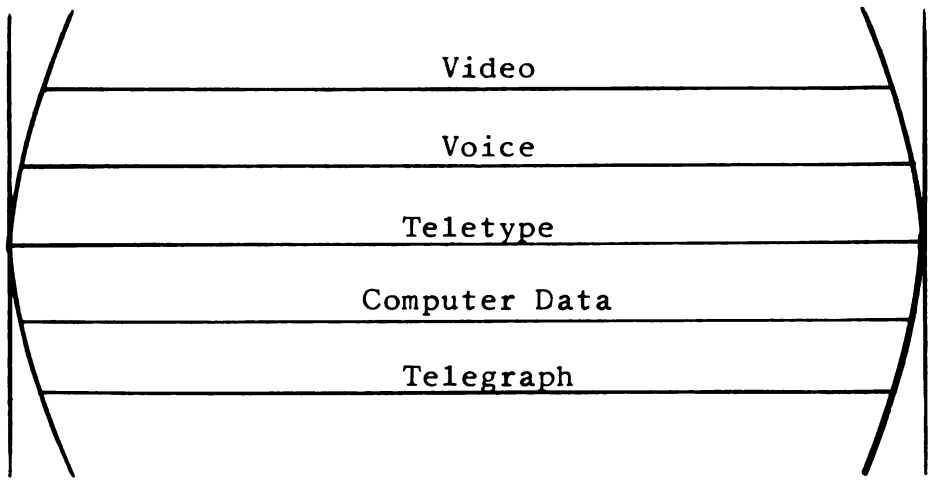

Figure 14. Multiple channel capacity of a microwave signal. Source: Adapted from Telpak Hearings, FCC, Docket No. 14251, Bell System Exhibit No. 3, Attachment E, p. 36.

Certain cost advantages are associated with radio relay as opposed to metallic circuits. In addition to its existing capacity, a microwave system can increase its capacity by additional equipment at each relay station. Increased channel capacity in metallic circuits is more expensive since additional wires must be strung.

The spacing of microwave towers eliminates wire, poles, and right-of-way, and the concommitant maintenance costs

thereof. Since towers are less susceptible to acts of nature, microwave systems tend to be a more reliable means of conveying voice and record data. The blow-up of a typical microwave repeater station and its components is shown in Figure 15.

At the receiving station the information signal (telephone, telegraph, video, etc.) is impressed (modulated) on the microwave carrier signal. The signal is transmitted to an adjacent station and demodulated. The dotted line connecting the transmitting and receiving equipment is usually a wave guide--a tube that directs the signal flow to the antenna. Multiplex equipment derives from the wide spectrum of frequency lesser channels used in conveying voice or record messages. As in metallic circuits, carrier equipment permits the simultaneous transmission of many channels. The capacity of the system is increased by the addition of more radio equipment and emergency equipment is useful in case of a power failure.

The versatility of microwave systems is evidenced by the variety of signals it can handle. The Electronics Industry Association has classified the functional types of signals as the following (Table 13):

The size and potential of the microwave communication equipment market varies as to the source of data. The Small Business Administration in one survey included land mobile radio equipment--a component which tends to inflate the natural market size. Nevertheless, some indication

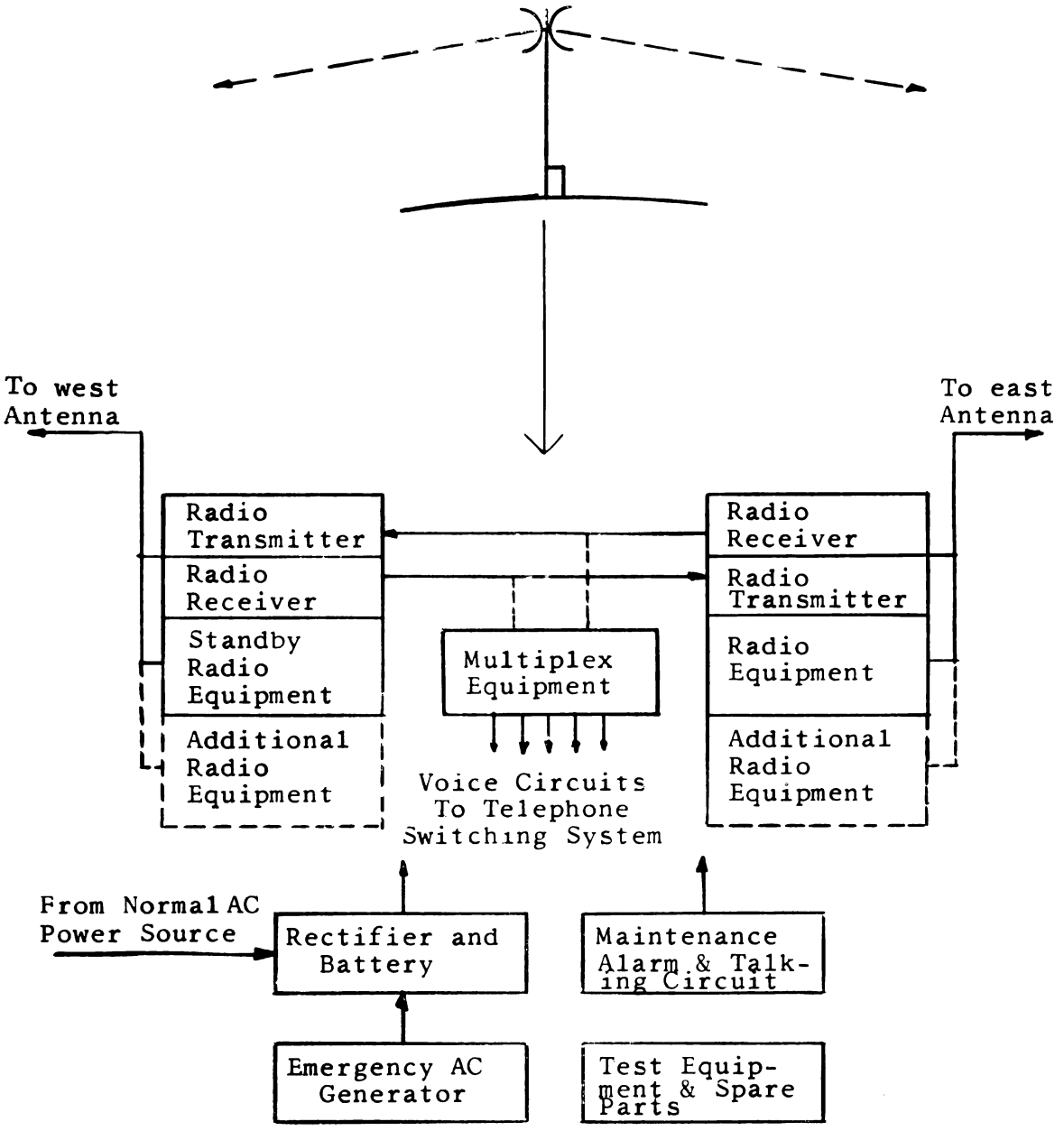

Figure 15. Components of a microwave repeater station. Source: H. E. Weppler, "The Use of Microwave Radio for Telecommunications," Communications, Science Technology and Development, United States Papers, prepared for the United Nations Conference on the Application of Science and Technology for the benefit of the Less Developed Areas, p. 108.

TABLE 13

CLASSIFICATION OF FUNCTIONAL TYPES OF SIGNALS

Functional Description	*Band-width	Comments
TELETYPE for printed or memorized pulsed type intelligence	.05	Only high speed teletype requires more than the .05 bandwidth which is normal for most equipment today.
TELEMETERING for remote instrumentation	.05	Pulse type telemetering can time space multiple functions within this small band space.
SUPERVISORY CONTROL for performing remote operations	.05	Same as Comment 2.
DATA PROCESS for transmitting pulsed type computer intelligence	.05-1	Normal intelligence transferred similar to teletype but some high speed circuits require full voice channel bandwidth.
PROTECTIVE RELAYING for electric power transmission line protection	.05-1	Speed of relaying operation will determine bandwidth requirement.
VOICE COMMUNICATION	1	This is the basic channel bandwidth.
REMOTE VHF	1	Essentially same as Comment 6, usually patched between systems at audio.
FACSIMILE for remote reproduction of pictoral displays	1-4	Depends on speed. Most popular requirement today is for narrow band equipment.
REMOTE RADAR	1-150	Depends on definition and number frames per second.

TABLE 13 (continued)

Functional Description	*Bandwidth	Comments
REMOTE ITV	1-300	Same as Comment 9.

*Bandwidth is expressed in equivalent voice channel multiplex band spacing as normally used today on typical point-to-point radio systems (4KC).

Source: Before the Federal Communications Commission, in the matter of allocation of frequencies in the bands above 890 mc, Electronics Industries Association, p. 6.

TABLE 14

THE MARKET FOR COMMUNICATION EQUIPMENT
1954-1965
(Millions of Dollars)

	1954	1955	1956	1957	1958	1959	1960
Land Mobile Radio Broadcast Equipment Microwave Communication Equipment	$90	$95	$120	$150	$155	$175	$190
Aviation/Marine Communication and Navigation Equipment	--	--	100	130	140	175	200
Commercial Sound Equipment	--	--	110	135	140	150	160
Total	$250	$270	$330	$415	$435	$500	$550

Source: "A Study of Small Business in the Electronics Industry," Small Business Administration, Washington, 25, D. C., p. 32.

of market growth is revealed in their study.

Recently Motorola estimated that the 1961 industrial and commercial microwave market approached some 60 million dollars.[1]

Given the wide range of market estimates, the equipment suppliers include both common carrier subsidiaries as well as the non-integrated equipment firms. Some estimates suggest that Western Electric accounts for some 60 per cent of all equipment[2] manufactured and sold, with some eight to ten firms sharing the remaining 40 per cent.

A rough tabulation of the market distribution of these nonintegrated manufacturers is shown in Table 15.

An indirect assessment of non-common carrier subsidiaries is revealed in the private microwave license applications and the construction permit applications of the FCC (Table 16). Another stab at assessing market shares was made by the Small Business Administration. They concluded that, excluding the common carriers' manufacturing subsidiaries of AT&T and GT&E, 75 per cent of the microwave equipment was manufactured by Motorola, Collins, RCA, and General Electric.[3]

The market demand for microwave communication systems include common carrier and non-common carrier segments--with

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[1] "Microwave Market Research," Military and Electronics, Inc., Motorola, 1962, p. 3.

[2] Ibid., p. 8.

[3] Small Business Administration, op. cit., p. 33.

TABLE 15

APPROXIMATION OF SALES VOLUME IN MICROWAVE POINT-TO-POINT COMMUNICATIONS SYSTEMS OF LEADING MANUFACTURERS

Company	Market	1960 Volume
Budelman Corp. (C)	(P)	$300,000 - $500,000
Collins	(P)	est. $2,000,000
General Electric	(P)	est. $2,000,000
Int. Tel. & Tel. (P)	(T)	$4,000,000
Lenkurt Electric	(P)	est. $6,000,000
Motorola	(P)	$6-8,000,000
Radio Corp. of America (P)	(T)	$10,000,000

Market Symbols:

P - Private sales
C - Common carrier sales
T - Total world sales

Source: C. A. Tyson, et al., "Microwave Communications: Commercial Possibilities in the 60's," Micron Association, 1961.

TABLE 16

SUMMARY OF PRIVATE MICROWAVE INFORMATION BASED ON CONSTRUCTION PERMIT APPLICATIONS

	As of 12-31-55	As of 9-30-60
Transmitters	1,846	4,525
Transmitter miles	44,678.2	105,176.1
Companies applying for construction permits	117	236
Transmitters by Manufacturer:		
Collins	84	317
Federal	309	358
General Electric	186	638
Motorola	680	1,771
Philco	15	39
RCA	337	897
Westinghouse	128	323
All other, including combinations	107	182
Total	1,846	4,525

Source: Telpak Hearings, FCC Docket No. 14251, Bell System Exhibit No. 10, Attachment B, p. 7.

the former existing as the dominant share. The Bell System uses heavy duty microwave systems (600 voice channels plus), such as TD-2 and TH, in the rendition of video and long distance telephone service. In fact, some 60 per cent of today's video programs are relayed through the air, and 40 per cent of the toll exchange channels are relayed via microwave link.[1] The Bell operating companies adhere to the

[1]H. E. Weppler, "The Use of Microwave Radio for Telecommunications Communications," Space Technology and Development, United States papers prepared for the United Nations Conference on the application of Science and Technology for the Benefit of the Less Developed Areas, Vol. 12, p. 106.

policy of procuring the bulk of their equipment needs from Western Electric.

The nonintegrated equipment firms are dependent upon two markets. First, they sell equipment to the common carriers--including the Western Union Company, the independent telephone companies, and the Bell operating companies. Western Electric purchases some 35 per cent of its radio telephone equipment from outside suppliers.[1] That the latter provides the predominant market outlet is attested by a breakdown of Motorola's microwave equipment sales to the telephone industry. Of a total of 246 stations, the Bell System accounts for almost 50 per cent of Motorola's total.

A second market for microwave equipment takes the form of private microwave systems. This market includes the Federal government, public safety organizations, and the general group of right-of-way companies, such as railroad, pipeline companies, and power utilities.

An indication of the demand components of this market is revealed in the number of FCC license applications depicted in Table 18.

What is the future potential market for private microwave? The answer to this question is becoming increasingly uncertain. One market projection, established by Motorola, indicates an annual growth rate of 13 per cent (Table 19).

On the basis of a new frequency eligibility policy of the FCC permitting liberalized licensing for commercial use of private microwave systems, the Electronic Industries

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[1]Letter from AT&T to author, May 3, 1963.

TABLE 17

MOTOROLA CUSTOMERS

Company Name	No. of Stations
American Telephone & Telegraph Company	60
Bell Telephone Company of Nevada	6
Cameron Telephone Company	5
Central California Telephone Company	2
Chesapeake and Potomac Telephone Company	18
Citizens Utilities Company	5
Commonwealth Telephone Company	2
General Telephone of Florida	2
Greenwood Telephone Company	4
Inter-County Telephone and Telegraph Company	10
Kern Mutual Telephone	2
La Fourche Telephone Company	4
Leelanau Telephone Company	1
Linn County Telephone Company	3
Mansfield Telephone Company	2
Michigan Bell Telephone Company	1
Midland Telephone Company	5
Mountain States Telephone and Telegraph Company	23
New York Telephone Company	7
North Carolina Telephone Company	2
Northern Ohio Telephone Company	7
Northwest Bell Telephone Company	15
Ohio Bell Telephone Company	2
Pacific Power and Light Company	2
Pacific Telephone and Telegraph Company	2
Pennsylvania Bell Telephone Company	4
Pioneer Telephone Cooperative	3
Rochester Telephone Corporation	4
Sierra Telephone Company	2
Southern Bell Telephone Company	4
Southwestern Bell Telephone Company	2
Telephone Services Incorporated	9
Texas Telephone and Telegraph Company	5
West Coast Telephone Company	2
Western Carolina Telephone Company	5
Western Telephone Company	10
Bell System Companies	126

Source: Motorola Microwave equipment sales to the telephone industry, Motorola, 1961.

TABLE 18

FCC MICROWAVE LICENSE APPLICATIONS

Transmitters by Services	As of 12-31-55	As of 9-30-60
Aeronautical	5	38
Business	0	0
Forestry conservation	0	6
Forest products	0	10
Highway Maintenance	2	16
Local government	39	242
Manufacturers	0	0
Marine	0	0
Motor carrier	0	5
Petroleum	766	1,813
Police	34	346
Power	272	1,354
Public safety	6	44
Railroads	8	88
Special industrial	12	27
Not classified	1	1
Total	1,145	3,990

Source: Telpak Docket, Bell System Exhibit No. 10, Attachment B, p. 9.

TABLE 19

MICROWAVE EQUIPMENT MARKETS, 1961 - 1971

	Millions of Dollars 1961	1971	Growth Rate per Year (per cent)
Military Radar Systems	800	1100	3.5
Military Communications & Navigation	300	450	4.0
Military Countermeasure	150	300	7.0
Industrial & Commercial Communications	60	200	13.0
Nonmilitary Radar	50	150	11.5
Test Equipment	75	300	15.0
Miscellaneous:			
Military	50	200	15.0
Nonmilitary	15	100	21.0
	1500	2800	6.5

Source: Microwave Market Research, Military and Electronics, Inc., Motorola, 1962, p. 8.

Association (EIA) projected demand in the following table:

TABLE 20

NUMBER OF MICROWAVE STATIONS

Year	Present Eligibility High	Low	Avg.	Expanded Eligibility High	Low	Avg.
1966	9,800	3,600	7,600	12,000	6,000	10,000
1976	15,000	600	12,000	21,000	11,000	18,000

Source: The Above 890 Docket, Electronic Industries Association.

As we shall see, these projections are highly speculative since they do not take into account such market variables as the pricing policy of the American Telephone and Telegraph System.

However, the impact of microwave technology is not as striking in the public message market as it is in the private line market. It will be recalled that in this latter market, the common carriers lease their circuits for private commerical use. Now private microwave has introduced a new element in this market. Translating the virtues of greater capacity, lower cost, greater reliability, and less maintenance, plus the ability to handle simultaneously record and voice signals, private microwave systems have conferred to the end-user of bulk communication an additional option. In addition to exercising the alternative of leasing his communication needs from the common carriers, the end-user may elect

to own his own radio relay system. It is the exercise of this latter option that has provided the entre for the non-integrated supplier vis-a-vis Western Electric. Thus, if the end-user elects to lease his needs from the Bell System, then Western Electric "wins"; if the consumer chooses private microwave, then the nonintegrated manufacturer "wins."

Figure 16 contrasts the options confronting the consumer and illustrates the relevance of this additional choice of owning to the problem of market entry.

The additional choice granted the consumer because of microwave technology, enables the nonintegrated supplier to circumvent the integrated complex of the Bell System. As such, it creates a provocative set of market relationships. The nonintegrated supplier now competes directly with the Bell operating companies who lease service in their private line markets. And since Western Electric manufactures and supplies the system's equipment, the nonintegrated manufacturer competes indirectly with AT&T's manufacturing subsidiary. Yet, there remains a second market for the non-integrated supplier reminiscent of the independent equipment suppliers of the 1930's; namely, they supply equipment to the Bell System via Western Electric. In this second market relationship, the nonintegrated suppliers act as subcontractors to Western Electric.

In our review of the literature, vertical integration was classed by one of two characteristics: the nonintegrated firm resided only in the product market or resided only in the factor market.

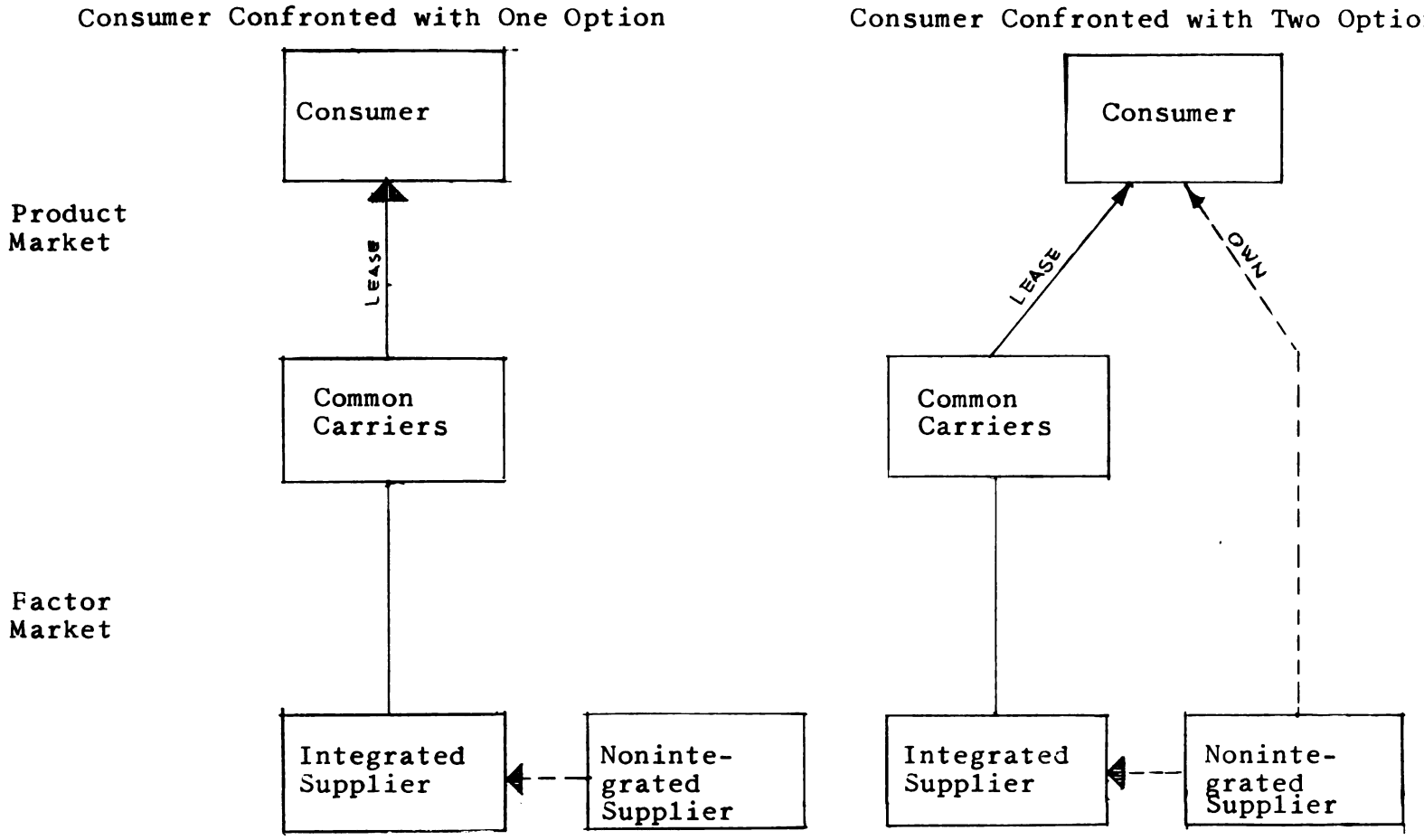

Figure 16. Domestic market - entry.

In the communication industry, microwave technology has produced a specie that does not fit into the conventional format of vertical combinations. The nonintegrated supplier under consideration sells in both product and factor markets. His good in the factor market is microwave equipment, and his good in the product market is raw bandwidth.

In sum, market entry elicits two traits. Microwave circuits compete with metallic circuits, and nonintegrated suppliers seek entry into the communication industry by selling bandwidth "wholesale."

International Market

Conventional Technology

The conventional techniques employed for overseas transmission of communications includes high frequency radio and submarine cable systems. Both systems provide a total of 491 telephone circuits of which 226 are radio and 256 are cable (9 are open wire land lines) (Figure 17).[1]

Radio transmission by high frequency (HF) techniques or short wave radio utilizes the frequency bands between three and thirty megacycles. As a sky wave, HF radio signals are dependent upon ionospheric reflection for their transmission. Since the ionosphere is subject to changes dependent upon the hour of the day and the time of the year, in addition to being susceptible to magnetic disturbances, this type of service is of poor quality and subject to prolonged

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[1]R. Kestenbaum, "Global Communications, State of the Art," Electro-Technology (November, 1961), 68:5, p. 63.

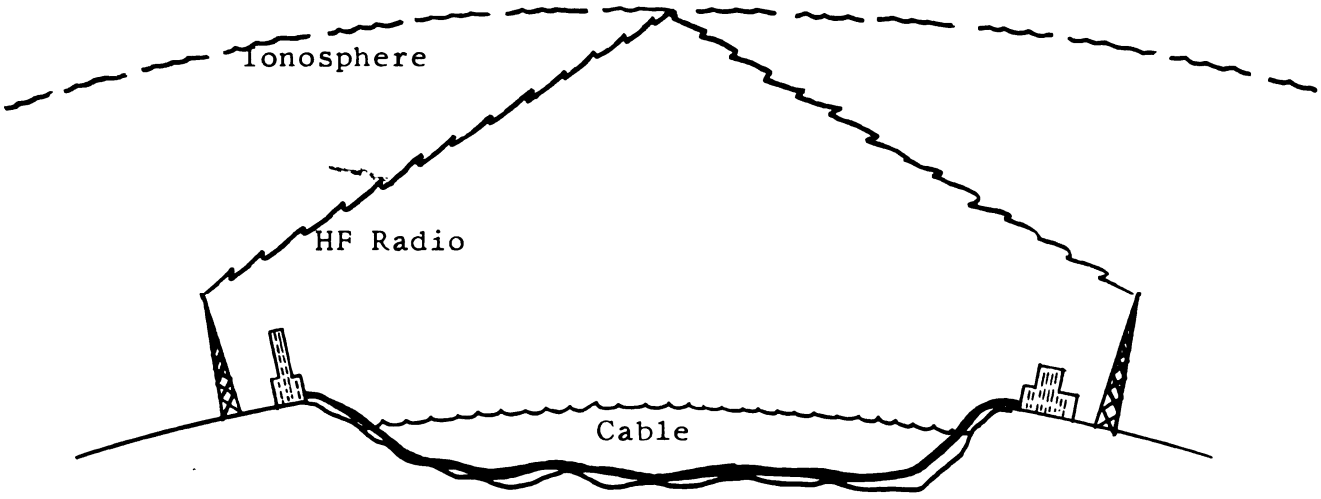

Figure 17. Conventional transoceanic means of communication. Source: Telesat, Business Planning Study for a Commercial Telecommunication Satellite, Part I, Lockheed Aircraft Corporation, Missiles and Space Division, pp. 5-7.

interruptions. In fact, ionospheric disturbances and solar flares result in only a 70 to 80 per cent availability of HF radio circuits.[1] Within the next fifteen years it is expected the usable bandwidth of HF radio telephone will decline because of the sun-spot cycle. Radio service is assuming the position of a backup to submarine cable service.

Superior in quality and reliability, the first submarine cable system capable of voice transmission across the

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[1] Telecomsat Study, Final Report Missile and Space Vehicle Department, General Electric, p. II-A-6, 1960.

Atlantic was laid in 1956. The cable transmits voice signals by amplifying the signal with repeaters spaced at adjacent intervals. Because of the expense of raising the cable for repair and maintenance, the vacuum tubes in the repeaters are designed with a twenty-year life. The submarine cable has a limited capacity of voice channels since the emphasis has been directed to cable reliability and longevity. Thus, the cable's bandwidth is .14 Kc/s or about 1/50 of the bandwidth provided by a terrestrial coaxial cable. (A land microwave system has a 24 mc. capacity.) As the state of the art has progressed, capacity has been increased. One method, called TASI, uses switching techniques which permits the doubling of capacity by taking advantage of the silent intervals in a conversation.

The difference in the bandwidth capacity available for overseas communication and those available for domestic service is such that a north-south bisection through the continental United States would sever over 100 mc of cables and microwave systems; while the same bisection in the mid-Atlantic would cut only one megacycle.[1] Thus, submarine cable capacity is limited in that it possesses no broadband capabilities such as are needed to transmit a video signal.

The important cable systems interconnecting the U. S. with the rest of the world are owned by AT&T outright or

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[1]Before the Federal Communications Commission in the matter of Allocation of Frequencies of the Bands above 890 mc, Docket No. 11866, American Telephone and Telegraph Company, Testimony of John R. Pierce, p. 3 (hereafter cited as the Above 890 Docket).

owned as a joint venture with foreign agencies, most of which are foreign governments. Table 21 includes a list of existing and pending cable systems.

TABLE 21

HIGH CAPACITY DEEP-SEA TELEPHONE TYPE SUBMARINE CABLE SYSTEMS OWNED WHOLLY OR PARTLY BY UNITED STATES COMPANIES
April 1, 1962

Name of Cable	Primary Communication Terminals	Date Open for Service	Present Capacity-Voice Channels (Without TASI)	Owners
Transatlantic-1 (TAT-1)	New York Montreal London	9-25-56	48	AT&T Canada England
Alaska	Seattle Ketchikan	12-11-56	51	AT&T
Hawaii	Oakland Honolulu	10-8-57	47	AT&T Hawaiian Tel.
Transatlantic-2 (TAT-2)	New York Paris Frankfurt	9-22-59	48	AT&T France Germany
Puerto Rico	Miami San Juan	1-26-1960	48	AT&T Radio Corp. of P.R.
Bermuda	New York Bermuda	1-8-62	80	AT&T Cable & Wireless
P.R.-Antigua	San Juan Antigua	Expected 1963	84	AT&T Cable & Wireless
Jamaica	Miami Jamaica	Expected late 1962	128	AT&T Cable & Wireless

TABLE 21 (continued)

Name of Cable	Primary Communication Terminals	Date Open for Service	Present Capacity-Voice Channels (Without TASI)	Owners
Transatlantic-3 (TAT-3)	New York London	Expected late 1936	128	AT&T England
Japan	Honolulu Midway Wake Guam Tokyo	Expected July 1964	128	AT&T K.D.D. * Hawaiian Tel.

*K.D.D. - Kokusai Denshin Denwa Co., Ltd., a Japanese Corporation

Source: Federal Communications Commission, Common Carrier Bureau, International Division.

Since a voice signal requires some twenty times the bandwidth capacity of a telegraph signal, on the basis of cable channel capacity, some 90 per cent is devoted to voice service.

The total revenues associated with U. S. overseas communication is small relative to the U.S. domestic market. Table 22 depicts the total annual revenue for 1960 and its voice and record components.

On a revenue basis, revenues from record services account for about two-thirds of the market, the remaining is voice.

TABLE 22

U.S. INTERNATIONAL CARRIERS REVENUES

Telegraph	
Cable	$36,169,000
Radio	50,806,000
Telephone	48,096,000
	$135,071,000

Source: Federal Communications Commission, Statistics of Communications Common Carrier, 1960.

Figures 18 and 19 view over time the relative growth of voice and record message volume.

A closer look at the international voice market (Table 23) reveals the relative importance of AT&T, Cuban American Telephone and Telegraph (nationalized), Radio Corporation of Puerto Rico, and the Hawaiian Telephone Company. Again, AT&T is of central importance, controlling over 90 per cent of the voice market.

The overseas record market differs from its voice counterpart in that competition exists between some seven companies as illustrated in Table 24.

Table 25 indicates the relative distribution of all international common carriers. Clearly, American Telephone and Telegraph, International Telephone and Telegraph, Radio Corporation of America Communications, and Western Union account for 94 per cent of the market. AT&T's revenue includes some $850,000[1] representing rentals received from leasing

[1]U.S. Congress, House, Antitrust Consent Decrees and the Television Broadcasting Industry, Hearings before the Antitrust Subcommittee No. 5 of the Committee of the Judiciary, 87th Congress, 1st session, 1961, p. 6.

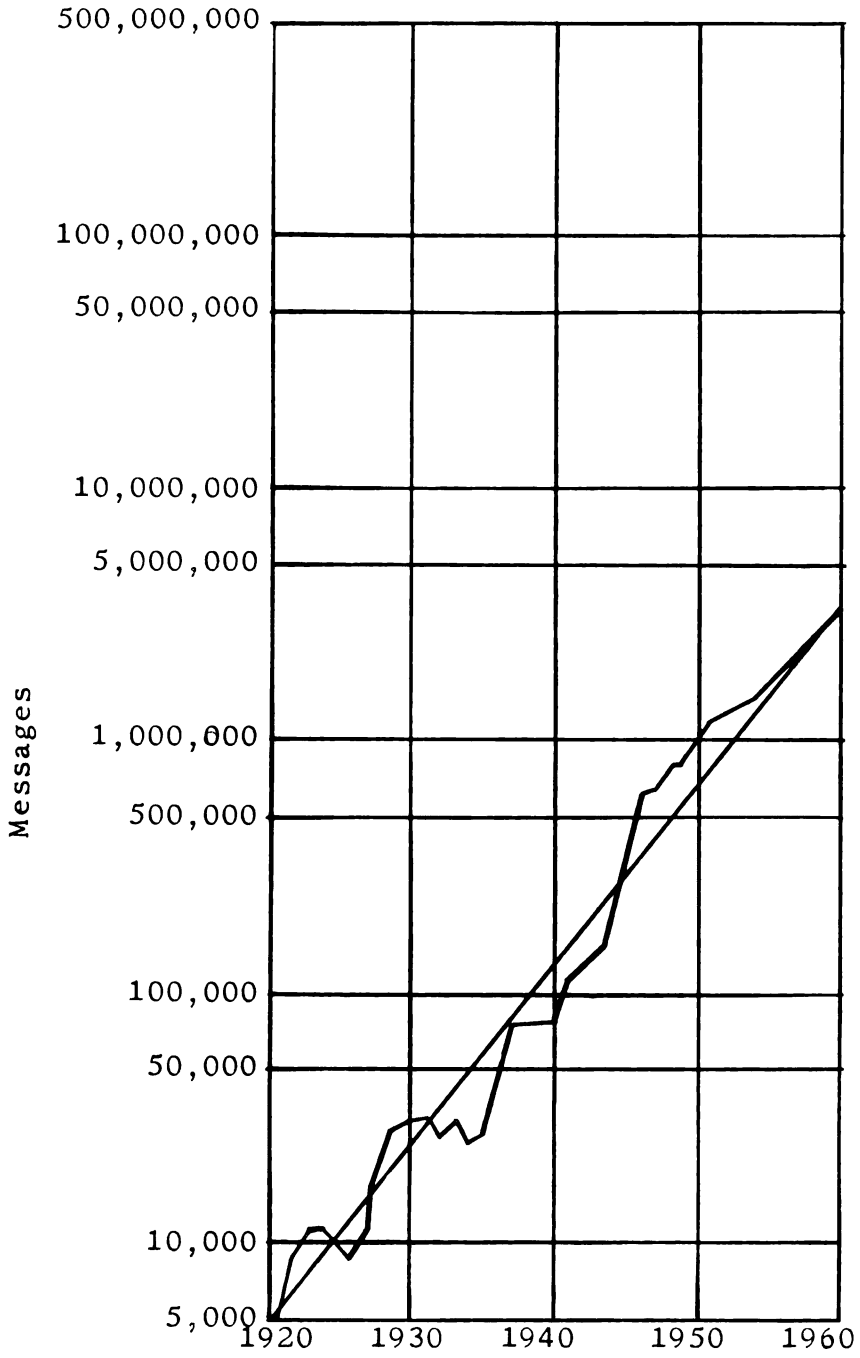

Figure 18. U. S. overseas telephone messages. Source: Telecomsat Study, Final Report, Missile and Space Vehicle Department, Lockheed, p. II-B-6 (adapted).

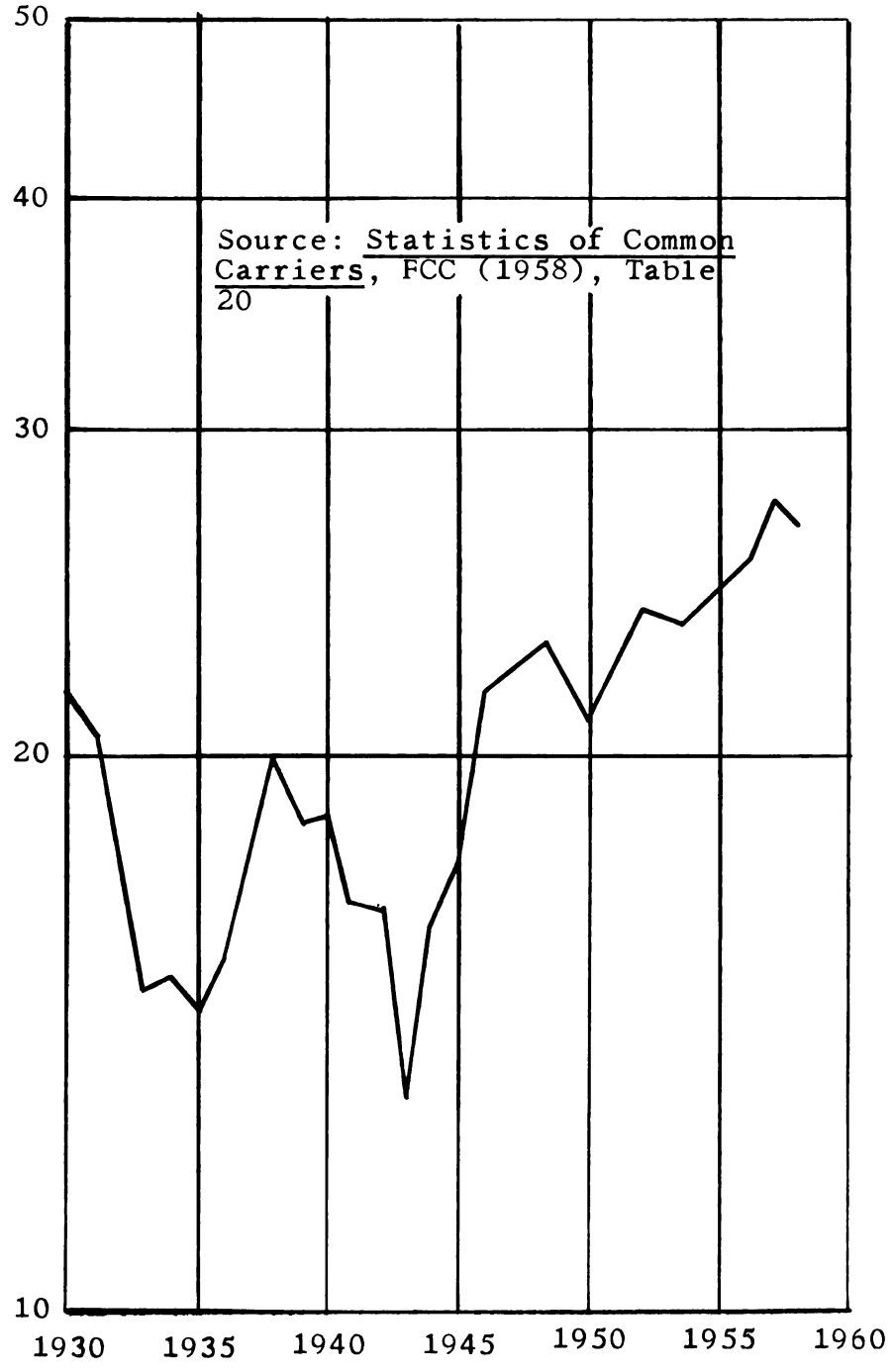

Figure 19. U. S. international telegraph message volume (1930-1959).
Source: The Rand Corporation Communications Satellites and Public Policy: An Introductory Report by B. H. Klein, et al., September 15, 1960. Prepared for National Aeronautics and Space Administration (adapted).

TABLE 23

REVENUES FROM OVERSEAS COMMUNICATIONS SERVICES REPORTED BY TELEPHONE CARRIERS FOR THE YEARS 1951 TO 1960, INCLUSIVE[a]
(Thousands of dollars)

Year	American Telephone & Telegraph Co.		Cuban American Telephone & Telegraph Co.		Radio Corp. of Puerto Rico		Hawaiian Telephone Co.		Total	
	Message (b)	Private line (c)	Message (d)	Private line	Message	Private Line(c)	Message	Private line(c)	Message	Private line
1951	$9,831	$242	$586	$96	$297	$1	--	--	$10,714	$339
1952	10,010	215	613	98	335	1	--	--	10,958	314
1953	10,521	162	617	103	398	1	--	--	11,536	266
1954	10,991	126	659	90	449	4	--	--	12,099	220
1955	12,456	148	784	95	545	--	--	--	13,785	243
1956	15,133[e]	188	894	131	669	--	--	--	16,696	319
1957	20,743	717	850	162	809	--	$277[f]	--	22,679	879
1958	24,745	1,358	737	177	933	2	1,426	$118	27,841	1,655
1959	29,344	3,120	721	182	1,094	1	1,951	322	33,110	3,625
1960	37,659	5,075[c]	403	151	2,057[g]	1	2,203	547	42,322	5,774

[a]Relatively minor amounts of revenues from U.S. sources from telephone operations of RCA Communications, Inc. in Guam (and Hawaii, prior to October 9, 1957) and of All America Cables and Radio, Inc. in the Virgin Islands are not included in this tabulation.

[b]Includes the carrier's share of the overseas service charges attributable to the landline haul in the U.S., except that for the years 1951-56 such share on Cuban calls is omitted.

[c]The private line revenues of AT&T Co. for 1960 include an estimated $850,000 received from international telegraph carriers for the rental of overseas communications channels used by the lessees for the services offered by them. Private line revenues of Radio Corporation of Puerto Rico do not include its share of revenues from leases to the international telephone carriers. It has not been ascertained whether or not private line revenues of Hawaiian Telephone Co. include such revenues.

[d]The revenues of Cuban American Telephone & Telegraph Co. were affected by changes in operating arrangements made when the "over-the-horizon" microwave radio system (owned jointly by AT&T Co. & Radio Corp. of Cuba) between the U.S. and Cuba was placed in service Sept. 12, 1957.

[e]The first transoceanic cable was placed in service September 25, 1956.

TABLE 23 (continued)

[f]The Hawaiian cable, in which the Hawaiian Telephone Co. owns an interest, was placed in operation October 9, 1957. Prior to that date the Hawaiian-U.S. service was via radio and the Hawaiian radio facilities were supplied by RCA Communications, Inc.
[g]The telephone cable between U. S. and Puerto Rico was placed in operation January 26, 1960.

Source: Federal Communications Commission, Statistics of Communications Common Carriers, 1960, p. 173.

TABLE 24

REVENUE DISTRIBUTION OF OVERSEAS RECORD CARRIERS

IT&T (American Cable and Radio Corporation)	
All American cables and radio	15,503,769
Commercial cable	6,957,776
Globe Wireless	848,839
Mackay Radio & Telegraph Co.	11,975,874
Radio Corporation of Puerto Rico	2,416,994
Press Wireless	2,050,195
United States Liberia	113,921
RCA Corporation	32,543,226
Tropical Radio	3,274,379
Western Union	13,707,852
South Porto Rico Sugar	No data

Source: Federal Communications Commission, 1960 Statistics

TABLE 25

REVENUE DISTRIBUTION OF MAJOR INTERNATIONAL CARRIERS

International Common Carrier	Revenue	%
AT&T	42	32
AC&R (ITT)	34	26
RCAC	33	25
Western Union	14	11
Other	7	6

Source: Federal Communications Commission, 1960 Statistics

cable channels to the international telegraph carriers. (IT&T, for example, owns no cables, but conducts its operations through leased channels.)

The remaining 6 per cent of the market is shared by several companies, who, although classified as international common carriers, engage in activity ancillary to the rendition of communication services.

Press Wireless, engaged in sending press dispatches, is owned primarily by the New York Herald Tribune, the New York Times, and Time, Inc. The United States-Liberia Radio Corporation is a subsidiary of Firestone Tire and Rubber Company; Tropical Radio is a subsidiary of the United Fruit Company; and South Porto Rico Radio is a subsidiary of a commercial sugar firm.

Both international voice and record carriers offer public message and private line service. Table 25 depicts the proportion of each service supplied by the voice carriers, and Table 26 shows the breakdown of services for the record carriers.

It is interesting to observe the significance of government expenditures on the demand side of the market, particularly in the lease channel or private line market. Thus, U. S. government expenditures account for 40 per cent of the demand for the Telegraph carriers leased channel service, and 99 per cent for AT&T's leased channel service (Table 27).

TABLE 26

INTERNATIONAL TELEGRAPH CARRIERS COMBINED GROWTH OF OPERATING REVENUES
1955-1961

Year	Direct customer-to-customer telegraph service				Revenues from other services[3]	Total revenues
	Message revenues[1]	Telex revenues	Leased Channel Revenues[2]	Total		
	Amount of operating revenues (in thousands)					
1955	$55,086	$1,226	$5,696	$6,922	$4,276	$66,284
1956	59,672	1,884	6,406	8,290	4,900	72,862
1957	61,305	2,829	7,048	9,877	5,576	76,758
1958	60,803	3,581	7,790	111,371	5,011	77,185
1959	64,248	5,393	9,371	14,764	5,256	84,268
1960	65,078	7,542	8,558	16,100	5,683	86,861
1961	64,297	11,005	9,540	19,545	6,086	89,928

[1]Represents revenues from all point-to-point and marine messages.
[2]Includes the revenues from international metered communications service (IMCO) of Western Union.
[3]Principally revenues from telephone multiple address press, broadcast and facsimile services, servicing stations, and rental of equipment to customers.

Source: Federal Communications Commission, Common Carrier Bureau, International Division.

TABLE 27
U.S. GOVERNMENT PURCHASES OF OVERSEAS COMMUNICATION SERVICES
(estimate of revenues of the three major telegraph carriers)

Service	Total revenues	U.S. Government	
		Amount	Percent of Total
Telegraph carriers:			
Message[1]	$14,431	$162	1.1
Telex[2]	2,974	70	2.4
Leased channel[3]	2,250	899	40.0
Broadcast[4]	39	5	11.7
Facsimile[4]	87	51	59.4
All services	[5]21,520	1,189	5.5
American Telephone & Telegraph Co.:[6]			
Message	44,292	(7)	(7)
Leased channel	6,231	6,170	[8]99.0
Broadcast	367	33	9.0

[1]Based on Western Union cables estimate of 8/10 of 1 percent for 1st quarter, 1962, and assumes that American Cable & Radio Corp. and RCA Communications, Inc. accounted for 50 percent more, percentagewise of Government message.
[2]Based on American Cable & Radio Corp.'s study of its billings for 2nd quarter 1962 (3.5 percent) and RCA Communications, Inc.'s estimate of 1 to 2 percent. Western Union cables reported no Government Telex business.
[3]Based on American Cable & Radio Corp.'s (34.5 percent) and RCA Communications', Inc. (41.8 percent) studies of their billings for 2d quarter 1962 and Western Union cables' study (43.9 percent) of its 1st quarter billings.
[4]Based on RCA Communications, Inc.'s study of 2d quarter 1962 billings which showed 11.7 percent for broadcast and 59.4 percent for facsimile.
[5]Includes revenues for other miscellaneous services not included in details.
[6]Data are for year 1961.
[7]Not available.
[8]American Telephone & Telegraph Reports that, because of increased use of leased channel services by users other than U.S. Government, May 1962, showed U.S. Government accounting for 93.5 percent of that month's total revenues from leased channel service.

Source: U.S. Congress, Senate, Communications Satellite Act of 1962, Hearings before the Committee on Foreign Relations, 87th Congress, 2nd Session on H.R. 11040, p. 444.

No data exist that indicate the magnitude or structure of the international communication equipment market, but, again, in contrast to the domestic hardware market, it is small. Equipment components include the apparatus and equipment associated with high frequency radio systems and submarine cable systems.

The outstanding trait of the U.S. overseas communication market is its structure of vertical integration linking both service and equipment markets. The AT&T-Western Electric integration accounts for the central fact of integration. Nevertheless, International Telephone and Telegraph and RCAC have communication equipment subsidiaries (although ITT asserts that it purchases 90 per cent from outside its own subsidiary).[1] As a matter of fact, International Telephone and Telegraph Company is essentially a manufacturing concern since less than 10 per cent of its revenues come from common carrier activity.[2] Its English subsidiary, Standard Telephone and Cable, Ltd., is England's largest manufacturer of submarine cables, termination equipment, etc. The company engages in cable construction for the British government, since all of Britain's communication services are handled by the British Post Office.

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[1]Senate Small Business Hearings, op. cit., p. 539.

[2]Ibid., p. 226.

Radio Corporation of America's international common carrier, RCAC, contributes some 2.13 per cent to RCA's total income.[1] In fact, RCA is predominately a manufacturing concern.

In sum, 81 per cent of the total overseas revenues derived from voice or record services are generated by firms who are integreated as both manufacturers and common carriers, and with the exception of AT&T, the size of its manufacturing activities outweighs their common carrier activities.

New Technology

Communications via satellites represents the application of microwave techniques to transoceanic communications. Given the property of traveling in straight lines, terrestrial adaptation of microwave necessitated the building of repeater stations or towers at approximate intervals of twenty-five miles. Such techniques were totally inadequate since the construction of ocean towers was economically prohibitive. The advent of the missile and the successful launching of satellites prompted speculation as to use of satellites to receive, amplify, and transmit the microwave signal across large bodies of water. The satellite is functionally analogous to a terrestrial microwave tower (Figure 20).

The operation of a communication system via satellite includes five phases (Figure 21). First, the local

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[1] Ibid., Testimony of RCA, p. 140.

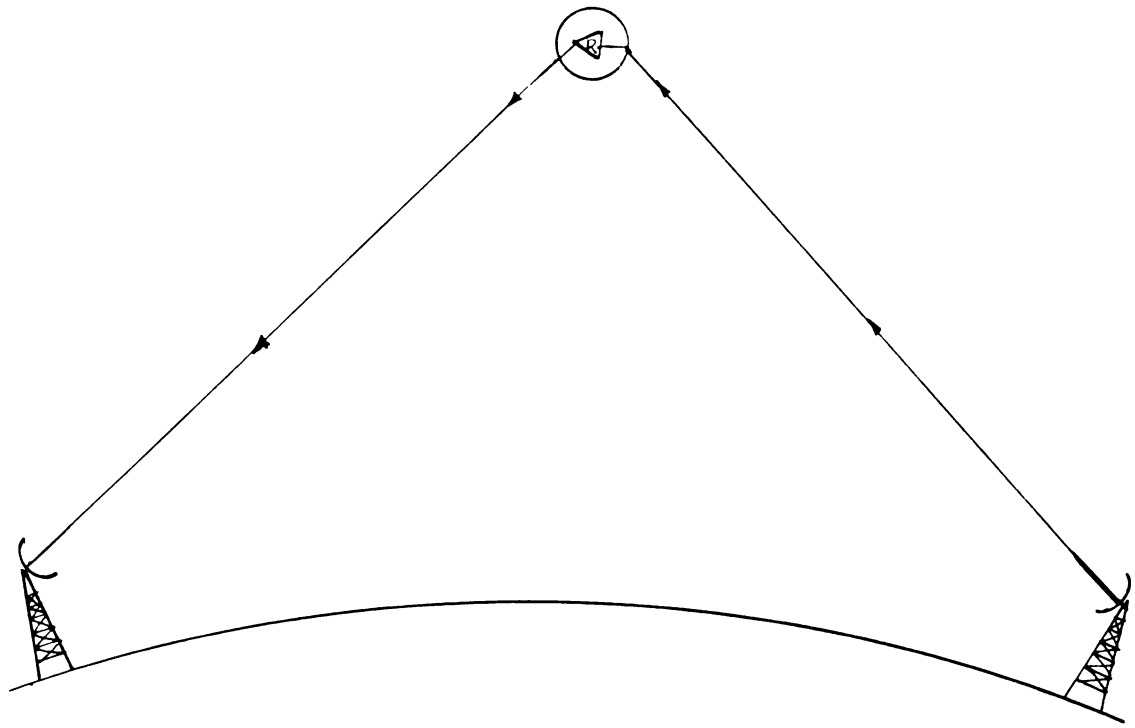

Figure 20. Satellite as a microwave repeater.
Source: R. Kestenbaum, "Global Communications, State of the Art," Electro-Technology, 68:5 (November, 1961), p. 69. (Adapted from)

connection or pickup by telephone is made; then collection of the various signals at a central station; third, the signal is transmitted to and relayed by the satellite repeater; fourth, it is received; and finally the signal is distributed to point of destination.

A communications satellite system is composed of the basic component, the ground station and the launching vehicle, and satellite. Of the two components, it has been estimated that the "space" component represents about 90 per

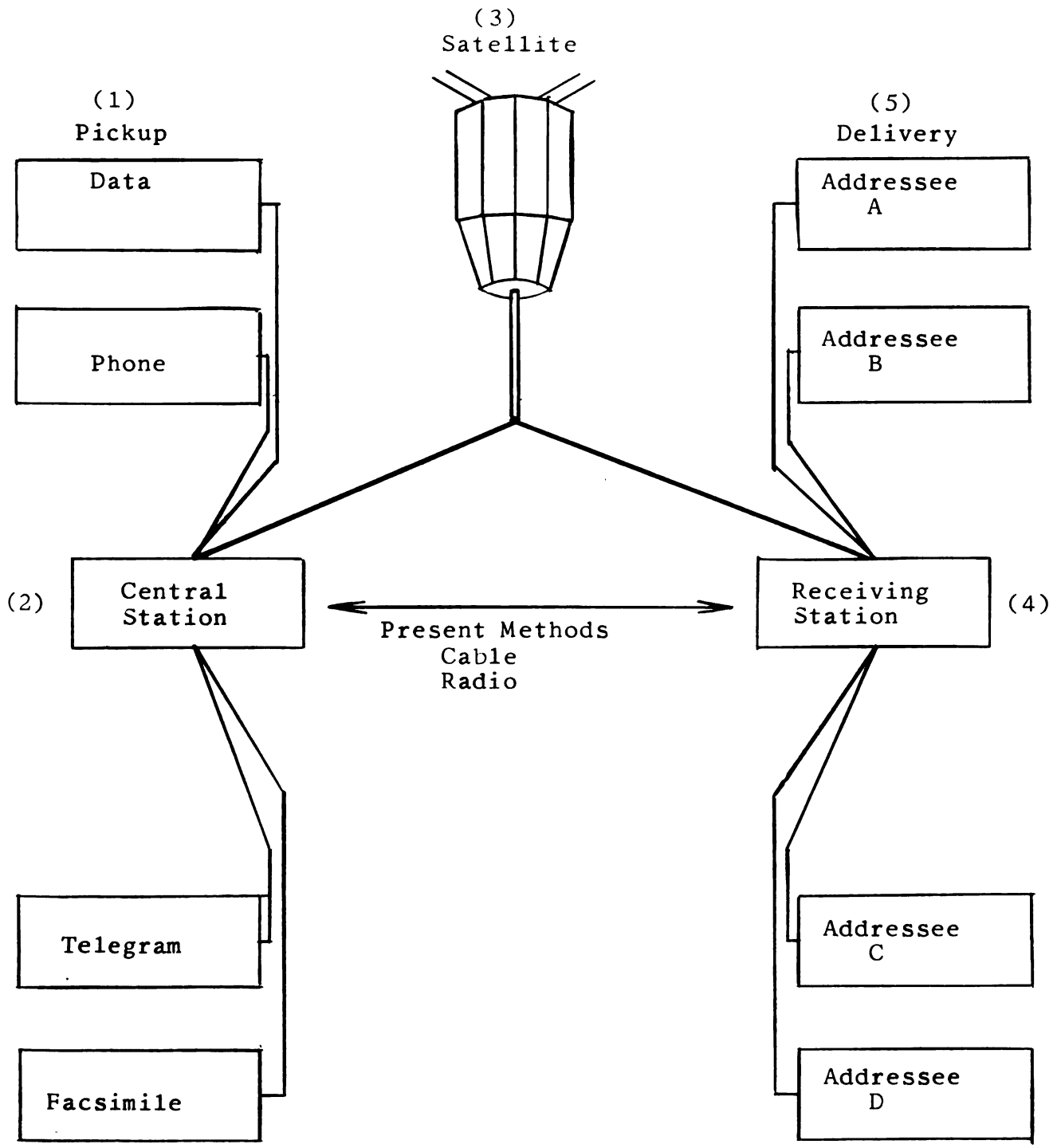

Figure 21. The satellite in a communications system. Source: Senate Small Business Hearings, RCA, p. 127.

cent of the system's total cost.[1] The ground equipment includes receivers and transmitter, telemetry equipment, antennaes, etc. Much of the controversy as to the nature of the satellite system centered around the type of system to be established. Although this question was debated on a technical level, it is important to know at least the alleged advantages and disadvantages of various communication systems.

Satellites can be active or passive. A passive satellite acts as a mere reflector of the microwave signal. The signal is "bounced" off the reflector without being amplified. The classic example of this type was Project Echo (a high school student sent messages via the Echo balloon). Another example of a passive system was Project Westford or Project Needles. Here bits of tin foil were launched to create a reflecting belt for radio relaying purposes.

The advantage of a passive satellite lies in its simplicity. Most of the complexity of such a system resides on the ground in the form of transmitting, receiving, and tracking equipment. The disadvantage of such a system is the high power required to send the signal, since the satellite does not boost or amplify it. The attenuation of the signal necessitates rather complex equipment to receive it

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[1] Communications Satellite Act of 1962, Hearings before the Committee on Foreign Relations, United States Senate, 87th Congress, Second Session on H.R. 11040, p. 319. Statement by John H. Rubel, Assistant Secretary of Defense, Deputy Director of Defense Research and Engineering. Secretary R. S. McNamara disputed this ratio. See pp. 319-21.

as well. Most of the current effort today is directed towards the development of active satellites.

As its name implies, the active satellite amplifies the microwave signal between destinations. In this sense, an active satellite is a repeater similar to a microwave tower. The energy for such amplification can come from the sun (solar cells convert light energy into electrical energy) or from a nuclear battery (conversion of a radioactive substance into electrical energy). An example of the former mode of energy is the Telstar satellite; an example of the latter includes the Navy's Transit satellites.

Active satellites have the advantage of decreasing the ground network complexity, but of increasing the complexity of the satellite. Since the signal is amplified, the ground station's sending and receiving equipment is reduced in power and complexity. The satellite, however, operating in the hazardous environment of space encounters problems of longevity and reliability.

A further refinement of active satellites classifies them as low, medium, and high orbit systems. Passive satellites can also fall into these categories. Furthermore, the satellites can rotate in a polar orbit or an equatorial orbit.

A low orbit satellite is one that revolves at a height of 3,000 to 6,000 miles. The Bell System has sponsored this satellite system as a first step in the commercial innovation of satellite techniques. Since a low orbit system

would contain satellites revolving in random fashion and since no one satellite would be in view longer than twenty or twenty-five minutes, communication via such a system would necessitate dual sending and receiving equipment. While one station would "lock on" a satellite in view, another station would be searching for another approaching satellite.

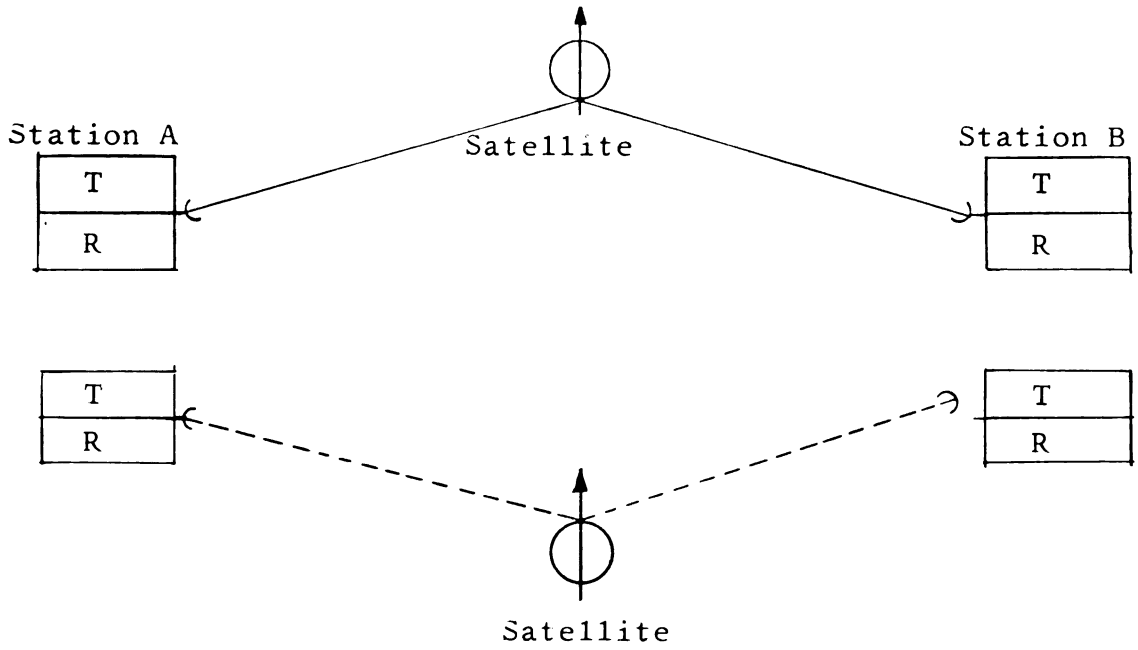

Figure 22. Anterior view of a low orbit satellite system. Source: Senate Small Business Hearings, RCA, p. 127.

Figure 22 demonstrates the anterior view of how ground stations would phase from one satellite to another.

Total coverage of the world would require some forty to sixty satellites. The advantages accorded by such a system are several. Foremost is the availability of launching

vehicles capable of pushing up the satellites. The disadvantages attributed to such a system are the complexity of the ground stations (dual stations plus telemetry equipment) and the limited accessibility of the ground stations. Some have asserted that the cost of a world wide, low orbit system would be prohibitive and that the satellites would be living in the Van Allen radiation belt resulting in damage to satellite components.

The twenty-four hour or synchronous orbit system exists as one alternative to the low orbit system. Sponsored by ITT, Hughes, Lockheed, RCA, and General Telephone, the essence of this system rests upon its altitude. If a satellite could be thrust to a distance of 23,300 miles above the earth, then the period of its orbit would be the same as or synchronous with the earth's period of rotation. Viewed from the earth, the satellite would look as if it were a fixed star. This fixity would eliminate the complexity of ground station equipment since their only function would be to aim at one point. Furthermore, it is contended that three such synchronous satellites would cover 99 per cent of the earth's surface (Figure 23). More important, those favoring a synchronous system, is the fact that accessibility is greatly facilitated by the satellite as depicted in Figure 24.

The synchronous system of satellites has several disadvantages. The first is the problem of launching boosters. Although this is expected to erode in time, there is

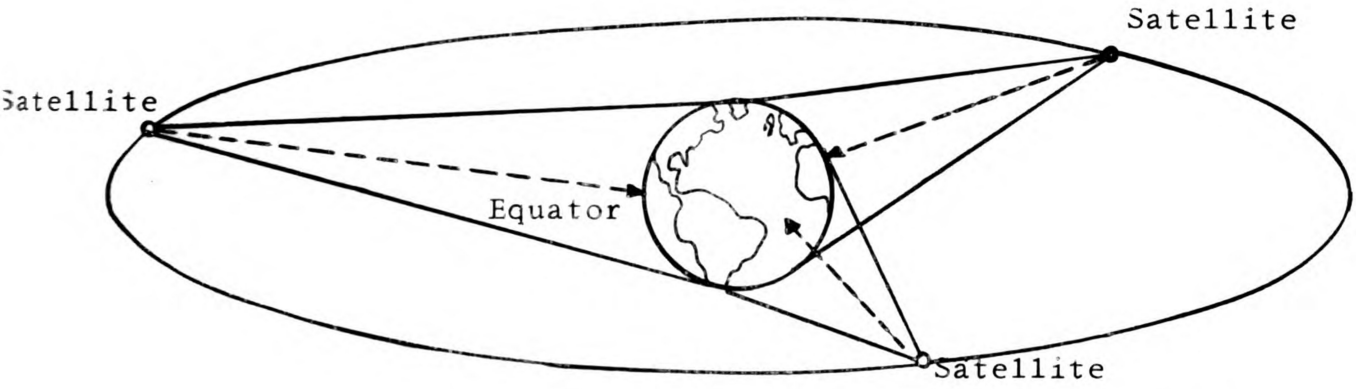

Figure 23. High altitude communications system.
Source: New York Times, October 8, 1961, "Satellite Signals--Relay Stations in Space Provide New World of Communications," by David Sarnoff, p. M15.

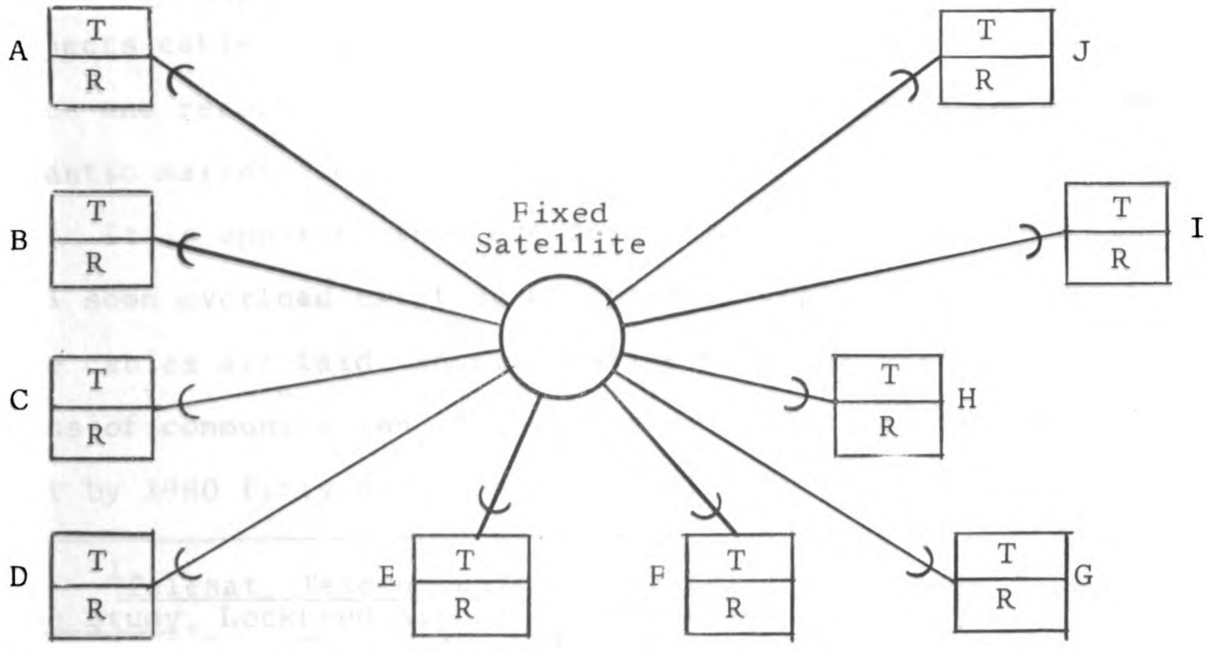

Figure 24. Synchronous relays.
Source: Senate Small Business Hearings, RCA, p. 127.

serious doubt that as of today, such a system could be hoisted into a synchronous orbit because of inadequate rocket power. Another complication is keeping the satellites in a fixed position--the problem of attitude control. A further problem is the problem of delay (six seconds) and echo control.

It is generally acknowledged that the ultimate system will be some form of synchronous satellite, but the innovation of such a system awaits further advances on several fronts in the state of the art.

Assuming that a satellite system will be established (and hence a wide band multi-channel communications system available), what are the market demand prospects of its use?

General Electric has projected the world-wide telecommunication revenues available in Figure 25. Figure 26 projects cable capacity against the projected demand for voice and record services and Figure 27 focuses on the transatlantic market alone.

It is apparent that overseas communication demands will soon overload existing and planned capacity. Unless more cables are laid, an alternative means of transoceanic means of communication is inevitable. (AT&T has estimated that by 1980 fifty overseas cables will be needed.)[1]

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[1] Telesat, Telecommunication Satellite Business Planning Study, Lockheed Aircraft Corporation, Missiles and Space Division, Sunnyside, California.

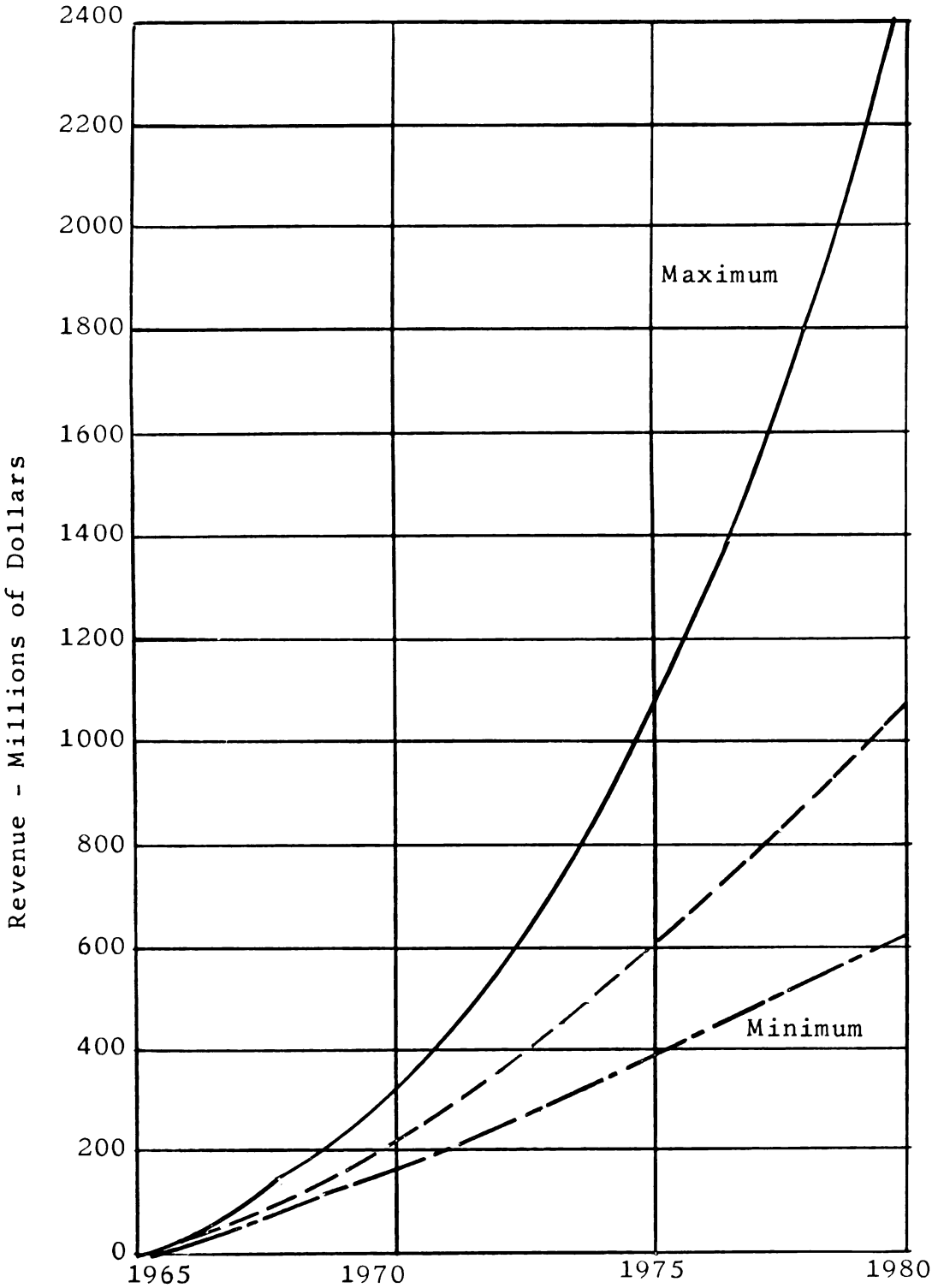

Figure 25. World-wide telecommunication revenue potentially available to Telecomsat.
Source: Telecomsat Study, Final Report, Missile and Space Vehicle Department, General Electric, p. II-B-32.

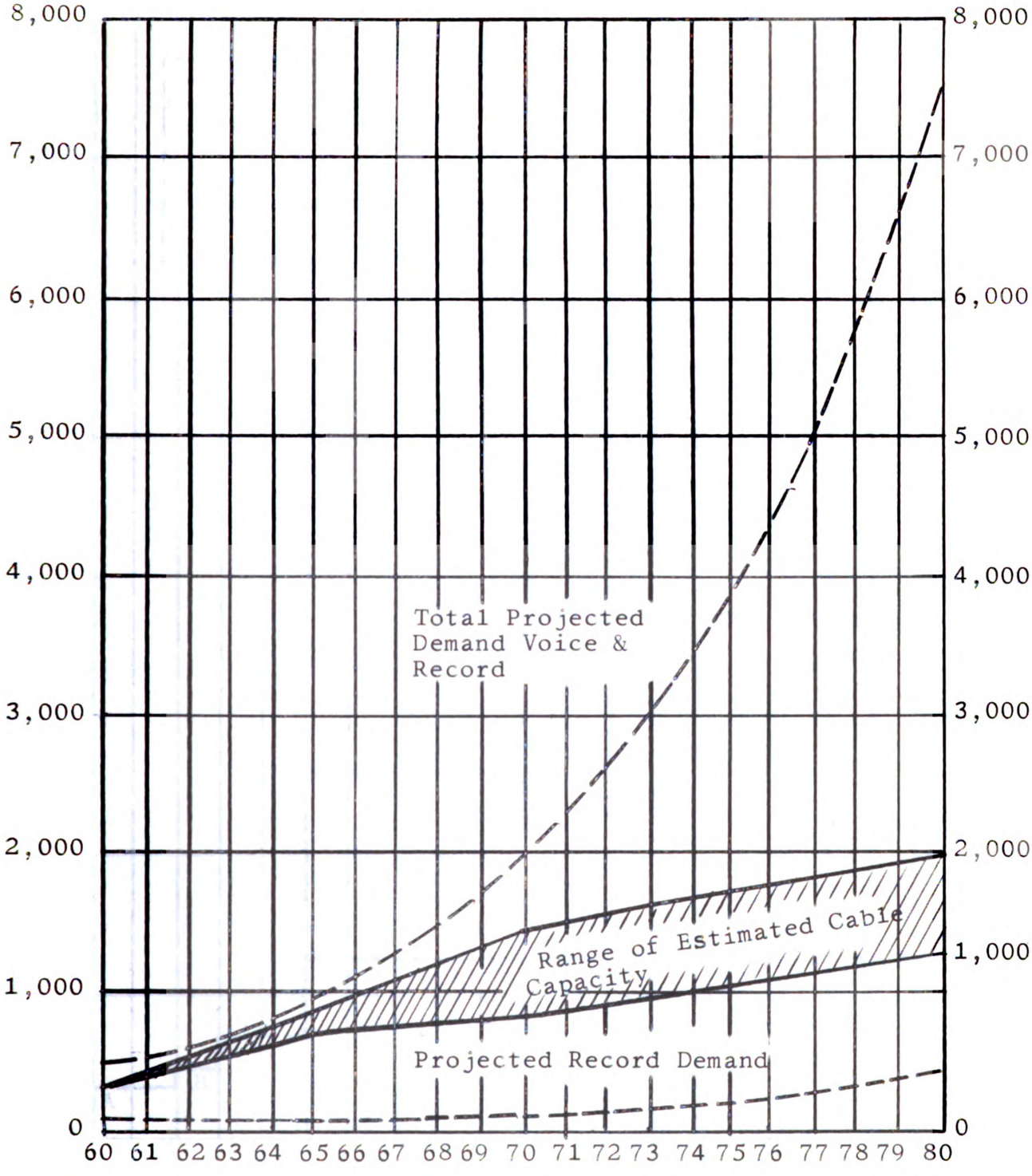

Figure 26. Projected world wide intercontinental telecommunications demand versus estimated capacity of existing, planned, and proposed telephone cables, 1960-1980.
Source: Telesat, Telecommunication Satellite Business Planning Study, Lockheed Aircraft Corp., Missile & Space Division, Sunnyside, California.

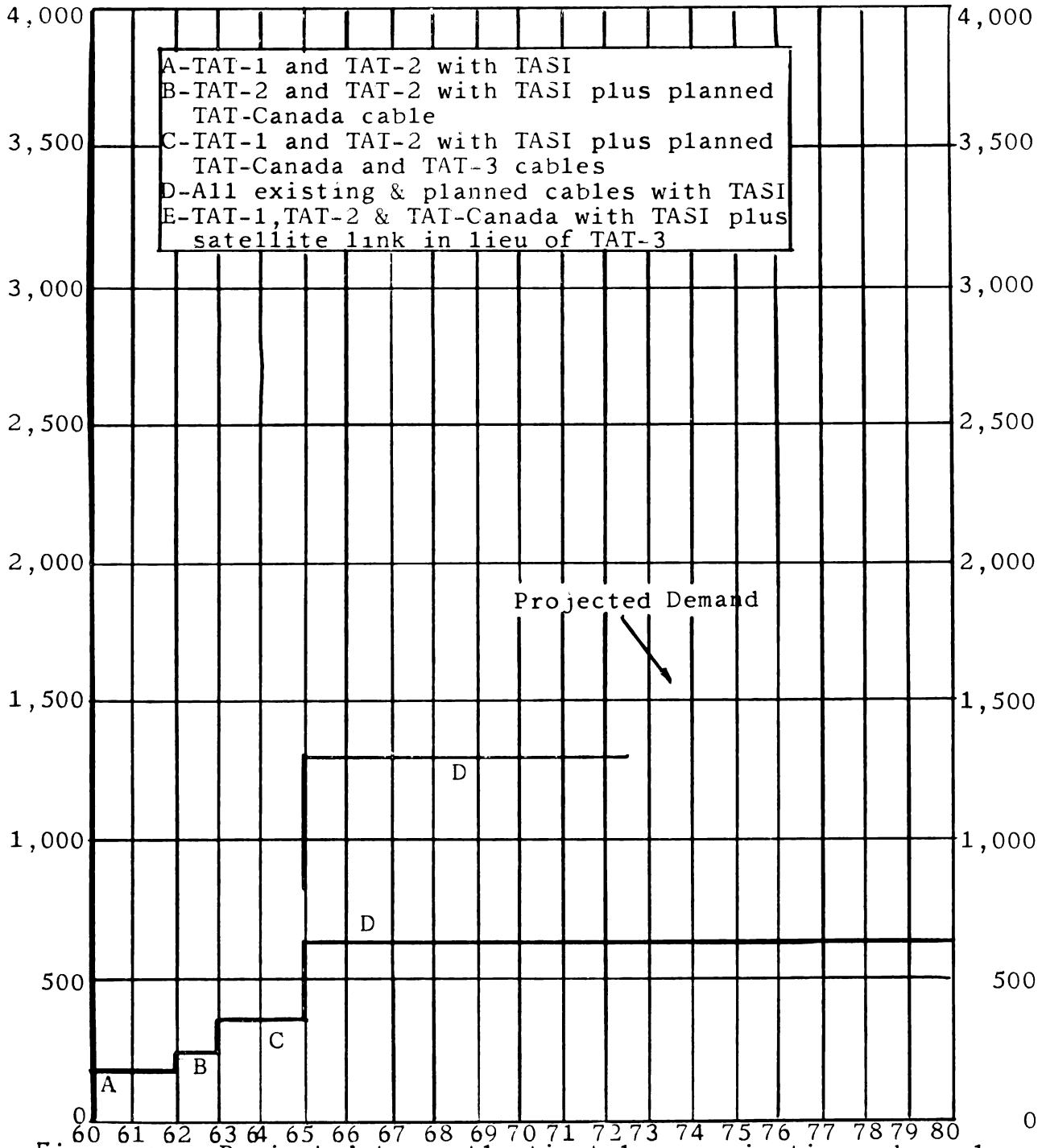

Figure 27. Projected transatlantic telecommunications channel demand versus capacity of existing planned and proposed cables, 1960-1980.
Source: Telesat, Telecommunication Satellite Business Planning Study, Lockheed Aircraft Corp., Missiles and Space Division, Sunnyside, Calif.

No definitive estimate has been made regarding the potential of the equipment market for a communication system of satellites. It is evident from the cost ratio of the "space" component of such a system that aerospace firms seek to participate in the supplying of boosters, satellites, and even the ground station complex of antennas, transmission and relay equipment, tracking apparatus, etc.

As subcontractors to other prime contractors, Western Electric, for example, is classified as an aerospace firm as well as a communication equipment firm, having participated in such projects as the Nike series, the Titan program, Project Echo, and Project Mercury.[1]

In addition to the captive equipment subsidiaries of the common carriers, there exist firms in the aerospace industry who have participated in major portions of the space program. Although Lockheed and General Electric originally had expressed a desire to participate in the communication satellite equipment program, other companies less articulate but nevertheless appeared very willing to participate (Hughes, Philco, Bendix, North American, etc.). Again, these firms had gained experience and competence as a result of participating in the U. S. space effort.

The real problem confronting the nonintegrated equipment supplier in the international market was how to

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[1]The 1961 Aerospace Year Book, 42nd Annual Edition (Aerospace Industries Association of America, Inc.), p. 160.

participate in supplying his space knowhow and technology. Since the overseas common carriers, particularly AT&T, were integrated into subsidiaries having some aerospace experience, the tendency to funnel all equipment orders to their own equipment firms would prove, as in the past, irresistible. Furthermore, the projected capacity of a satellite system, be it low or high orbit, was of such a magnitude that one system only would handle all the traffic. A second system would merely be redundant. Thus, unlike the domestic equipment market, the nonintegrated supplier could not circumvent the integrated complex of the overseas common carrier and their equipment subsidiaries by establishing a rival system. General Electric and Lockheed expressed apprehension of being "frozen out" of one of the first commercial applications of space technology.

Furthermore, even if Western Electric chose to supplement its communication satellite equipment needs from the nonintegrated supplier, the fact remained that the status of the non-Bell equipment firm was reduced to that of a subcontractor (Figure 28).

Hence, it was not surprising that the nonintegrated equipment firms advocated a new organizational entity that would assure them of market entry. This organization, promoted by both General Electric and Lockheed, came to be known as a common carriers' common carrier. The function of the organization would be to own ground stations and/or satellites. The common carriers' carrier would purchase the

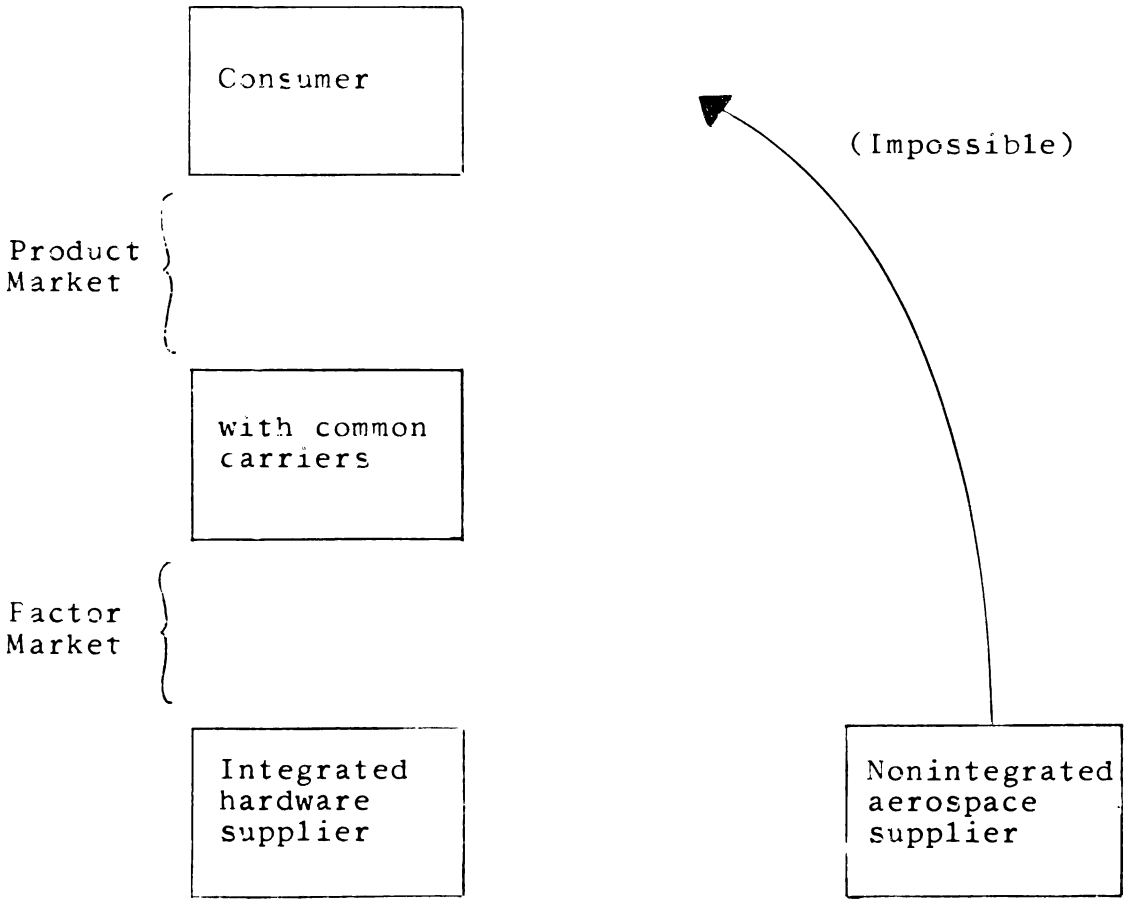

Figure 28. Market access--international equipment firms.

equipment necessitated by a satellite system and then lease channels to the international common carriers who, in turn, would sell services to the end-user. To insure that non-affiliated equipment suppliers would receive "equitable" treatment, the new entity would reside between the common carriers and the equipment market.

In summary, both domestic and overseas markets exhibit several parallel patterns.

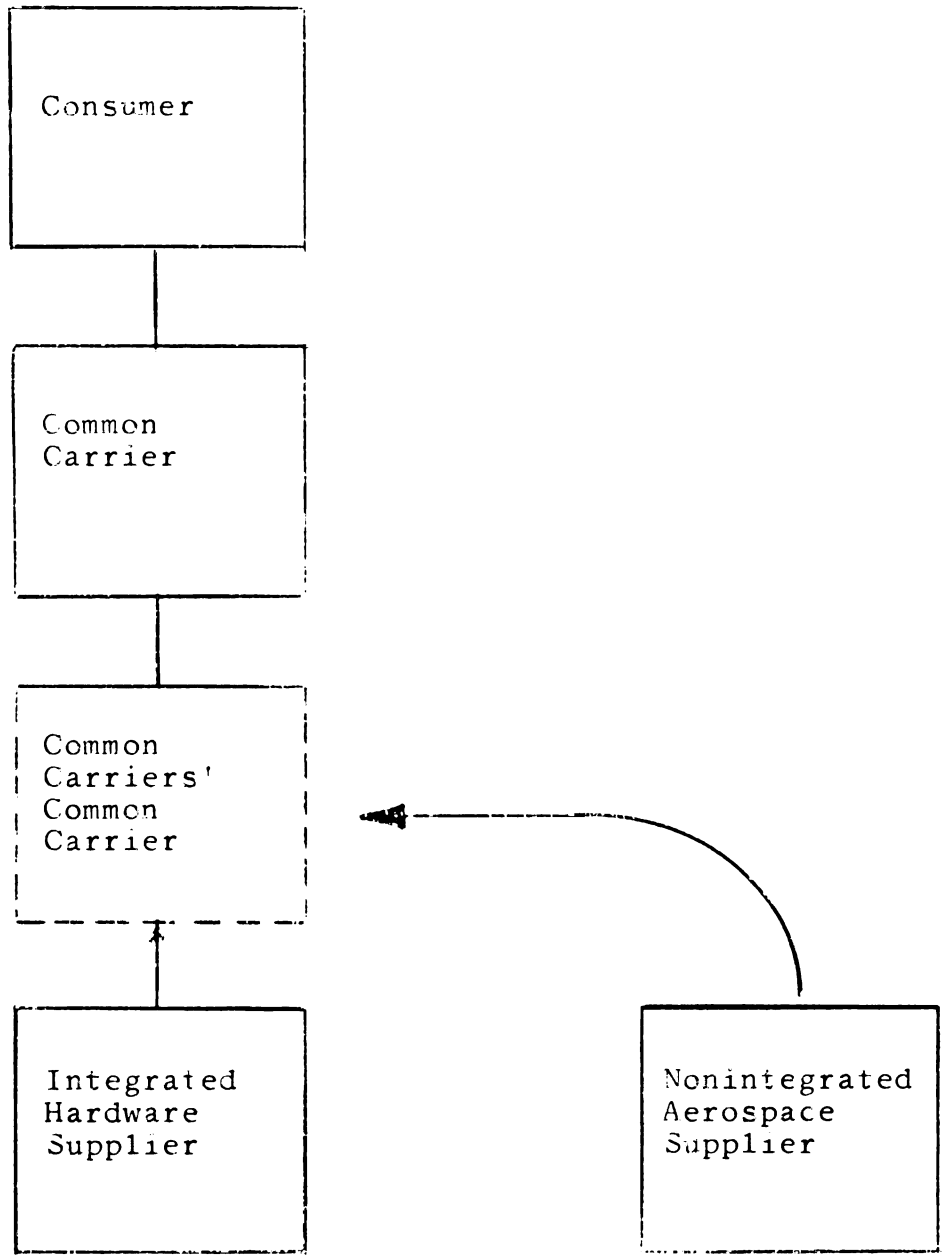

Figure 29. GE-Lockheed common carriers' common carrier concept.

First, the existing market structure is an extension of metallic circuitry--cable and wire in the domestic market, submarine cables in the overseas market. Second, both domestic and overseas markets are highly integrated into both the service market and the equipment market. Third, a new technical alternative, microwave, challenges the conventional technology. In the domestic market microwave takes the form of private microwave systems; in the international market, microwave is being projected as a communication satellite system. Fourth, nonintegrated equipment firms, in both domestic and international markets, have a vested interest in this competing technology. Fifth, the nonintegrated firm seeks market access for his goods and services; hence the problem of entry.

We have attempted to delineate the similarities and the differences of market entry in both domestic and international markets. Figure 30 attempts to portray the general issue of entry confronting the nonintegrated equipment firm vis-a-vis the integrated equipment firm.

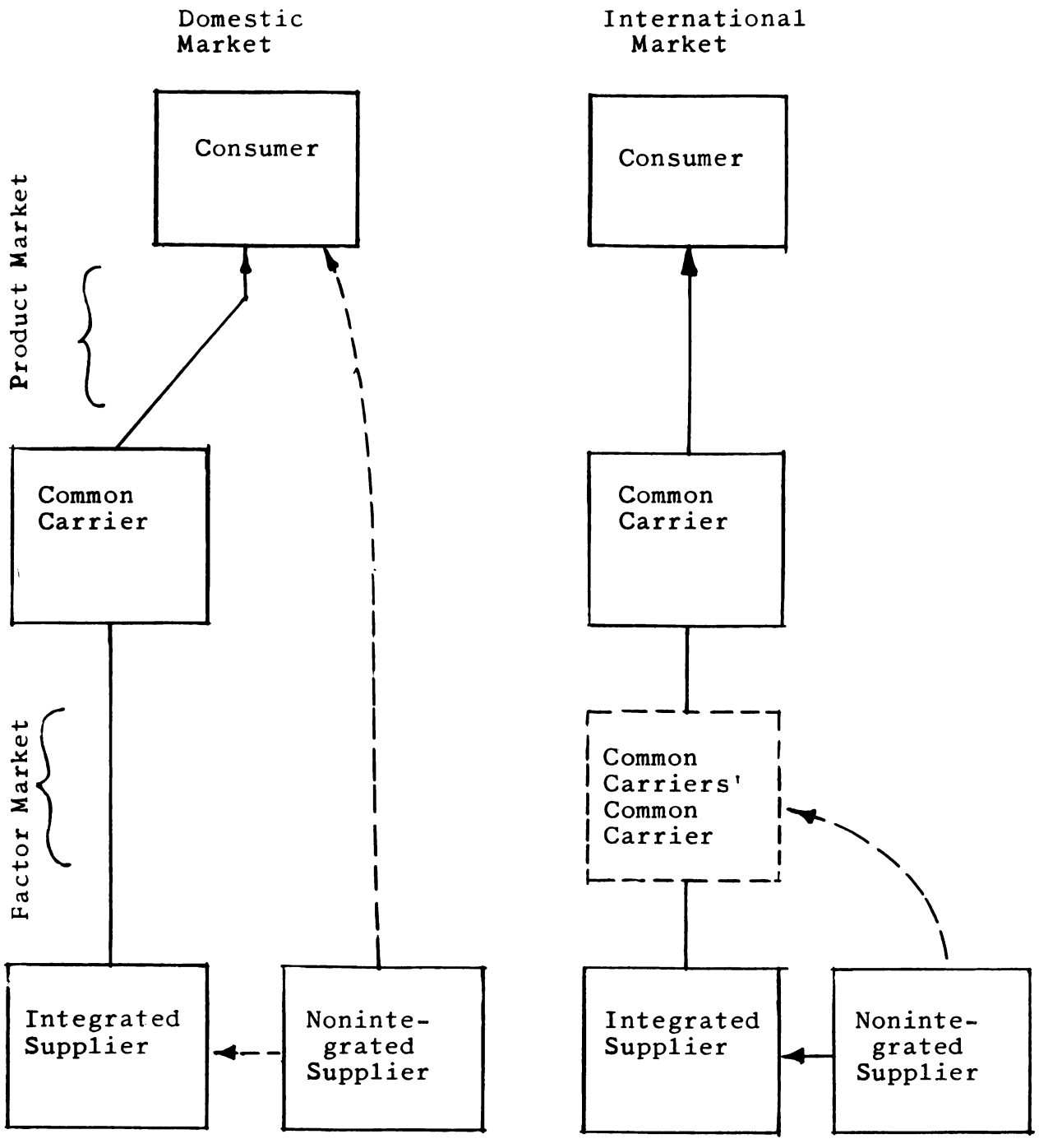

Figure 30. Summary--entry problem of nonintegrated equipment firms.

CHAPTER III

DOMESTIC MARKET

Having attempted to delineate and define the general problem of market access, we turn now to the domestic market with the question, what are the real or potential restraints to market entry? As noted previously these alleged restraints are classified in the following manner:

1. Legal and technological
2. Market structure
3. Government policy

Legal and Technological Restraints

This chapter will examine the first category, legal and technological restraints; and will include a consideration of, first, the role of the patent right, second, the size of the frequency spectrum, and third, capital requirements.

The Patent

The analysis of the patent right will be discussed under two general headings: first, what is the role of the patent as a barrier to entry; and, second, has this barrier eroded with time. The discussion of patent erosion will indicate an assessment of the impact of the public sector upon the communication industries and an evaluation of the 1956 AT&T consent decree.

The role of the patent grant in the evolution of the communications industry is of critical import. In fact,

it has been observed that the Bell System was constructed on patents.

As a legal grant by the state, a patent confers to the recipient certain property rights relating to the possession and use of knowledge. The patent system, in granting this monopoly position exists as an exception to the general theme of the competitive enterprise system. The rationale of the patent system rests upon the hope that a short-run grant of monopoly right will generate the invention and innovation of new products and processes so that in the long-run the total community will benefit in terms of economic growth. Thus, a limit is placed in the patent grant under the assumption that seventeen years should provide adequate incentive to the hazardous and risky occupation of the inventor.

Following three years of litigation, the first and crucial patent on the telephone instrument was granted to the Bell Patent Association in 1879. On the basis of this patent, the Bell Association leased patent licenses to operating companies formed to render telephone service. In return for the patent license, the Bell group received an option to purchase 30 to 50 per cent[1] of the capital stock in the licensee companies, as well as supervision over the financial development of the companies. By the time the

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[1]U. S. Congress, House, Consent Decree Program of the Department of Justice, Hearing before the Antitrust Subcommittee (Subcommittee No. 5) of the Committee on the Judiciary, 85th Congress, 2nd Session, Part II, Volume I, American Telephone and Telegraph Co., p. 1750.

original Bell patent expired in 1894, Bell owned or controlled, through stock purchases, most of the licensee operating companies.

In addition to consolidating its control of the telephone industry, the Bell interests embarked upon an aggressive policy of patent acquisition. Again, by 1894, the company had acquired some 900 patents associated with the rendition of telephone service. In 1935, the Bell System possessed an inventory of some 9,255 patents in addition to having licenses from 6,000 others.[1] Although the patent base of the Bell System included most of the devices in the rendition of voice messages, patent dominance was particularly paramount in the technology of long distance telephony. Substantially, all of these patents originated outside of the Bell System and were purchased from independent inventors by the Bell interests.

During the term of the first patent grant, the Bell Association initiated infringement suits against independent telephone groups operating under rival patents. Some 600 infringement suits were initiated, 200 alone directed against the American Cushman Telephone Company. After 1894, with basic patent expiration, Bell initiated suits against both the users and manufacturers of non-Bell Telephone

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[1] Federal Communications Commission, Report on Telephone Investigation (pursuant to Public Res. No. 8, 74th Congress), House Document 340, 76th Congress, 1st Session, June 14, 1939, p. 267. (Hereafter cited as 1939 Telephone Report.)

equipment.[1] In addition, no licenses under Bell patents were granted to others in the telephone field from 1879 to 1912.[2]

In the evolution of the communication industry, long distance telephony appears as a crucial variable in market control. As suggested, Bell's position soon became impregnable. The first device, the Pupin loading coil, permitted the extension of voice transmission by reducing the attenuation of the voice signal in a wire conductor. Although it did not energize or amplify the signal, the early loading coils increased the efficiency of the metallic medium. Bell's patents on the coil were purchased from Michael Pupin at the turn of the century and remained in effect until 1921.

More important to the long distance transmission of voice was the telephone repeater. The repeater differed from the loading coil in that it amplified the voice signal. The continual boosting of the signal permitted the first transcontinental line to be established in 1915. The repeater as an amplifier was dependent upon the triode or the radio vacuum tube. As a result of purchases of the DeForest vacuum tube and the Arnold high vacuum tube, the Bell position in telephone repeaters was again preeminent.

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[1] U. S. Congress, House, Consent Decree Program of the Department of Justice, op. cit., p. 1749.

[2] Federal Communications Commission, Telephone Investigation, 74th Congress pursuant to Public Resolution No. 8, 1938. Known as the Walker Report, not adopted by the Commission, p. 248.

Closely allied to the vacuum tube was the development of carrier systems, devices that permitted the simultaneous transmission of several voices by generating higher bands of frequency. Bell's position in carrier systems became secure and its refusal to license the telegraph industry delayed that industry's innovation of this technique.

Another important development in telephone technology was the coaxial cable. A product of Bell Laboratories, a research subsidiary formed in 1925, the cable as a broadband multi-channel circuit permitted the transmission of such wide signals as FM radio and television. An experimental cable was laid in 1936, and in 1941 the cable was innovated for commercial use. Substantially all the patents on the cable were owned by Bell.

The formation of Bell Laboratories as the research arm of the Bell System ostensibly removed the dependence of the Bell System research upon external sources and placed research in-house. Thus, by the 1930's, of the total patent portfolio of 9,000 odd patents, only 3.5 per cent represented outside purchases.[1] Nevertheless, Bell's market position rested heavily on the patents relating to long distance telephony, the most crucial, including the Pupin loading coil, the DeForest vacuum tube, and the repeater circuits of Grissinger. These three devices were regarded

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[1]Floyd L. Vaughan, The United States Patent System--Legal and Economic Conflicts in American Patent History Norman: Oklahoma Press, 1956), p. 74.

as the most important patents since the original two telephone patents granted in 1879. All three were purchased from inventors external to the Bell System.

The examination of the Bell System's structure by the Federal Communications Commission in 1938 is perhaps the most extensive probe undertaken by any government agency.[1] The investigation revealed that of the total telephone patents owned by Bell, 46.7 per cent were in actual use, 845 patents were not used because of the need for further development, 2,126 were unused due to the existence of superior alternatives, and 660 were awaiting application.[2] Some 1,300 patents were not utilized as no need was determined for their innovation. Bell's licensing policy was restricted to those operating companies within the Bell System and the telephone refused to grant patent licenses to other companies. The denial of patent licenses that AT&T held idle, prompted charges that the system was exercising undue discretion in the innovation of communication techniques (65 per cent of Bell's telephone patents were idle).[3]

In summary, by the 1930's the Bell patent base encompassed the entire field of telephones and telephone apparatus

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[1]For a criticism of the FCC investigation, see: John F. Bickley, "That Two-year Phone Probe--Review of the Proposed Report on the FCC Investigation of the Bell System," Public Utilities Fortnightly, XXI:13 (June 23, 1938), particularly p. 781.

[2]1939 Telephone Report, op. cit., p. 234.

[3]Ibid., p. 235.

and with concentrated strength in the fields of long distance transmission--including repeaters, carrier systems, and coaxial systems.

The only serious challenge to Bell's position in toll exchange circuits occurred with the advent of an alternative means in the rendition of voice--the radio. Again, however, Bell's patent base served it well.

Much of the early experimentation in radio transmission occurred prior to World War I and several firms were engaged in pressing the state of the art. As each firm patented new radio devices and components and refused to license each others'devices, a patent stalemate emerged by the outbreak of the war. In fact, radios were not produced in large quantities since no one company controlled all the essential components for a complete radio system.[1]

The stalemate was temporarily alleviated by the first World War when a government guarantee was issued protecting all manufacturers from infringement suits on work performed for the government. By the Armistice, wartime research and development had extended the art to where mass commercial

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[1]The patents situation of radio before World War I: "There were prior to the entrance of the U.S. into the World War, a number of inventions covered by patents, which could have been utilized in the manufacture of a large portion of the modern radio apparatus, and also numerous inventions covering various systems which could have been employed in rendering a more efficient transoceanic radio communication service. These patents were, however, controlled by opposing interests who refused to license one another." Federal Trade Commission, Report on the Radio Industry, 1924, p. 14.

introduction of radio was impending. However, with the lapse of wartime conditions and the withdrawal of the government's anti-infringement guarantee, the patent barriers were soon erected. Most of the key radio patents were owned by the American Marconi Company (a subsidiary of the British Marconi Company), General Electric, Westinghouse, and AT&T. Not only did each firm have an ownership segment of the radio art, but the government found itself in substantial possession of radio patents acquired through the Alien Property Custodian. Included were German patents on radio circuitry.[1]

The refusal of rival firms to license one another prompted General Electric to open negotiations with British Marconi with the end of disposing its patents and clearing out of the radio field.[2] The War Department was distressed by these negotiations--particularly the Navy. The Navy did

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[1]Dallas W. Smythe, The Structure and Policy of Electronic Communications (Urbana: University of Illinois, 1958), p. 50. "The Government, in its own right, acquired a sufficient patent position to dominate the field. These patents came to it through the purchase for 1.6 million from the Federal Telegraph Company and the Poulsen Werden Corporation of 22 patents and the purchase of some 110 German patents (including the Schlolmilch and VonBronken patent) from the Alien Property Custodian."

[2]N. R. Danielian, AT&T: The Story of Industrial Conquest (New York: The Vanguard Press, 1939), p. 109. The patent stalemate was as follows:

DeForest Vacuum Tube (AT&T), overlapping Fleming Vacuum Tube (Radio Corporation)

Arnold High Vacuum (AT&T), interference with Langmuir High Vacuum (General Electric)

Colpitts Grid Modulator (AT&T), interference with Alexanderson Alternator (General Electric)

Hartley Plate Modulator (AT&T), interference with White Plate Modulator (General Electric)

DeForest Oscillator (AT&T), interference with Langmuir Oscillator (General Electric)

Armstrong Oscillator (Westinghouse)

not want to be dependent upon a foreign supplier for its radio apparatus; thus, in the name of national security the Navy advocated public ownership of the radio industry.[1] Under this threat, the triad of American companies initiated the formation of a domestic radio patent pool. The cross-licensing agreement included General Electric, Westinghouse, and AT&T.[2] The agreement resulted in the formation of a patent holding corporation, Radio Corporation of America. RCA incorporated the assets of American Marconi as well as acquiring substantially all of the domestic patent rights on radio.[3]

Subsequently, when the struggle over radio networks ensued, the Bell System's long distance lines conferred to AT&T the strategic advantage of interconnecting several radio stations into a network. When AT&T refused to permit network rivals to have access to the telephone long distance facilities, the broadcasters turned to the two telegraph common carriers. Since RCA, as a result of the patent pool,

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[1]U.S. Navy was the largest consumer of radio apparatus and feared British dominance of key equipment. See: Gleason L. Archer, History of Radio (New York: American Historical Society, 1938), p. 168.

[2]RCA agreed to purchase radios in the ratio of 40 per cent from Westinghouse and 60 per cent from General Electric.

[3]As a result of these and other agreements, RCA obtained rights to over 2,000 patents, including practically all the patents of importance in the radio science of that day. W. Rupert Maclauren, Invention and Innovation in the Radio Industry (New York: MacMillan Co., 1949), p. 107.

now had access to the telephone patents, it was possible for RCA to transmit voice messages via transcontinental telegraph lines.[1] The emergence of a discrete parallel long distance telephone system posed a latent threat to the Bell System's toll circuits.

This threat, plus RCA's dissatisfaction with the quality of speech transmission over telegraph lines, induced a market realignment in 1926. AT&T sold its network to RCA (who formed a subsidiary National Broadcasting Company). In return, RCA agreed to lease its program transmission channels from the Bell System. In short, AT&T sold its broadcasting business in exchange for maintaining the integrity of its long distance telephone circuits.

The structure of the equipment market also felt the influence of the patent.

In 1882, the Bell interests purchased the largest manufacturer of telegraph equipment, Western Electric. Incorporated into the system as the exclusive manufacturing subsidiary, Western Electric was given the sole right to manufacture telephones, telephone apparatus, and equipment under the Bell patents. Western Electric was committed to sell its equipment only to those companies who were licensees of the Bell

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[1]Dallas W. Smythe, op. cit., p. 51. "This monopoly position rested, to some extent, on the tacit policy of the Navy and the Department of Justice to refrain from enforcing government-owned radio patents against RCA-owned patents when the former appeared to be infringed on by the latter."

patents. Since Bell refused to grant patent licenses to non-Western Electric manufacturers--including the idle patents of AT&T (60%)--the equipment market was effectively cartellized and controlled.

The refusal of Western Electric to sell equipment to non-Bell operating companies prompted the formation of independent equipment firms as suppliers. The emergence of competition prompted a reversal of Western Electric's policy in 1908. Western Electric was permitted to sell to independent operating companies, but the products were restricted to switchboards and telephone equipment. The independents were denied equipment necessary in the rendition of long distance calls, such as loading coils, repeaters, and coaxial cable systems. Thus, in both markets Bell's patent policy effectively isolated competition into territorial pockets.

By the 1930's Western Electric's preemption of the communication equipment market (90%) included not only telephone equipment and apparatus, but telegraph and teleprinter equipment as well (Teletype Corporation).

The stockpiling of patents, the high ratio of idle patents, refusal to license total patent possessions to non-Bell operating companies, exclusive licenses to Western Electric, denial of equipment to non-Bell telephone companies, refusal to issue licenses to non-Bell equipment firms, denial of patent licenses to the telegraph industry, refusal of facilities to non-Bell broadcasters, swapping patents in obtaining exclusivity in certain markets prompted some

observers to speculate as to whether the patent system was amenable to abuse. Certainly, the patent existed as one entry restraint in the communication equipment market.

Having examined the role of the patent in the evolution and structuring of the communication industry, we proceed to an examination of the factors that have tended to erode the patent as a barrier to entry. The discussion will include first an examination of the impact of the public sector of the economy, emphasizing first the role of government research and development expenditures (R & D); second, the innovation of communication techniques under government auspices; and, third, the diffusion of technical knowledge attendant government research and development and procurement contracts. Following the impact of the public sector on the patent barrier, we shall then examine the impact of the 1956 AT&T consent decree with special reference to the patent provisions of the decree.

Government Research and Development

Table 28 and Figure 24 suggest three trends as a consequence of the second World War. In the first place, the absolute aggregate expenditures on research and development expanded from a base of 166 million dollars to a wartime average of 600 million dollars. In the second place, the burden of funding research and development shifted during the war from the private sector of the economy to the public sector. In 1930, for example, industry accounted for 70 per

TABLE 28

COMPARISON OF NATIONAL RESEARCH AND DEVELOPMENT EXPENDITURES, 1930-1945
(excluding atomic energy)

	Millions of dollars expended					Percentage of total expenditures			
Year	Total	Federal Government	Industry	Universities	Other[1]	Federal Government	Industry	Universities	Other
1930	166	23	116	20	7	14	70	12	4
1932	191	39	120	25	7	20	63	13	4
1934	172	21	124	19	8	12	73	11	4
1936	218	33	152	25	8	15	70	11	4
1938	264	48	177	28	11	18	67	11	4
1940	345	67	234	31	13	19	68	9	4
1941-45 ave	600	500	80	10	10	83	13	2	2

[1]State governments, private foundations, and research institutes, including nonprofit industrial institutes.

Source: John R. Steelman, Science and Public Policy, A Program for the Nation, A Report to the President, The President's Scientific Research Board, August 27, 1947, Vol. 1, p. 10.

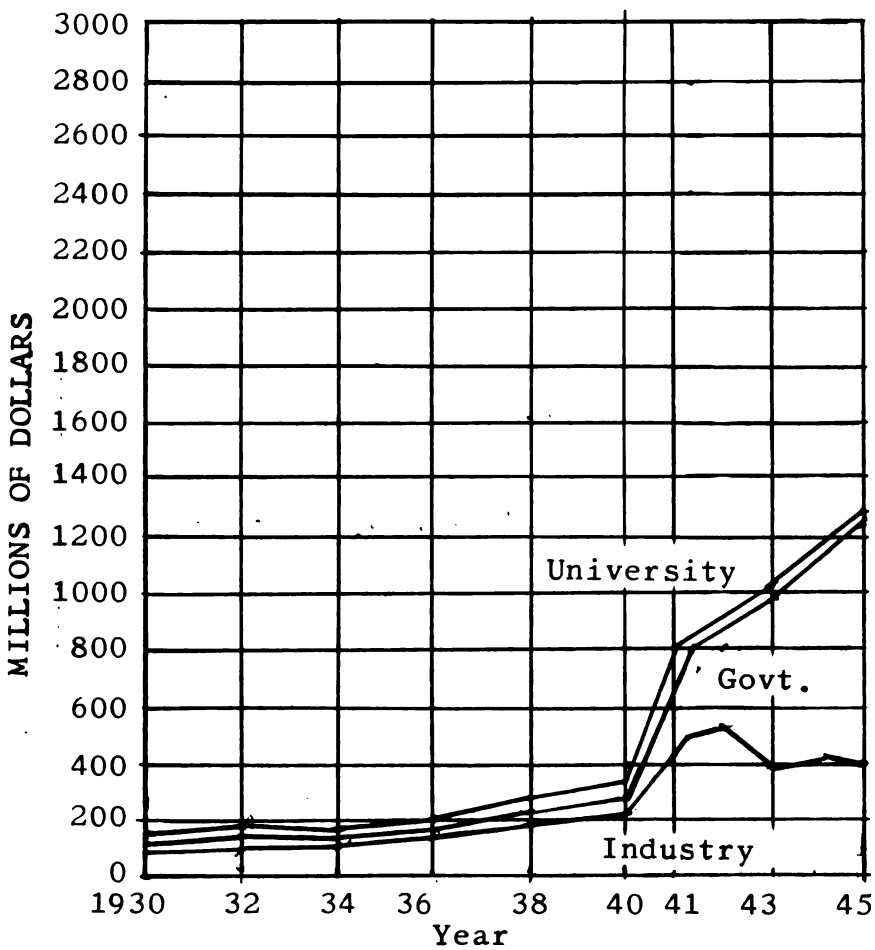

Figure 31. Research and development expenditures in the United States, 1930-45.
Source: Howard I. Forman, Patents--Their Ownership and Administration by the United States Government (New York: Central Book Company, Inc., 1957), p. 13.

cent of aggregate research and development, the government performed 14 per cent. By 1945, industry's share had fallen precipitously to 13 per cent. The government's share had ascended to 83 per cent. In the third place, a change occurred in the residence of research and development performance. In the era prior to the war, most of the research undertaken by the government was primarily within the public sector. Research projects were oriented toward the immediate problems of a specific segment of the economy. The Department of Agriculture represented a classic example of prewar in-house research.

With the advent of World War II, it became apparent that in-house or government laboratories could not accommodate the expanded role of military research. Although the government coordinated U.S. research effort through the formation of the Office of Scientific Research and Development (OSRD) the performance of research and development began to shift from the public to the private sector.

> For the first time the Government relied heavily upon contracts for the conduct of research and development projects, most of which applied scientific knowledge to military use.[1]

Thus, large research and development contracts were let to organizations in the private sector and, in fact, government laboratories performed only 20 per cent of all research

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[1]Federal Organization for Scientific Activities, 1962, National Science Foundation, Washington, D.C., 1963, p. 2.

and development effort.[1]

As the largest consumer of communication and electronic equipment between 1940 and 1945 (July), the government purchased over 10-1/2 billion dollars worth of hardware. The breakdown was as follows:

TABLE 29

WORLD WAR II COMMUNICATION PROCUREMENT

Radio	$4.417 billion
Radar	$3.731 billion
Other	$2.518 billion

Source: Office of Scientific Research and Development Cost Analysis of Research and Development Work and Related Fiscal Information, June 1940 to November 1946. Prepared by the OSRD Budget and Finance Office, May, 1947.

Trends initiated during the second World War were continued during the cold war; in fact, research and development became a growth industry. As Gross National Product rose 43 per cent between 1953 and 1961, outlays for research increased 300 per cent. In 1960 total expenditures reached 13 billion; in 1961, some 15 billion.

Of the expenditures devoted to research and development in 1961, government funding accounted for 65 per cent of the total[2] and according to a 1962 report of the Budget Bureau,

[1]Allen V. Astin, Basic Research in Government Laboratories, Symposium in Basic Research, No. 56, American Association for the Advancement of Science, Dale Wolfe, Ed., 1959, p. 147.

[2]Report to the President on Government Contracting for Research and Development, April 30, 1962, Bureau of the Budget, p. 7.

TABLE 30

ESTIMATE OF FUNDING AND CONDUCT OF RESEARCH AND DEVELOPMENT
1960
(Billions of Dollars)

	Government	Industry	Other	Total
Government	$1.6	$5.9	$0.8	$8.3
Industry	--	4.1	0.3	4.4
Other	--	--	0.3	0.3

Source: A Study of Small Business in the Electronics Industry, Small Business Administration, Washington, D.C., 1961, p. 7.

the trend towards a higher government ratio is expected to continue. Again the performance of this research effort does not reside within the public sector, but 80 per cent[1] is performed in non-government laboratories. The specific impact on the electrical equipment and communications industry is illustrated by a National Science Foundation study.

Shifting from recent research and development trends to procurement, it is apparent that the government is predominant as a consumer of electronic equipment.

According to the Electronics Industry Association, government purchases in 1961 accounted for 59 per cent of the

[1]Statistical Abstract of the United States, 1962, 83rd Annual Edition, U. S. Department of Commerce, Bureau of the Census, Washington, D.C., 1962.

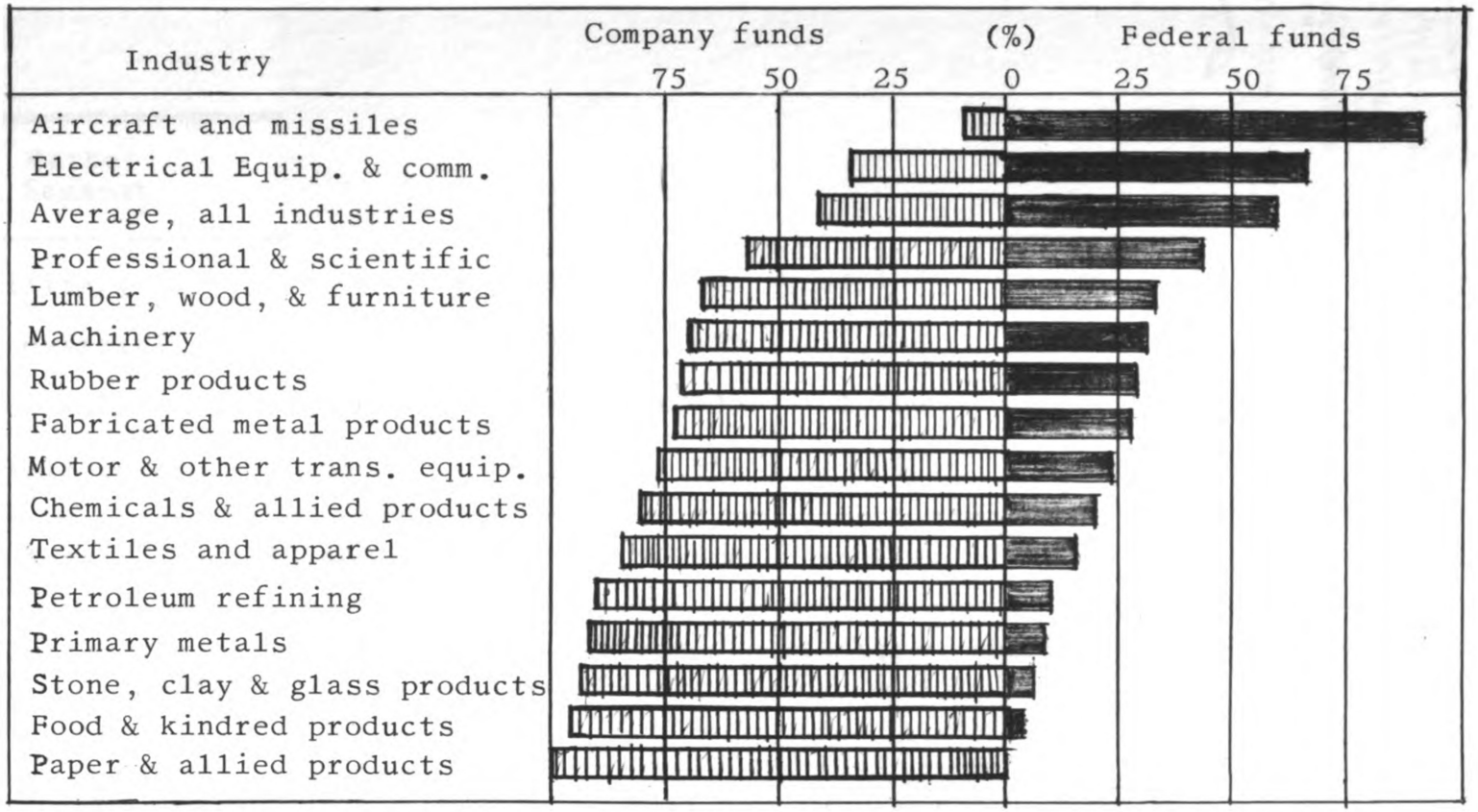

Figure 35. Percentage distribution of funds for performance of research and development, by industry and source, 1961.
Source: National Science Foundation, Reviews of Data on Research and Development, No. 36 (September, 1962), p. 7.

TABLE 31

THE MARKET FOR ELECTRONIC EQUIPMENT
1954-1965
(Millions of Dollars)

Market Segment	1954	1955	1956	1957	1958	1959	1960	1965
Military	$2,700	$2,800	$3,400	$4,100	$4,400	$4,700	$5,000	$8,000
Industrial	650	750	950	1,300	1,400	1,600	1,800	3,200
Consumer	1,400	1,500	1,600	1,700	1,600	2,000	2,100	2,500
Replacement	650	750	850	900	900	900	900	1,300
Total	$5,400	$5,800	$6,800	$8,000	$8,300	$9,200	$9,800	$15,000

Source: Small Business in the Electronics Industry, Small Business Administration, Washington, D.C., 1961, p. 20.

12 billion dollar electronic products market.[1]

In summary, the communication industry has felt both the direct and indirect impact of government research and development expenditures and government procurement policy.

This displacement of research funding from the private to the public sector and the movement of research performance in the reverse direction has tended to diffuse knowledge, information, and know-how beyond the traditional provinces of the common carriers.

Innovation of Radio Relay

A second consequence originating in the public sector has been the widespread application and innovation of terrestrial radio relay techniques. Because of the persistent belief that the existing communication industry, in and of itself, proved to be the fountain head of radio relay innovation, it is incumbent that a detailed account of this innovation be traced. It might be added, parenthetically, that innovation is, in a sense, more crucial then invention; for innovation implies application and use of a new process or product--the only form that ultimately benefits the consumer.

Radio relay techniques existed in crude form in the 1920's. In seeking an alternative to the long distance telephone circuits, Westinghouse inaugurated a form of AM radio

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[1]"Markets for Electronic Products as Per Cent of Total Factory Sales by Selected Years," 1962 Yearbook, Electronic Industry Association, Market Services Department, Washington 6, D.C., p. 5.

relay in attempting to transmit radio programs from Pittsburgh to Cleveland. However, with the rapproachment between AT&T and RCA in the mid-twenties, the major consumer of broadcast channels was committed to Bell's toll line network and radio relay techniques remained primarily in the laboratory stage.[1]

In the 1930's research in radio relay techniques were conducted by RCA, ITT, Philco, and AT&T. However, Dr. Edwin Armstrong's announcement of a new method of modulation, called frequency modulation ((FM) as opposed to amplitude modulation (AM)), prompted a new look at radio relay as a medium for relaying wide band signals, such as FM and television. By the end of the 40's, two methods emerged capable of handling multichannel signals--the Bell coaxial cable and FM radio relay.[2] Prompted by the wider band of frequencies associated with FM, Armstrong encouraged the establishment of the Yankee network--a small FM chain of stations in New

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[1]Llewellyn White, The American Radio--A Report on the Broadcasting Industry in the United States, Commission on Freedom of the Press (Chicago: The University of Chicago Press, 1948), p. 16.

[2]John Jewkes, David Sawers, Richard Stillerman, The Sources of Inventions (London: Macmillan, 1958), p. 252. "RCA refuses to develop it (FM) and broadcasting companies opposed it." Terret Dulaney, U. S. Army in World War II--The Technical Service--The Signal Corps--The Emergency in December 1941 (Washington, D.C.: Office of the Chief of Military History Department, 1956), p. 145. Comment on why FM was delayed in its Army innovation: ". . . the large radio chains in much of the communications opposed it and were successful indeed in delaying its general acceptance even after World War II. FM threatened them because it gave promise of reopening commercial broadcast competition."

England; and in attempting to avoid the prohibitive costs of leasing coaxial channel, Armstrong established an FM radio relay system.[1] He predicted in 1939 that:

> The future undoubtedly will see the introduction of chains of relaying stations equipped with highly directional antennae arrays operating on frequencies considerably higher than those used in broadcasting.[2]

Armstrong suggested that radio relay might be a lower cost medium than coaxial cable.[3]

An early prewar innovation of radio relay technique was employed by the Connecticut StatePolice, who constructed eight relay chains as links for their mobile radio units. Early manufacturers participating in supplying equipment included Motorola and the Fred Link Company (a small manufacturer of police radio equipment) operating under Armstrong patents.[4]

Wartime research and development accorded simultaneous progress in several of the areas of radio electronics. The investigation and development of tubes, circuits, antennas, wave guides, keystrons, magnetrons for radar technology resulted from radar research; research conveyed indirect benefits

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[1]L. Lessing, Man of High Fidelity, Edwin H. Armstrong, A Biography (Philadelphia: J. P. Lippincott, 1956), p. 273.

[2]Ibid., p. 274.

[3]Edwin Armstrong, "FM and Its Uses," The Annals of the American Academy of Political and Social Science (January, 1941), V. 213, p. 159. "While it may be possible ultimately to obtain the same technical performance by the use of the coaxial cable method of transmission, there will be large sections of the country where it is not economically feasible to use this and where it cannot compete with radio relay."

[4]Terret Dulaney, op. cit., p. 158.

to radio relay in the investigation of frequency propagation above 30 MC/S.[1]

The chain of developments of radio relay techniques is associated with FM vehicular radio. The ceiling of usable spectrum of most military radio equipment prior to the war was about 30 MC/S, and all radio was amplitude modulated (AM). However, AM radio had several liabilities, particularly as vehicular radio, since the AM signal was susceptible to static and ignition interference. The traditional means of dampening the interference was by shielding techniques between the radio and the engine of the vehicle. This problem was overcome by the introduction of vehicular UHF or FM which eliminated both ignition interference and static caused by lightning, thus eliciting clear voice reception.

Apparently the Connecticut State Police was among the first civilian agencies to purchase and adopt FM techniques for their mobile units. The equipment was manufactured by Motorola.[2]

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[1]Radar--A Report on Science and War, Joint Board on Scientific Research and Development, War Department, Navy Department, August 15, 1945, p. 50. "The biggest influence radar will have after the war is indirect. . . . Many of these components being identical with those of a radio or television set or other electronic devices." Also: "Radar and Western Electric," Bell Telephone Magazine (Winter, 1945-46), pp. 293-4. "Of still greater value may be the indirect applications of radar technology. The Bell System recently demonstrated a multichannel system of radio telephony, etc., . . . the circuit arrangements and electronic components of the new system are greatly indebted to radar." ITT experimented with VHF in 1931.

[2]Terret Dulaney, op. cit., p. 372.

The introduction of FM occurred in tank units, since the problem of ignition static rendered AM radio sometimes useless.[1] The earlier FM radio units were called SCR-500's. (FM was extensively used by ground troops in the form of a unit called the Walkie-Talkie (SCR-300), manufactured by GE, Westinghouse, Sylvania, RCA, and Galvin Radio (Motorola).)[2]

The division level still relied upon wires and cables as the main source of its communication system. High frequency radio (short wave) was regarded at best as an emergency backup to metallic circuits. Metallic circuits suffered from certain liabilities. One disadvantage was the logistics problem of shipping telephone poles, wire, cables, and all the equipment associated with pole lines.[3] Furthermore, once wire lines were constructed, they had to be patrolled in order to insure protection against sabotage. A further problem of

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[1]Dulaney Terret, op. cit., p. 144. "Not everyone was in favor of vehicular FM. Deprecation from Western Electric-Bell Laboratories was overborne by endorsements from his own staff and Colton directed the Signal Corps Laboratories to buy an FM receiver from General Electric and to make a mobile 50-watt transmitter."

[2]Laurence G. Fobes, "Multichannel Radio Communications Within the Army," IRE Transactions on Military Electronics, MIL-4:4 (October, 1960), p. 506.

[3]John J. Kelleher, "Radio-Relay and the War," Signals (May-June, 1947), 1:5, p. 37. Also a microwave possessed weight and volume advantages. "Reduction in weight and volume of equipment, for example, from 94,000 pounds to 17,000 pounds for a 100-mile system, 2700 cu. ft. to 700 cu. ft." Andrew R. Boone, "The Army's Radio Relay Equipment," Radio News (January, 1946), p. 155.

maintenance arose as a result of military vehicles damaging the wooden poles. FM techniques permitted radio relay techniques to graduate from HF to UHF signals. Since the UHF signal assumed the optical property of straight line propagation, the idea of a radio link developed. The first attempt at sending information via VHF radio link was employed in the Army maneuvers in North Carolina in 1941.[1] However, the real impulse to a generalized application of point-to-point techniques occurred in the African campaign. Tank mobility had created such a burden on wire line communication that an alternative means of communication was explored. In 1942, the Communications Laboratory of the Signal Corps (the Coles Signal Laboratory) sent men and radio relay equipment and, under battlefield conditions, set up the first operating radio relay system. Equipment used in this system was manufactured by the Fred Link Company, since converted police transmitters were an essential element in the system.[2] The Signal Corps labelled this equipment AN/TRC-1. It operated on 70-100 MC/S (UHF) with a capacity of one voice channel.[3] It is of interest to note that the AN/TRC-1 was originally designed as a link between wire facilities. However, as the war progressed, the Link concept expanded into a chain of relay stations that not merely supplemented metallic circuits

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[1]Roger B. Cotton, "Army Ground Communication Equipment," Electrical Engineering, 64:5 (May, 1945), p. 179.

[2]William S. Marks, Jr. et al., "Radio-Relay Communication Systems in the United States Army," Proceedings of the IRE, Vol. 33 (August, 1945), p. 506. Fred Link was a young promoter and manufacturer of special emergency mobile radios in the 1930's. Link's company had built both AM and FM radios for the Connecticut State Police.

[3]MC/S = megacycles per second.

but supplanted them. Thus, radio relay equipment was extended to the Sicilian, the Italian, the European, and the Pacific campaigns.[1] (AN/TRC-1 permitted communication between England and the Normandy beachhead and with the subsequent outbreak of Patton at St. Lo, permitted communications to be extended across France.)

The research and development base, as well as the production base of radio relay equipment, expanded with the war. In 1944, RCA manufacturered AN/TRC-8, a FM set operated between 230 to 250 MC/s and having a capacity of four voice channels.[2] Both AN/TRC-1 and AN/TRC-8 were similar in providing continuous frequency transmission.

In 1942 the Signal Corps, together with representatives from RCA and Bell Telephone Laboratory, visited England and examined secret British communication radio equipment, called the Wireless Set X-10. In contrast to U.S. equipment, this set employed the radar techniques of pulse modulation by transmitting the signal in short bursts. The equipment could transmit eight voice channels and operated in a frequency range of 4350 to 4800 MC/s. Radio relay techniques had been pushed into the UHF and SHF frequency range. Frequencies in this range are called microwaves.

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[1]George Raynor and Thompson et al., United States Army in World War II--The Technical Services, The Signal Corps, The Test, December 1941 to July 1943, Office of the Chief Military History, Department of the Army, Washington, D.C., 1947, pp. 371-2.

[2]Laurence Fobes, op. cit., p. 507.

Simulating this British equipment (largely because the equipment had to match British components),[1] the United States Signal Corps let two contracts. RCA developed and manufactured the AN/TRC-5, operating on a frequency range of 1350 to 1500MC/S,pm (pulse modulated), and AT&T (Western Electric) received the contract to develop the AN/TRC-6, operating at 4350 to 4800 MC/s, pm. These sets were introduced in the closing months of the war and it is generally acknowledged that AN/TRC-5 and AN/TRC-6 became the basis for the commercial innovation of microwave radio relay subsequent to the war.

In sum, Signal Corps personnel developed and innovated under battlefield conditions the general application of radio relay techniques.

Diffusion Effects

As a result of military contracts and experience, several companies entertained plans of establishing commercial radio relay systems. As we have seen, AT&T participated in wartime microwave research in general and manufactured AN/TRC-6 in particular. However, in addition to Bell, a rundown of companies seeking to innovate commercial radio relay systems for communication purposes reveals that new competitors had entered the market place of the common carriers.

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[1] Ibid., p. 507.

Western Union established the first commercial postwar system employing RCA and Philco equipment. Subsequently, AT&T announced plans of establishing a radio relay system and innovated the same equipment (AN/TRC-6)[1] that it had built under a Signal Corps contract. Philco established a microwave system between Washington and Philadelphia. International Business Machines, Inc. and General Electric announced a joint radio relay project between New York City and Schenectady, New York. Westinghouse embarked on an airborne radio relay system for television, while Raytheon outlined a nationwide plan for a radio relay system. RCA submitted its proposals before the FCC and DuMont Laboratories, Inc. likewise announced plans for a microwave link system. Finally, a nationwide relay network was proposed by International Telephone and Telegraph.

Prior to the war, construction was started on Bell's coaxial cable system as a means of relaying broadband signals. Radio relay was largely in the experiment and talking stage.[2]

If the knowledge of radio relay technology was not

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[1] "This radio equipment (AN/TRC-6) employs a technique originally developed by the Bell Lab for use of the armed forces." AT&T Annual Report, 1946, p. 14. Also: "The radio system planned is basically of a type developed by Bell Laboratories for war-use--known to the Army and Navy as AN/TRC-6." Telecommunication Reports, 12:20 (January 9, 1946), p. 8.

[2] Edward H. Armstrong, "The Evolution of Frequency Modulation," Electrical Engineering, 59:12 (December, 1940), p. 159. In commenting on the growth of FM radio techniques, Armstrong observed: "The burden of the development has been carried almost entirely by the small units."

available directly by participating in government contracts, it was to become available indirectly. MIT's Radiation Laboratory published a twenty-eight volume work summarizing its contribution to microwave technology.[1] Information on microwave equipment following the war was declassified and disseminated throughout the radio industry. The Signal Corps shipped captured German radio relay equipment to this country for study and perusal by the industry.[2] (Some of the equipment reputedly was superior to our own.) The Commerce Department published reports on captured German electronic and communications equipment--reports gathered by Allied intelligence teams.[3] (Industry could obtain these reports for ten cents and up.)

Not only was knowledge diffused by direct and indirect means, the patent situation had been altered--particularly in the field of microwaves (radar and radio relay). Ninety-five per cent of the radar patents had come into existence

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[1]Louis N. Ridenour, Massachusetts Institute of Technology, Radiation Laboratory Series, Preparation of the Laboratories series, Vol. 28, p. xxvii (New York: McGraw-Hill, 1953).

[2]Telecommunication Reports, 12:26 (February 23, 1946), p. 3. "Under arrangements now being completed the communications unit of the Technical Industrial Intelligence branch under the Department of Commerce Production Board, will stage an exhibition of German communication and electronic equipment in Washington. German relay systems are said to be outstanding from a mechanical standpoint and electrically equals or surpasses American equipment.

[3]Telecommunication Reports, 12:19 (January 5, 1946), p. 23. Reports were gathered from German equipment by Allied Intelligence Teams and included data on television radio-relay systems, carrier telephone systems, designs of magnetrons and keystrons, etc.

since the outbreak of the war--patents secured under military contracts.[1] In contrast to the heavily concentrated portfolios possessed by AT&T and RCA prior to the war, an Army-Navy Committee report found:

> . . . that privately held electronic patent rights are so widely dispersed in ownership, so interrelated in subject matter and so numerous that obtaining licenses on an individual basis is practically impossible either to the industry or to the government.[2]

Patent dispersal in electronics in the post-World War II era is in striking contrast to the World War I era when patent concentration enabled three firms to cartellize the radio industry. Patent dispersal was of such dimension that some authorities were prompted to form a domestic patent pool in order to preclude impending infringement suits. Admiral Dow, in charge of Navy wartime research, advocated the formation of a nonprofit radar patent pool.[3]

Further erosion of the patent barrier appears to be occurring in the post-World War II era, as suggested by the declining ratios of patents to total research and development (Figure 33). Again the source of the erosion appears to be the shift in mix from privately funded research and development to public funded research and development.

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[1]J. B. Dow, "The Navy Electronics Program and Some of the Past, Present and Future Problems," Proceedings of the IRE (May, 1945), 33:5, p. 296.

[2]Telecommunication Reports, 12:12 (January 24, 1946), p. 10.

[3]Dow, op. cit., p. 296.

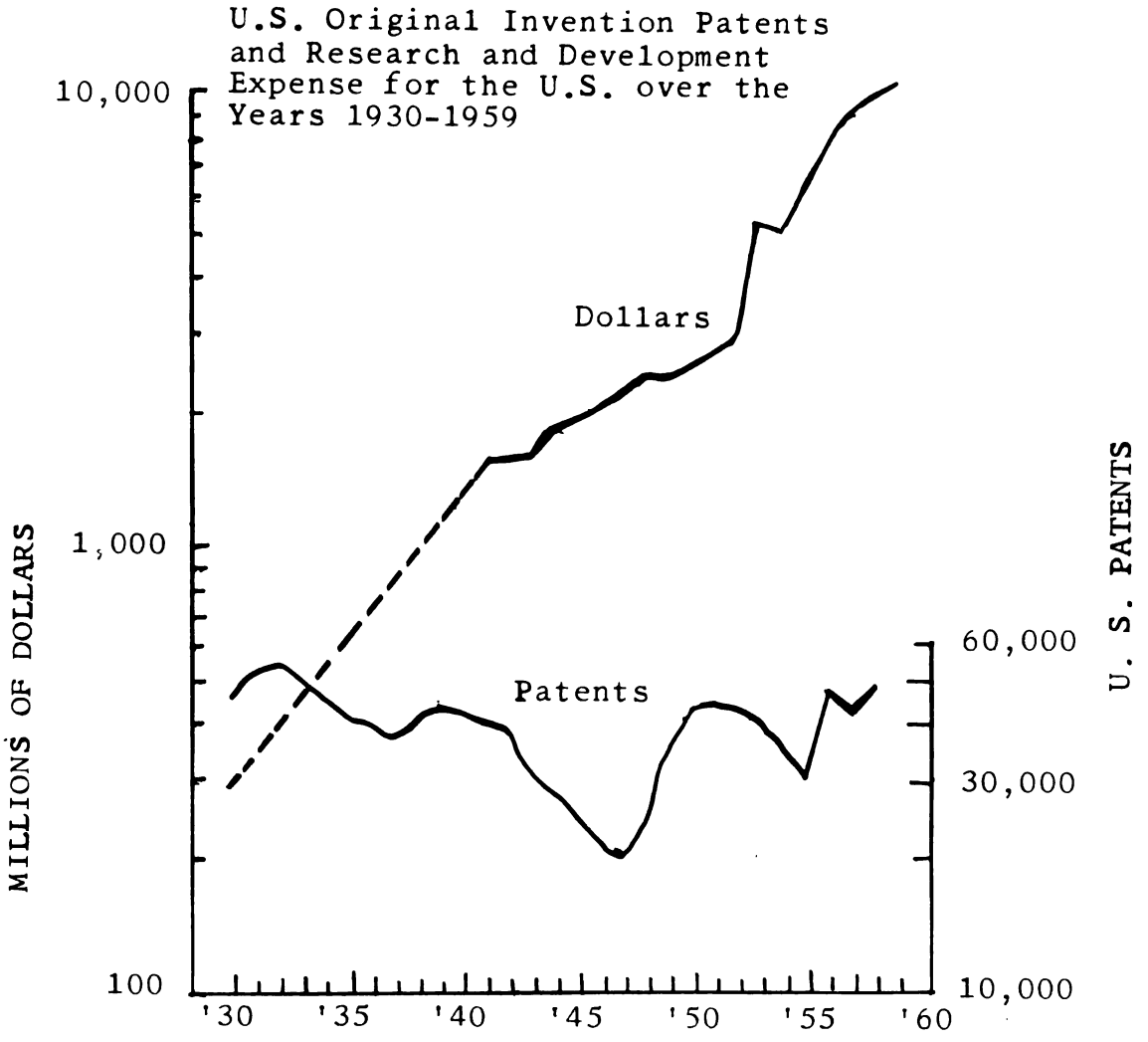

Figure 33. Decline of patent ratios.
Source: U.S. Congress, Senate, The Impact of the Patent System on Research by Seymour Melmen, Study of the Subcommittee on Patents, Trademarks and Copyrights of the Committee of the Judiciary, 85th Congress, 2nd Session, Study No. 11, p. 32.

Access to military research contracts is becoming crucial for firms attempting to keep abreast of new technology. One specific case involves the Raytheon Corporation. Raytheon did not possess a microwave tube that would generate a sufficiently wide band of frequencies to carry a television signal. Knowing that the Air Force was letting contracts on such a tube, Raytheon successfully bid on the contract, completed it, and then introduced the necessary component into their private radio relay system.[1] Again, the government contract played a crucial role.

Today, one implication of government research upon the patent system is its influence upon the rate of technical change. Walton Hamilton prophetically observed:

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[1]Before the Federal Communications Commission, in re Application of Raytheon Manufacturing Company, Waltham, Massachusetts, for Modification of Construction permit to extend date of completion of construction of television broadcast station, WRTB, Waltham, Massachusetts, Docket No. 8756, December 15, 1959. Federal Communications Commission Reports, Vol. 14 (June 1, 1949, to June 30, 1950), p. 390. Raytheon won a subcontract bid from Bell Aircraft Corporation for Air Force for research and development work on wide band relay equipment essentially the type of relay television signals. Subsequently, Raytheon as a result of this experience marketed commercial relay video equipment. Also: Before the Federal Communications Commission, in the matter of allocation of frequencies in the bands above 890 mc, Docket 11866, Electronics Institute, Exhibit, Highlights of Radio Relaying History, p. 4. "Motorola under contract with Signal Corps investigated frequency range 6,000 mc to 12,000 mc studying effects of rain attenuation and antenna feed horn design. Under same contract developed 7,000 mc to 8,000 mc radio relay system handling 2 video and 8 multiplex signals in each direction, 1946-7." Subsequently, 1949, Motorola developed microwave equipment at 6,000 mc with 12 channel multiplex, p. 7.

> Technology moves now with a speed once undreamed of--its swift march dictates a shortening of the life of a patent.[1]

Thus, some electronic firms do not bother to file patent rights because of the high rate of obsolescence generated by new products;[2] and if a patent is needed, there has developed a general tendency of patent cross-licensing.

In summary, the increased role of the public sector in research and procurement has set into motion certain factors that tend to dilute the once formidable patent portfolio of the Bell System. First, it was noted that the U.S. government is literally the research patron in the communication industry. Second, we have seen that under the exigencies of wartime pressure, the Signal Corps pulled radio relay out of the laboratory and innovated it under battlefield conditions. Third, as a consequence of federal research and development expanditures and contracts during World War II, patents on microwave technology and circuits were widely dispersed and additional firms acquired radio relay knowhow. Finally, the continued government expenditures devoted to electronic research has tended to increase the pace of technical change. It is becoming apparent that access to the frontiers of new knowledge in the communication industry

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[1]Walton Hamilton, Investigation of Concentration of Economic Power, Temporary National Economic Committee, Monograph No. 31, Patents and Free Enterprise (March 14, 1941), 76th Congress, 3rd Session, p. 157.

[2]Weldon Welfing, "The Role of Patents in Boston Electronics," Patent Trademark and Copyright of Research, Education, Vol. 5, 1961, p. 372.

is vested in securing the government contract. (For example, 50 per cent of Bell Laboratories' income is derived from government contracts.)

A discussion of AT&T's patent position is not complete without some assessment of the 1956 consent judgment.

In 1949 the Justice Department charged that the integration of AT&T and Western Electric violated Sections 1 and 2 of the Sherman Act. In citing Western Electric's predominant position in the communication equipment market, the Justice Department sought two remedies. First, Western Electric was to be divested from the Bell System, AT&T was to dispose of its Western Electric stock, and Western was to pull out of Bell Laboratories. Second, Western Electric was to be separated into three competing corporations. The aim of Western's divestiture from the Bell System was to introduce price competition into communication equipment. As noted, the price of telephone equipment and apparatus has a direct bearing on the cost of telephone service since equipment costs are included in telephone rate bases.

In 1955 the Attorney General discontinued insisting upon Western Electric's divestiture and AT&T was requested to submit a consent decree proposal. The proposal was adopted a year later by both parties.

The 1956 consent decree, hailed as a milestone in antitrust history, centered upon the patent position of the Bell System. On the assumption that patents represented the key barrier to competition in the communications equipment

market, AT&T was ordered to make available, on a royalty-free basis, its entire patent portfolio. This portfolio included some 8,600 patents. Not only were existing patents subject to compulsory licensing on a royalty-free basis, but all future Bell patents were subject to compulsory licensing on a reasonable royalty basis. The decree, in addition, required that Western Electric furnish technical information to all licensees at reasonable prices. Specifically, Section XIVB of the decree included:

> . . . manufacturing drawings and specifications of the materials and parts comprising such equipment, and manufacturing drawings and specifications covering the assembly, wiring and acceptance test requirements of such equipment.[1]

Presumably, the availability of technical information was the severest part of the decree.

To this date no comprehensive examination exists as to the impact of the consent decree upon the competitive nature of the equipment market. What little evidence exists is the result of probings sponsored by the House Judiciary's Antitrust Subcommittee.

The first impact of the decree was the compulsory licensing clause. The strength of this clause was somewhat diluted since Bell's postwar policy allegedly was to license all patents on a reasonable royalty basis. Bell's purpose

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[1] U.S. Congress, House, Report of the Antitrust Subcommittee (Subcommittee No. 5) of the Committee of the Judiciary, 86th Congress, 1st Session, pursuant to H. Res. 27 (Consent Decree Program of the Department of Justice), 1959, p. 107. (Hereafter cited as Celler Antitrust Report.)

apparently was not the receipt of royalty income per se, but rather patent grant-backs which enable it to use the patent rights of others. In short, Bell's patent portfolio enhanced its bargaining position in seeking access to other firms patents. Thus, commenting on the compulsory license policy of the decree, Mr. Lockwood, AT&T vice president, observed:

> This policy which has been voluntarily adopted was later made mandatory by the terms of the final judgment . . .[1]

Perhaps officials of the Justice Department will disagree with this observation, but if there is any substance to Mr. Lockwood's observation, the compulsory licensing section certainly lost much of its sting.

A second consequence of the decree obviously was to reduce the Bell Systems royalty income. Royalties declined as follows:

Year	Royalties
1955	$3,519,308
1956	1,963,854
1957	314,598[2]

Assuming that royalty income was regarded with some importance by the Bell System, such a decline appears to be transitory only. As one Bell official testified:

> Our patent position will be rapidly reestablished. There are approximately 2,000 patent applications

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[1]Edward T. Lockwood, "Bell System Patents: Why Do We Have Them?" Bell Telephone Magazine, XXXVIII:4 (Winter 1959-60), p. 20.

[2]U. S. Congress, House, Cellar Antitrust Report, op. cit., p. 111.

> on file in the United States Patent Office and we are continually adding to those applications. We would expect that between 400 and 500 patents will issue to us each year, thus restoring our bargaining position in acquiring rights from others as well as royalty income.[1]

A third impact of the decree related to the grantback provisions. As Bell officials observed before the Celler Hearings, accessibility to the patents of others was more important to them than the royalty income generated by their own patents.

As a condition for licensing its patents, Bell is entitled to a patent grantback limited to equipment:

> "useful in furnishing common carrier communications services" together with machines, tools and materials useful in manufacturing or operating any such equipment.[2]

The Antitrust Committee commented that:

> This limitation, while designed to confine the Bell operating companies to the common carrier communications field, is so broadly worded as to provide the Bell System extremely wide latitude in the type of grantbacks it may require.[3]

The royalty free licensing of all existing Bell patents has tended to reduce AT&T's bargaining position in receiving royalty grantbacks in that 7.7 per cent of pre-decree license agreements required that Bell pay patent royalties, while 25 per cent of the post-decree grantbacks were royalty bearing.[4]

The consent decree has not impaired AT&T's ability to obtain the patent rights of others. The decree has tended to raise the price of the patent grantback; but Western

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[1] Ibid., p. 111.
[2] Ibid., p. 105.
[3] Ibid., p. 111.
[4] Ibid., p. 109.

Electric observed that they raised the price of the grant-back, Western Electric observed that they:

> . . . still have a very powerful weapon to aid [them] in getting royalty-free licenses, i.e., which has been established over the years of permitting licensees to visit the laboratories and shops for discussion of developments of mutual interest falling within the scope of their license.[1]

A fourth component of the consent judgment relates to the requirement that Bell must furnish manufacturing drawings and specifications of its patents. This can be classified as "decree information." What is not required to be supplied is "nondecree information," such as data relating to:

> machinery used in the manufacture of such equipment, or to equipment manufactured by the Bell Laboratories, nor are they required to be given "manufacturing knowhow," to furnish any information on tools, machinery methods, processes, manufacturing layouts, or quality control, to furnish any Bell Laboratories papers, knowhow, consultation or similar services or to provide design or systems engineering data or installation of maintenance instructions.[2]

A Western Electric study of charges for technical information for total engineering costs reveals that decree information accounted for 14 per cent of the cost, non-decree information 28 per cent of the cost.[3]

Some observers feel that non-decree information is as useful as the required decree information.

> Often much information of an unpatentable nature is required to operate satisfactorily a given process or to produce a given product, including among other things, detailed information accumulated in the

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[1] Ibid., p. 110.

[2] Ibid., p. 115.

[3] Ibid., p. 115.

> operation of pilot plants and the initial periods of full-scale production.
> . . . . . .
> The accumulation of this knowhow is as necessary for the economic operation of a process, or production of a satisfactory product, as is the information given in the patent.[1]

Furthermore, a Bell official testified:

> Since the trading value of our patents will be quite limited for the next few years, the charges for technical information would be an important element in negotiating for a royalty-free licensing.[2]

The Subcommittee investigating the effect of the consent judgment upon Western Electric's market position concluded:

> . . . the patent licensing and technical information provisions of the decree neither materially aid independent manufacturers of telephone equipment to compete with Western, nor materially hamper Western in the enjoyment of its predecree patent monopoly. Despite this ability to demand a licence--a right which the Bell System had for years accorded applicants without compulsion of a decree--the independent manufacturer of telephone equipment is still under the necessity of finding a market for the product of which the patent is the basis.[3]

Concluding the assessment on patents, it is clear that historically the possession of strategic patent rights was an essential element in the evolution and structuring of the communication equipment industry.

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[1]U.S. Congress, Senate, Seymour Melman, The Impact of the Patent System on Research, Study of the Subcommittee on Patents, Trademarks and Copyrights of the Committee on the Judiciary, 85th Congress, 2nd Session, pursuant to S. Res. 236, Study No. 11, p. 35.

[2]U. S. Congress, House, Consent Decree Program of the Department of Justice, op. cit., p. 2739.

[3]U. S. Congress, House, Cellar Antitrust Report, op. cit., p. 119.

In recapitulating the two forces tending to erode the patent barrier, it is apparent that the impact of the public sector overrides the influence of the consent decree. In the first place, the government literally funded and now underwrites the vast majority of the research bill in the communication and electronic field. Second, we have seen that this burden was assumed during the second World War. Third, not only was the state of the art advanced under the impetus of the war, but radio relay systems were innovated during the war. Fourth, research and development as well as procurement contracts, even though biased toward the large firm, nevertheless resulted in a diffusion of microwave knowhow, knowledge, and technology beyond the traditional provinces of the common carriers. Fifth, by the end of the war, patents in the microwave field were dispersed to the extent that some members of the industry advocated a pooling of patents. Apparently the problem was resolved by a general policy of cross-licensing. Sixth, the relevance of patent erosion is seen by the number of companies who entered the radio relay field in the years subsequent to the war. Finally, while the impact of the consent decree is difficult to evaluate, it is important to note that the judgment merely converted Bell's voluntary licensing policy into a mandatory policy. In short, of the two factors tending to diminish patented knowledge as an entry restraint for the nonintegrated firm, government expenditures and contracts appear overriding.

Frequency Allocation

A second potential entry restraint confronting the non-integrated microwave firm is the supply of the raw material without which he could not hope to operate, i.e., the availability of microwave frequency bands. This availability is a function of the supply of frequencies which, in turn, is dependent upon the state of the radio art. Although historically, the state of the art continues to make available a greater quantity of usable spectrum, at any given point in time, the size of the spectrum is finite. In economic parlance, this inelasticity of supply coupled with a growing demand for its use necessitates that this spectrum as a scarce resource be subject to rationing and allocation, a function performed by the Federal Communications Commission.

Prior to the war, the limit of spectrum use was considered to be around 200 MC/s. Although experimentation had pushed beyond this limit, for routine use, the ceiling existed at 200 MC/s. Radio relay techniques, particularly AM, encountered problems of frequency congestion since bands were already crowded. On a limited basis, both the Mackay companies and RCA Communications operated domestic radiotelegraph service until June 30, 1942. However:

> The limiting factor in a nationwide radiotelegraph network was the lack of sufficient available radio frequencies.[1]

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[1]Hyman Golden, The Telegraph Industry and Public Policy (unpublished Ph.D. thesis, Harvard University, 1949), p. 244.

Wartime research lifted the usable spectrum range a hundredfold by making available the bands in the UHF and VHF regions.[1] These regions permitted directional point-to-point relaying.

As World War II entered its final months, this new spectrum was allocated by the FCC. About one-third of the spectrum was allocated for commercial point-to-point service, the rest was reserved to the government and other uses. The private segment of these frequency bands was then allocated between common carriers and subsequently private microwave systems. By 1955 some 10 per cent of the frequency band had been rationed to private microwave systems, 16 per cent assigned to the common carriers, and 7 per cent to the broadcasters.[2]

Spectrum assignments can be made on a regular basis or on a developmental basis. The latter is less permanent than the former since developmental licenses are granted for one

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Why radio relay was not in general use prior to World War II, according to Western Union: "Another factor in this situation was the frequency short age which existed. The number of channels which would be required to transmit the intercity trunk load of Western Union (950 million messages annually) would be quite impossible to secure by allocation from the Federal Communications Commission because of the demands of many other necessary services, for some of which the use of radio is unavoidable." Julian Z. Millar, "Telegrams on the Beam--A Preview of Western Union System of Radio Beam Telegraphy," Signal, 1:3 (January-February, 1947), p. 27.

[1]Louis N. Ridenour, "Radar in War and Peace," Electrical Engineering (May, 1946), Vol. CF, p. 207.

[2]Before the FCC, The Above 890 Docket, op. cit., p. 3.

TABLE 32

SPECTRUM ALLOCATION BEFORE "ABOVE 890 DOCKET"

Private			Common Carrier			Broadcast		
952 -	960 =	8 Mc	3,700 -	4,200 =	500 Mc	940 -	954 =	12 Mc
1,850 -	1,990 =	140 Mc	5,925 -	6,425 =	500 Mc	1,990 -	2,110 =	120 Mc
2,110 -	2,200 =	90 Mc	10,700 -	11,700 =	1000 Mc	6,875 -	7,050 =	175 Mc
2,450 -	2,500 =	50 Mc		Total	2000 Mc	12,700 -	13,200 =	500 Mc
2,500 -	2,700 =	200 Mc					Total	807 Mc
6,575 -	6,875 =	300 Mc						
12,200 -	12,700 =	500 Mc						
	Total	1288 Mc						

Source: The Above 890 Docket, EIA Exhibit.

year subject to renewal. Further, developmental frequencies are subject to reallocation at any time. The common carriers were assigned frequencies on a regular basis; the users of private microwave assigned frequencies on a developmental basis.

Those permitted to use private microwave (operational fixed as the FCC calls them) included members of the Radio and Special Services group--a composite of public safety organizations (police, highway) and right-of-way companies, such as railroads, power companies, etc. Each frequency assignment was made on a case-by-case basis. The potential possibility of frequency reallocation increased the risk of equipment obsolescence to this group, although it was possible to spread such a risk by several groups sharing the same microwave relay system. Multiple use of a microwave system also tended to diminish the individual's capital investment in establishing a radio relay network.

In 1955, following a cost study on telephone leasing, the Minute Maid Company decided that linking its orange processing plants in Florida via a microwave radio link would reduce the company's communication costs.[1] In order to shift from common carrier leasing to outright radio relay ownership, it was necessary to apply to the FCC for a license for frequency use. Now Minute Maid's application

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[1]Stanley W. Penn, "Versatile Signals," Wall Street Journal (September 29, 1960), Vol. 156, p. 1. "By building its own system, Minute Maid figures it would save about $1,400 a month."

differed from previous microwave users. Minute Maid was not classified as a right-of-way company, but as a manufacturer which, under the frequency licensing policy of the FCC, was excluded from frequency use. Subsequently, a Texas trucking firm filed application for a private microwave system. The trucking company expressed apprehension that its competition, the railroad common carriers, were able to use microwave systems while the denial of such systems to the trucking industry placed them at a competitive disadvantage. It is generally conceded that these two applications triggered the FCC to re-evaluate its allocation of the bands of frequency in microwave regions.[1] (Twelve years have elapsed since the spectrum use had been examined.) After some hesitation,[2] the FCC opened Docket No. 11866, known as the "above 890" docket. The Commission solicited views and information as to availability and use of frequencies above 890 MC/s--the microwave region.

Among the issues raised during the course of docket proceedings, two basic questions confronted the Commission--one technical and one economic.

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[1]Washington Bureau, Telephone Engineer and Management (August 1, 1957), 61:15, p. 15.

[2]Central Freight attempted and failed because a court order forcing the FCC to either grant or set hearings for its private microwave application. The company claimed that it could not prove its allegations of economies of microwave since it lacked "operational experience." The trucking firm noted that the Commission permitted the railroad industry, its competitor, to receive applications. "Washington News Letter," Telephone Engineer and Management, 62:12 (June 15, 1958), p. 12.

The technical question centered around the question of frequency supply in the bands above 890 MC/s. That is, was there a sufficient supply of frequencies relative to needs of the common carriers and others? In short, was it technically possible to accommodate additional commercial use of private microwave systems?

The common carriers, including AT&T, Western Union, General Telephone and Electronics, and the United States Independent Telephone Association were united in their opposition to liberalizing frequency use. The common carriers asserted that the microwave spectrum must be reserved for the growing needs of common carrier service. They emphasized the finiteness of the spectrum and the need for frequency conservation. They doubted the feasibility of spectrum sharing with private microwave systems, contending that frequency sharing was impractical. If frequencies were to be allocated on a free-for-all basis, the Commission would certainly encounter problems of interference that would degrade communication service for all concerned.

The Bell System emphasized that it had constructed 10.5 million miles of microwave (at the time carrying 27 per cent of long distance telephone service) and some 60,000 miles of intercity television circuit miles on microwave.[1] The

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[1]Before the Federal Communications Commission, Report and Order, in the Matter of Allocation of Frequencies in the Bands Above 890, Vol. 27, Adopted July 29, 1959, p. 364. (Cited as 1959 Above 890 Report and Order.)

growth of both markets necessitated the preservation of sufficient frequencies.

The opposition to the common carrier position included such interests as the National Association of Manufacturers, the Association of American Railroads, the American Trucking Association, and the Electronics Industry Association (EIA). As a trade organization for electrical equipment manufacturers, EIA assumed the burden of technically establishing the position that sufficient frequencies were available for private microwave systems.

EIA attempted to establish the need for private microwave systems by market studies coupled with twenty-year projections. EIA further attacked the problem of interference by suggesting that most (9/10's) private microwave systems would be constructed in open country rather than in urban areas.[1] Finally, under a host of assumptions, EIA attempted to establish that sufficient frequencies existed permitting the accommodation of all users in the foreseeable future.

In sum, the common carriers took the position that as a scarce resource, the microwave region should be carefully rationed; while the potential microwave users sought to prove that sufficient frequencies existed as to render it a "free" resource with enough for all.

The second issue confronting the Commission was an economic one. The common carriers contended that permitting

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[1] Ibid., p. 379.

expanded eligibility of private microwave systems would result in irreparable harm to their ability to render service and they observed that the entrance of private systems would hamper the improvements necessitated by the responsibility of providing service to everyone. The Bell witness stated his case by contending:

> . . . to permit the licensing of private microwave systems where common carrier facilities are available would cause irreparable harm to the telephone company's ability to provide a basic nationwide communication service, which is vital in times of peace but indispensible in times of emergency.[1]

The Bell System predicted that a drastic revision of rate schedules would be one result of entry since the heavy users of common carrier facilities would own their own microwave links over high volume, high cost routes, leaving to the common carriers the low volume, high cost routes. This factor is described as "cream skimming" in which the common carriers would be left with the skimmed milk.

Those favoring the position of private microwave systems suggested that the revenue loss suffered as a consequence of frequency liberalization would be negligible to the Bell System. Motorola's study entitled "The Effect of Microwave Installations on 1966 Bell Telephone Potential Gross Revenues," projected a revenue loss of $315 million or 2.87 per cent of Bell's gross.[1] AT&T criticized the study's

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[1] Ibid., p. 388.

[2] Before the FCC, The Above 890 Docket, op. cit. "Effect of Private Microwave Installations in 1966 Bell Telephone Potential Gross Revenue," Motorola Exhibit 142, p. 5.

conclusion by observing that Motorola took the smallest loss and compared it to the largest revenue figure (gross) in order to reach a small percentage. However, Bell offered no comparable study for the Commission to assess. In joining the Bell position, Western Union stated that its telegraph service would be impaired by diversion of revenues from its private lease business to private microwave. The common carrier, to sum up, alleged that frequency expansion would affect adversely their commitment to render service to the public.

Although the Above 890 Docket ostensibly concentrated on frequency adequacy or inadequacy, the theme of competition in the manufacturing of communication equipment was raised. The common carriers denied that the status quo tended to lessen competition and foster monopoly in the manufacture and sale of communication equipment. The Final Report of the FCC stated AT&T's position:

> It was further claimed that the advantage of competition will be retained if telephone company affiliates are permitted to devote their energies toward developing and improving equipment for microwave systems. It was their [AT&T] position that there is no microwave industry, per se, but rather the whole electronics industry which must be developed.[1] [Emphasis added.]

Furthermore, Bell witnesses suggested that restricted frequency eligibility would provide sufficient growth to microwave manufacturers.

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[1]Before the FCC, 1959 Above 890 Docket, Report and Order, op. cit., p. 394.

The private microwave advocates urged that expanded frequency eligibility would provide more competition in the microwave industry. In drawing attention to the integrated nature of the Bell System, the advocates noted that AT&T's natural tendency to purchase equipment from its own subsidiary, Western Electric, would hold monopoly implications in the equipment. Thus, neither Bell nor the private manufacturers could agree on the relevant market.

On August 14, 1959, the FCC Report was issued, directing its decision to frequency supply which, in turn, determined eligibility. The Commission concluded that:

> . . . it is not probable that there will be frequency shortages in the reasonable future in such areas.[1]

Hence, the Operational Fixed Classification was shifted from a developmental basis to a regular basis; and on this conclusion, the frequency licensing for microwave systems was liberalized to include all commercial applicants.

Directing itself to the economic effects on the carriers, the Commission concluded that:

> a finding of adverse economic effects cannot be based upon a speculative possibility of future adverse effects.[2]

Finally, on the issue of competition in the equipment market, FCC stated:

> We feel that expanded eligibility will afford a competitive spur in the manufacturing of equipment and in the development of the communications art.[3]

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[1] Ibid., p. 404. [2] Ibid., p. 412. [3] Ibid., p. 414.

If the essence of the 1959 Decision rested upon the availability of sufficient frequencies in the reasonable foreseeable future, this assumption was soon challenged.

On petition from AT&T and General Telephone, the Docket 11866 was reopened for the limited purpose of receiving information and data on a space communications system and the frequency requirements required of such a system. As suggested earlier, the launching of satellites in the late 50's (1957+) prompted conjecture as to feasibility of hoisting microwave repeaters, and AT&T's speculation had hardened into a specific proposal for world-wide communications.

Bell's position was the following: calls to Europe had increased 90 per cent following the installation of the first transatlantic cable; and all existing and projected cables would be overloaded by 1965.[1] Since the capacity of cables was limited, future channel capacity necessarily would have to be supplied by a satellite relay system. (However, it is of interest to note that AT&T's expansion of capable capacity, according to Chairman of the Board, F. Kappel,[2] may equal satellite relay capacity.)

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[1]Before the FCC, The Above 890 Docket, op. cit. "Frequency Needs for Space Communication," Testimony and Exhibits of American Telephone and Telegraph Company. Testimony of James Fisk, p. 5.

[2]"AT&T Sees Ocean Cables with Satellite Capabilities," Wall Street Journal, CLXI:54 (March 19, 1963), p. 14. According to Kappel, "We have a transistorized cable under development at the Bell Laboratories, for example, that will be able to transmit television."

A satellite communications system using microwave would provide broadband channels available for voice and record services--and AT&T's presentation contained cost estimates, the number of ground stations, a survey of alternative systems, etc.[1]

However, the thrust of the Bell position was directed to the optimum band of frequencies required for space communication. Frequencies below 1,000 MC/s were inadequate because insufficient bandwidth did not provide broadband modulation techniques (earth noise affected signal reception). The frequencies above 10,000 MC/s have a tendency to be absorbed by the moisture and oxygen in the air. Thus, the optimum frequency band for a space communication system included the frequencies between 1,000 MC to 10,000 MC/s often referred to as the "space window." AT&T suggested that a bandwidth range of 2,000 to 3,000 MC would be required for communication satellite use.

Since the frequencies now available to private microwave systems included the bands required for space use, and if private eligibility was continued, the frequencies above 1,000 MC would have to be shared with those common carriers establishing a communication satellite system. However, AT&T asserted, frequency sharing would inevitably encounter problems of interference since the returning satellite signal

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[1]Before the FCC, The Above 890 Docket, op. cit., AT&T, Testimony of Charles M. Mapes, p. 13.

tends to be weak. Further, a random low orbit system with swivelling ground stations would stare into terrestrial private microwave systems, resulting in mutual interference. Bell's brief concluded that the sharing of frequencies was neither practicable nor feasible for space communication since:

> Interference of terrestrial microwave systems into space systems is a serious hazard and it is not practical for them to share frequencies in populated North America.[1]

--AT&T requested that liberalized frequency eligibility of private microwave systems be rescinded.

The rebuttal to Bell's position was assumed, in the main, by the Electronic Industries Association (EIA). In a technical analysis EIA recognized the evolution and feasibility of a communications satellite system. However, the Association took issue with the position that space satellites communication required the exclusive allocation of frequencies ranging from 1,000 MC/S to 10,000 MC/S. EIA's brief took the tack that it was possible to have co-channel sharing of frequencies. EIA further examined the several alternative satellite systems in addition to the low orbit system, stressing the virtues of a synchronous system. Under a synchronous system, the fixity of the satellite negated swivelling ground stations and static ground stations

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[1]Before the FCC, The Above 890 Docket, op. cit., AT&T, Testimony of Brockway McMillan, p. 38.

reduced the chances of space interference with terrestrial microwave networks.

Turning specifically to the problems of frequency interference of a low orbit system, EIA suggested that "sterilized" areas could be established segregating land microwave towers from satellite ground stations. Thus, a low orbit system operating at 2,000 MC required a buffer zone of thirty-eight miles, while a system operating at 6,500 MC necessitated a zone of fifty-five miles.[1] The main source of frequency interference would occur when a satellite antennae swung into direct line of a terrestrial microwave tower operating on the same frequency. However, EIA suggested that proper precautions, frequency selection, etc. would eliminate such potential interference.

In commenting on AT&T's request for exclusive frequency allocation as a function of its space needs, the Association expressed apprehension that the private users might have to forego their frequency allocations and on this position the Association was joined by the National Association of Manufacturers, the American Trucking Association, and others.

In summary, Bell maintained that frequency sharing was impractical, the private microwave users asserted that co-channel sharing was feasible given "reasonable engineering care."

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[1]Before the FCC, Memorandum Opinion and Order, in the Matter of Frequencies in the Bands Above 890 MC, Docket No. 11866, October 1960, p. 846. (Hereafter cited as 1960 Above 890 Order.)

In assessing the position of both adversaries, the FCC observed that AT&T's argument was based upon the "worst possible situation," i.e., when mutual antennaes would be staring at each other face to face. The Commission said that EIA's argument rested on the assumption that mutual antennae would not be facing each other, and if they did, that this position was an exception to the rule.

Proceeding from different assumptions, the Commission noted that each party's conclusion

> resulted in large differences in the calculated required separation between earth terminals in the space service and stations in the microwave fixed area.[1]

The Commission concluded in a decision favoring the sharing of the 1,000 to 10,000 frequency bands:

> The Commission is of the opinion that the sharing of the spectrum is feasible provided adequate care is taken in system design and in the coordination of day-to-day changes in circuitry of the sharing systems.[2]

In short, no exclusive allocation was to be conferred for communication satellite purposes.

Figure 34 depicts the results of the "Above 890 MC" decision.

Although the FCC's determination to expand frequency eligibility was declared a victory for the manufacturers of private microwave equipment, there continues to exist the potential problem of frequency realocation.

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[1] Ibid., p. 847. [2] Ibid., p. 847.

Figure 34. Safety and special radio service--developmental basis.

In the first place, although private users can obtain frequency allocations without a proof of need or without a case-by-case approach, they may not share the use of a microwave system. It will be recalled that right-of-way users and public safety groups could band together and share utilization of a microwave link.

To the consumer confronted with the option to lease his facilities from the common carrier versus own his own microwave link, the FCC decision against shared use may tend to favor the leasing option and hence the common carriers.

In the second place, frequencies are not necessarily allocated permanently; they may be subject to reallocation as a result of domestic needs or international needs. To cite an example, currently three dockets are pending before the Commission eliminating the sharing of frequencies between the common carriers and private microwave systems. One docket, 14712, reallocates bands 2110 to 2200 MC into four discrete bands.[1] Another, No. 14729,[2] reallocates bands 6,000 and 10,000 to 12,000 MC, and a third, No. 14722,[3]

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[1]Before the Federal Communications Commission, Docket No. 14712, in the matter of amendment of Parts 2, 6, 7, 9, 10, 11, 16, and 21 of the Commission's Rules to designate portions of the 2110-2200 MC/s band exclusively for the use of domestic fixed public stations and for the use of operational fixed and international control stations and to reserve a portion thereof for omnidirectional operations, 1962.

[2]Before the Federal Communications Commission, Docket No. 14729, in the matter of amendments to Parts 2, 4, 7, 8, 9, 10, 11, 16, and 21 of the Commission's Rules concerning the allocation of the frequency bands 6425-6575, 10550-10680, and 11700-12200 MC/s, 1962.

[3]Before the Federal Communications Commission, Docket

suggests reallocation for educational television (ETV). Although no overt apprehension has been expressed by microwave users, the Commission's reallocation of the 2,500 to 2,690 bands from operational fixed to ETV states:

> Should the Commission eventually reallocate the 2500-2690 mc band for this new education service, it is further proposed that existing licensees in this band would be given a reasonable period of time in which to amortize their investment.[1] [Emphasis mine.]

(The common carriers, in general, are responsible for providing channels for ETV.)

Turning to space communication frequency needs, the problem of reallocation is latent but present. Again quoting the Commission on this issue:

> Accordingly, if future conditions warrant a reallocation of frequencies to provide for space communication needs we will then take whatever action may be necessary. Accordingly, all users in those bands are put on notice that if future developments in space communications should warrant they may be required to shift frequencies or otherwise modify existing authorizations to meet possible requirements for space communications needs.[2]

Although the frequency use and allocation situation in the short run may remain fluid, long run advances in the

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No. 14744, in the matter of amendments of Parts 2 and 4 of the Commission's Rules and Regulations to establish a new class of educational television service for the transmission of instructional and cultural material to multiple receiving locations on channels in the 1990-2110 mc/s or 2500-2690 mc/s frequency band. 1962.

[1] Ibid., p. 2.

[2] Before the Federal Communications Commission, 1960 Above 890 Order, op. cit., p. 848. Federal Communications Reports, Vol. 29, 1960, p. 848.

state of the art hint at breakthroughs indicating that the supply of frequencies may vastly exceed demand. Although largely funded by military research and development, the laser (acronym for light amplification by stimulated emission of radiation) or light beams may relieve some aspects of frequency congestion. Using coherent light beams at frequencies oscillating at billions per second, the laser potentially can serve as the medium for voice, record, and data signals. A laser generates frequencies at 500 trillion waves per second in contrast to the highest radio wave of 50 billion cycles per second.[1] Theoretically, one laser beam could carry as much data as existing radio frequencies. To contrast the laser with microwave, one microwave signal can carry 1,800 voice channels or one television signal; a laser beam can carry 100,000 telephone calls or 100 television programs.[2]

In summary, the "Above 890" decision was of crucial import to the non-affiliated firms in microwave equipment industry. We have seen that prior to this decision, the use

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[1]"Powerful Laser Light Beams Show Signs of Many Potential Uses; Research Pushed," Wall Street Journal, CLIX: 73 (April 13, 1962), p. 18.

[2]Jerry E. Bishop, "Communication via Laser," Wall Street Journal (December 11, 1962), p. 6. "A little calculation shows that the visible region between the wavelengths of 4,000 and 7,000 angstrom units could contain 80 million television channels." Arthur L. Schawlow, "Optical Masses," Scientific American, 204:6 (June, 1961), p. 53. "Lasers Hit the Jackpot," Business Week (November 3, 1962), p. 34. "IBM and GE said they consider their new lasers a major breakthrough that will immeasurably speed up the use of lasers as communications carriers . . ."

of microwave systems was limited to the Federal government, public safety organizations, communication common carriers, and certain right-of-way companies. By expanding the eligibility of licensing of private microwave systems, the FCC literally expanded market potential from the public utility class to the manufacturing and commercial class. This decision was prompted by two factors: first, in the opinion of the Commission, the supply of microwave bands was now sufficient to permit free access to all; and, second, liberalized eligibility would "spur" manufacturing competition. Thus, as one potential barrier to entry, the raw material of private microwave systems was, with certain reservations, diminished.

Under the classification of legal and technological restraints, we have considered the patent and the availability of microwave frequency band. A third barrier is associated with the capital requirements necessitated in installing wide band multichannel systems. If

> . . . the ranks of effective potential entrants are often greatly thinned by capital requirements . . .[1]

then, the availability of knowledge and the free abundance of the factor resources may not be sufficient to overcome capital cost barriers.

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[1]Joe S. Bain, Industrial Organization (New York: John Wiley and Sons, Inc., 1959), p. 252.

Capital Requirements

Although the data in this sectionare unfortunately meager, an attempt will be made to assess cost barriers in the resource market (common carriers purchasing equipment) and in the product market (end-users purchasing radio relay equipment). Finally, an attempt will be made to evaluate the implications these costs hold for entry into the equipment market. We turn first to metallic circuits and then microwave circuits.

The coaxial cable, as a multichannel broadband medium, is the product of the research efforts of Bell Laboratory and Western Electric. The coaxial cable originated as a device to handle the heavy traffic routes of the Bell System.

Research on the cable preceded by twenty years the first experimental cable in 1936 between New York and Philadelphia. The cable, containing repeaters every ten miles, supplied a capacity of over 200 two-way voice conversations. In addition, television pictures were relayed over the cable to study the practicability of the cable as a medium for the wideband signal. Greater experimentation produced a cable of 3 MC/s bandwidth and, in 1941, the cable was innovated for commercial use.

Work on the cable ceased during the early years of the war. Bell's research and development effort shifted to military contracts and there was the more urgent need to develop transcontinental long-distance lines as these facilities

were jammed.[1]

As the war entered the third year, work resumed on the 1941 cable. This resumption was largely dictated by the shortage of lead and copper as a war material. As opposed to other telephone media, the cable required less of the strategic material.[2] Another factor was the advent of television. On February 24, 1944, NBC's President, Niles Trammel, wrote AT&T stating:

> The National Broadcasting Company looks to the Bell System to provide and make available to NBC the necessary interconnecting facilities for such a television network.[3]

Five days later, Mr. Keith S. McHugh, AT&T vice president, replied that the Bell System planned to construct six to seven thousand miles of coaxial cables within the next five years.[4] The cable was to be nationwide and transcontinental, linking New York with Los Angeles. On March 17 of the same year, AT&T announced, in The Wall Street Journal, that it would set up an experimental microwave radio relay system of television capacity between New York and Boston. However, the announcement indicated that AT&T would rely

> . . . on the concentric cable as the best means for further expansion . . .[5]

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[1]M. E. Strieby, "Coaxial Cable Systems in the U.S.," Signals (January-February, 1947), 1:3, p. 40.

[2]Ibid., p. 40.

[3]Telecommunication Report, 10:29 (March 2, 1944), p. 6.

[4]New York Times, 11:5 (March 17, 1944).

[5]Before the Federal Communications Commission, Above 890 Docket, op. cit., Electronics Industries Association, "Highlights of Radio Relaying History," p. 1.

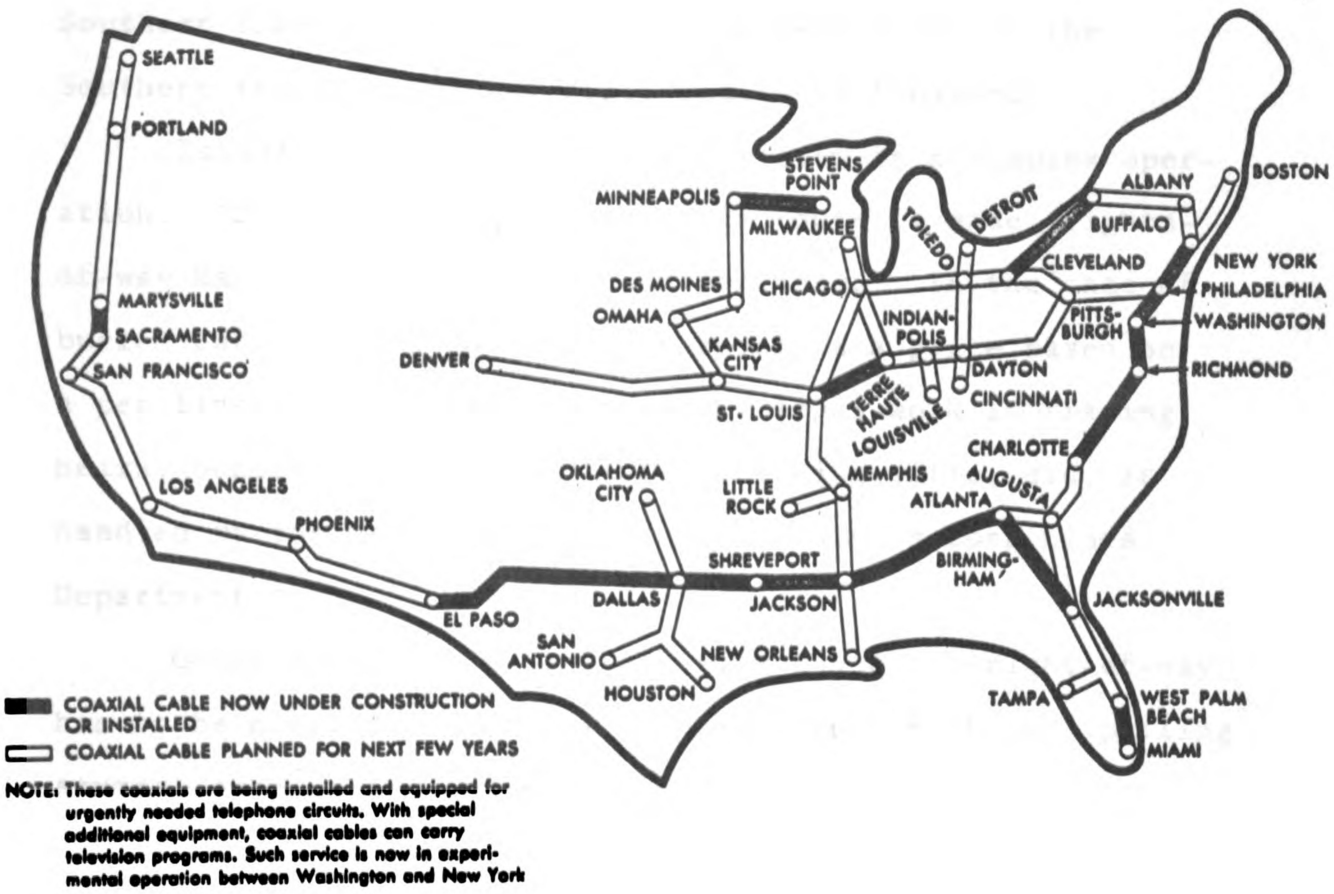

Figure 35. The Bell System coaxial cable program. Source: M. E. Strieby, op. cit., p. 42.

As a matter of thoroughness, the Bell System would give radio relay a trial. As noted earlier, the Bell System had received contracts for classified research and production of Signal Corps radio relay systems (AN/TRC-6).

The time table of the coaxial cable system included completing the New York-Washington link by 1945; the New York-Boston, Washington-Charlotte, Chicago-Terre Haute-St. Louis, Los Angeles-Phoenix links by 1946. The 1947 schedule included

Chicago-Toledo-Cleveland-Buffalo link and part of the Southern Transcontinental route. Between 1948-50, the Southern transcontinental route was to be finished.

Establishing a coaxial cable system is a complex operation. After selection of the cable route is made, rights-of-way have to be negotiated and purchased. In the case of buried cable, the property owner receives a price based on a per linear rod (16-1/2 feet). The legal work in tracing heirs, ownership, property lines, checking title, etc. is handled by the Legal Department of the AT&T's Long Lines Department.[1]

Construction is relatively slow since the right-of-way has to be cleared--a process involving cutting trees, pulling stumps, opening fences, etc. After the coaxial cable is delivered to the laying site, a rooter plow digs a slot, then a cable-laying plow buries the cable. A cleanup crew follows the cable crew, preceding the legal department which must make settlements for crop losses and other construction damages.[2]

The cost of a transatlantic coaxial system was of such magnitude that the combination of research expenditures and the capital outlay required to institute a nationwide system apparently eliminated all the common carriers except the

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[1]Harry H. Hoopes, "Right of Way Comes First," Bell Telephone Magazine, XXVII:4 (Winter 1948-49), pp. 241-3.

[2]Ibid., p. 243.

Bell System (neglecting, for this analysis, AT&T(s patent position on the coaxial cable).

In 1945, for example, 339 miles were laid at a cost of $7,056,000 or $21,000 a mile.[1] The nationwide cable system of 3,287 miles was estimated at $56,356,000 or an average of $17,000 a mile.[2] Furthermore, in 1946, AT&T compressed its five-year program into three years, increasing the annual investment burden.[3] It was hoped that by 1950 some 12,000 route miles of this broadband system would be in service. Projecting the lower figure of $17,000 per mile, the capital outlay by Bell for its coaxial system approached a total of one billion dollars within a five-year period (Figure 36).[4] As an alternative to broadband metallic circuits, a radio relay system was proposed by Western Union and Raytheon (other proposals are not meant to be slighted, but these three firms actually started construction).

Western Union announced its plan in the Fall of 1944. Employing RCA equipment, the telegraph company constructed and innovated the first commercial radio relay system in 1947. Western Union's plan incorporated a nationwide radio relay system capable of handling all communication service,

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[1] Telecommunication Report, 11:51 (August 9, 1945), p. 6.

[2] Ibid., p. 6.

[3] Lawrence G. Woodford, "The Bell System's Progress in Television Networks," Bell Telephone Magazine, XXVI:3 (Autumn 1946), p. 147.

[4] Author's estimate ($17,000 x 50,000 miles).

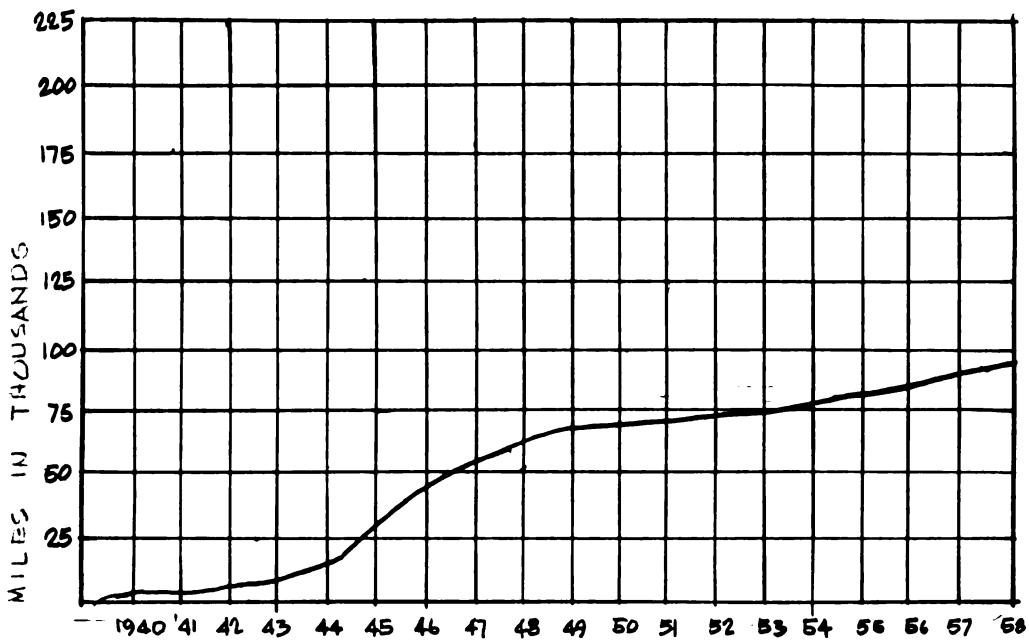

Figure 36. Coaxial cable.
Source: Long Lines Department, Our Company and How It Works, October, 1960, p. 99.

including television. The first triangle included Pittsburgh, Washington, and New York with subsequent sites purchased as far south as Atlanta and as far west as Omaha.

Microwave links as opposed to coaxial systems require neither extensive rights-of-way nor the time consumed in the laying of cables. Western Union's system as projected included the linking of eight major cities, the eastern triangle by 1948, and sixteen other links planned by 1949-51.

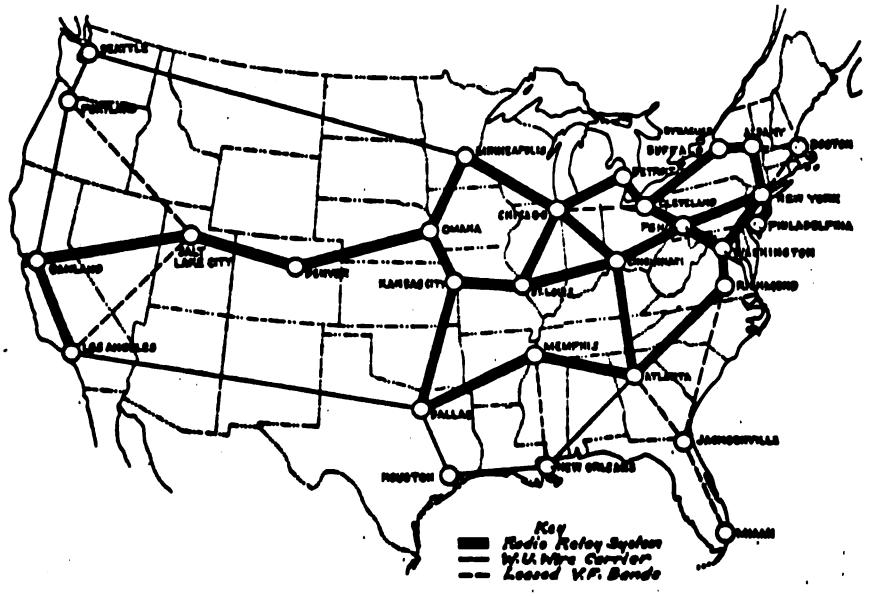

Figure 37. Proposed Western Union radio relay system with supplementary trunk facilities.
Source: Julian Z. Millar, "Telegrams on the Beam --A Preview of the Western Union System of Radio Beam Telegraph," Signals, 1:3 (January-February) p. 27.

The cost of such a transcontinental relay system was considerably less than a comparable coaxial network. Thus Western Union's costs were projected at $17,100,000 in contrast to the $56 million coaxial system.[1] Although the telegraph company assumed an early lead in the construction of a nationwide radio relay system, even this $17 million capital requirement proved to be formidable. By 1949, the company had spent only $2-1/2 million on its radio relay network.[2]

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[1]Hyman A. Golden, The Domestic Telegraph Industry and the Public Interest (unpublished Ph.D. thesis, Harvard University, 1950), p. 246.

[2]Ibid., p. 247.

The main problem was Western Union's financial situation. During the crucial construction years between 1945-50, the telegraph company incurred a deficit in three of the five years. Among other factors, Western Union's financial posture eliminated any hope of establishing an immediate nationwide radio relay network.

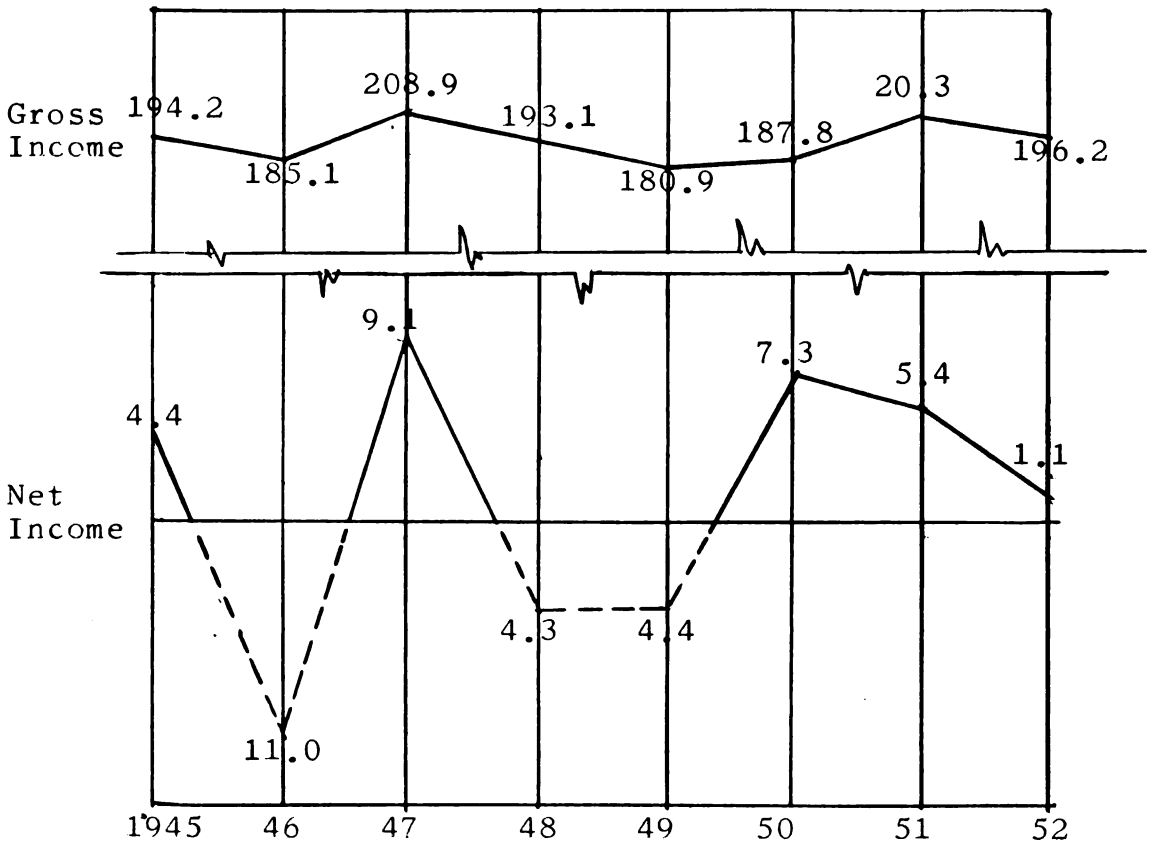

Figure 38. Western Union income.
Source: Annual Report 1955, p. 25.

A second nationwide radio relay system was announced by Raytheon in the Fall of 1944:

> As a result of the experience which it had acquired during the recent war from the use of microwave frequencies in connection with its development of magnetron and radar equipment . . .[1]

Raytheon intended that its transcontinental system sould handle all communication signals, including FM and video. As in Western Union's case, Raytheon purchased sites, towers, erected buildings, and by 1946 six stations were put into operation on an experimental basis between New York and Boston.[2] Estimated cost of the link was $1 million. However, rather than a broadband facility, Raytheon constructed a narrow band link and it lacked the capability and the equipment to transmit television signals. Early in 1946, the company landed an Air Force research contract for wide television transmission equipment.

> . . . the construction of which involved the same type of research and development which appeared to be essential for the type of equipment required for relaying TV signals between New York and Boston.[3]

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[1]Before the Federal Communications Commission, op. cit., in re. Application of Raytheon Manufacturing Company, Docket No. 8756, Federal Communications Reports, p. 387.

[2]Ibid., p. 389.

[3]Ibid., pp. 389-90. "Raytheon believed that the experience which its staff would gain in the work would be helpful in carrying out its plan for a nationwide microwave relay system. Raytheon, therefore, took advantage of this opportunity and became successful bidder as subcontractor to the Bell Aircraft Corporation."

Raytheon, in winning the contract developed the equipment for the Air Force and subsequently marketed the product commercially. But the company had paid the price of delaying development of its radio relay system. As the postwar era began, Raytheon's dependence upon military hardware made it particularly vulnerable to the peacetime transition period. Finding it difficult to raise the necessary capital, the firm attempted to enlist the help of Western Union, IT&T, and others, but to no avail. By 1947, the economic and financial plight of Raytheon forced it to abandon its radio relay plans (Figure 39).

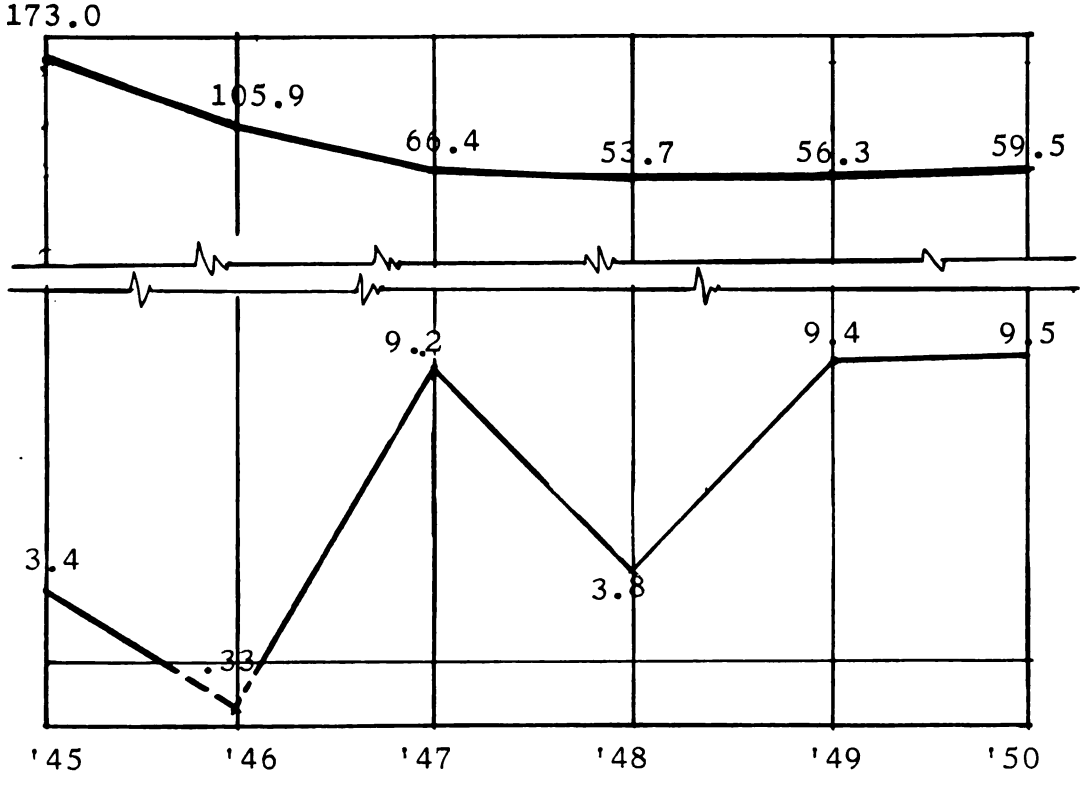

Figure 39. Raytheon income series.
Source: Raytheon, Annual Report, 1950, p. 30.

Although presumably committed to a metallic broadband network, subsequent to World War II, AT&T continued research and experimentation on radio relay techniques. As noted earlier, the telephone company innovated essentially its AN/TRC-6 equipment for use off the New England and California coasts. However, these were essentially narrow band systems--incapable of transmitting a wide band television signal. Apparently all the elements encompassing Bell's broadband relay system were available except a miniature electron tube that generated the frequency and permitted the relaying of broadband signals without the remodulation technique required at each relay station.

While construction of Bell's relay network was begun, Dr. Jack Morton of Bell made the breakthrough of this component known as a closed space triode.[1] Completing the last link in the TD-2 system (as the Bell relay equipment was called), AT&T embarked on a nationwide construction program that soon not only eclipsed Bell's competitors but supplanted its own coaxial system. The estimated cost of the transcontinental extension of TD-2 was $40 million[2] and Bell's

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[1]Merton J. Peck, The Weapons Acquisition Process: An Economic Analysis (Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1962), p. 247. "In 1947 the success of an important and costly American Telephone and Telegraph Company radio relay system development hinged upon the uncertain producibility of a miniature electron table . . ." There was a breakthrough for AT&T only; RCA employed a traveling wave tube with success.

[2]John R. Pierce, "Hazards of Communication Satellites," Bulletin of the Atomic Scientists: A Magazine of Science and Public Affairs, XVII:5-6 (May-June, 1961), p. 183.

resources were able to handle this capital expenditure with considerable ease. By 1951, the first coast to coast link was completed (Figure 40).

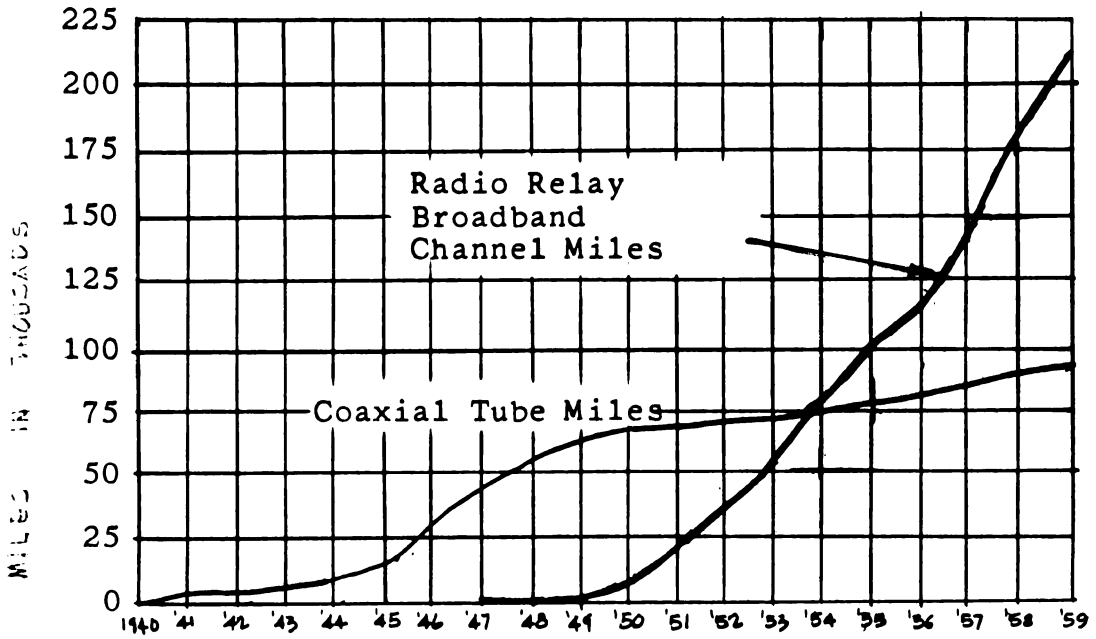

Figure 40. AT&T coaxial and radio relay channel miles. Source: Our Company and How It Operates, Long Lines Department, AT&T, October, 1960.

The previous evaluation has centered on the factor or resource market in that it attempts to delineate the capital expenditure alternative confronting common carriers who employ equipment in the rendition of services to the consumer.

In this market only one carrier, AT&T, was capable of constructing a nationwide broadband metallic system. When radio relay techniques became available again the commitments of fixed investment were such (even though substantially less than coaxial) that both Western Union's and Raytheon's efforts proved abortive. Apparently the Bell System possessed sufficient financial resources to elect and pursue heavy investments in metallic and radio facilities.

In the product market the cost of duplicating common carrier facilities deterred the individual end-user from exercising any option other than leasing his services from the carriers.

Existing evidence suggests that the costs of heavy duty microwave equipment may not be as formidable as they once were in the immediate postwar era. Two factors may account for this erosion in the resource market. The first may be a rise in the financial resources of the firm relative to the size of capital outlay for microwave and the second factor may be the decline in the cost of the capital equipment itself.

Western Union is a case in point of the first trend. In 1960 Western Union, using RCA 600 voice channel equipment, initiated construction of a nationwide microwave relay

system. The system, costing 96.5 million dollars, is to be completed in 1964.[1]

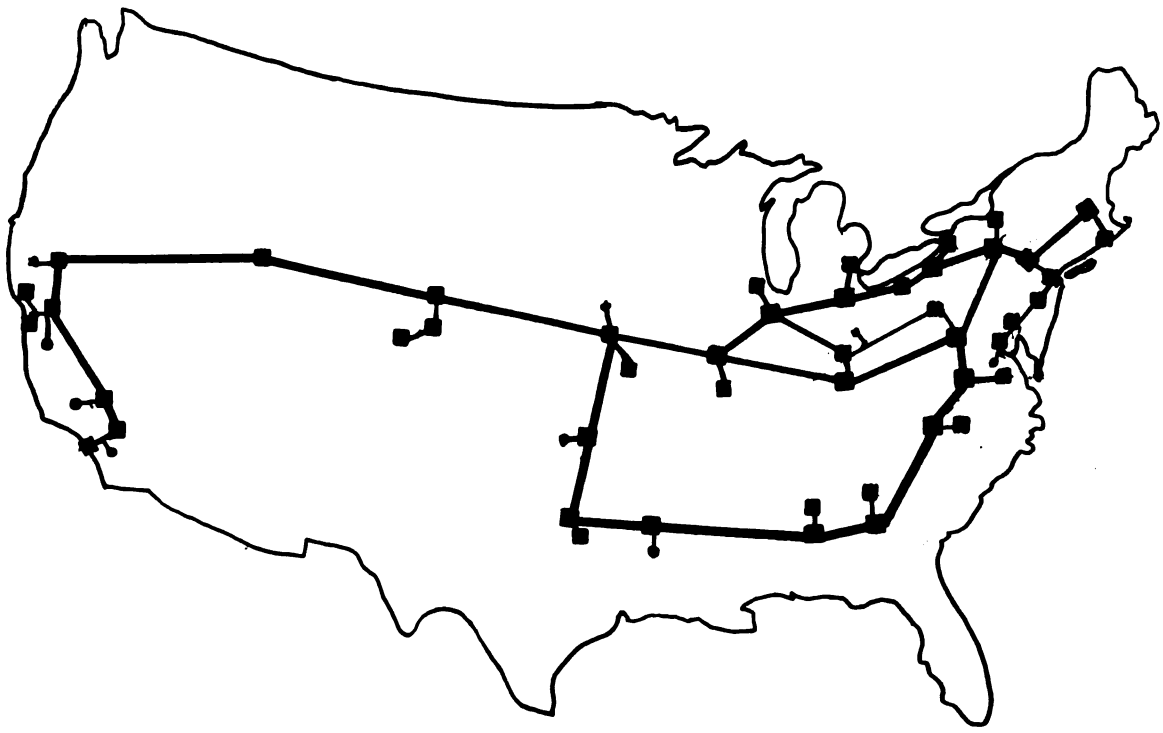

Figure 41. Map of new transcontinental microwave network and planned southern extension.
Source: Western Union Annual Report, 1961, p. 3.

Western Union's financial picture has reversed since the bleak postwar days, with operating revenues of around $277.5 million, net income around $10 million.[2] Western Union's private line market has grown rapidly and the timely award of Air Force contracts for a nationwide data

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[1]W. P. Marshall, A Review of Western Union Today as Summarized before the FCC Commissioners on March 9, 1961, p. 23.

[2]Western Union Annual Report, 1961, p. 10.

transmission system, a bomb alarm system, plus contracts from the Weather Bureau and the Federal Aviation Agency have enabled Western Union to construct its relay system--the first nationwide microwave system paralleling the AT&T system. (The Air Force Datacom and Bomb Alert System will generate an additional annual income of $38 million.[1]

A second factor tending to induce entry is the decline in equipment costs. It is of interest to note that Western Union's relay system employs RCA equipment. This same equipment is being utilized by the Canadian Government for a transcontinental system at a cost of $12 million for 3,000 miles.[2]

Western Union's construction cost of $4,000 per mile represents a substantial decline in equipment costs if the TD-2 costs averaged around $13,000 per mile (3,000 miles at $40 million).[3] As a matter of fact, the Bell System's TD-2 radio relay system has declined in cost by 23 per cent since the end of 1950.[4] In any event, the inadequacy of data dictates that any observations on equipment cost erosion be extremely speculative.

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[1] Ibid., p. 4.

[2] E. J. Hart, "RCA Microwave Selected for Canadian Communications Network," Radio Corporation of America, Industrial Electronics Products, Camden, New Jersey, 1962.

[3] Author's estimate (3,000 miles at $12 million).

[4] U.S. Congress, Senate, Antitrust Problems of the Space Satellite Communications System, Hearings before the Subcommittee on Antitrust and Monopoly, Committee of the Judiciary, 87th Congress, 2nd Session, pursuant to S. Res. 258, Part 2, 1962, p. 686 (letter from H. I. Romnes, Western Electric president to Newton W. Minow, Chairman, FCC).

The impact of microwave systems on the product market is as profound as it is on the factor market. Radio relay has conferred to the consumer an additional option of owning his communication system versus leasing his services from the common carriers. Of course, the equipment needed by end-users is not the heavy duty apparatus utilized by the carrier; rather it tends to be the lighter or skinny route equipment (less channel capacity). Nevertheless, the attributes of productivity, flexibility, reliability, and maintenance, when translated into costs, make owning a system attractive vis-a-vis monthly leasing rates.

Again, the potential users of radio relay systems must be of such a size that the capital outlay attendant such a system is within their reach. Table 33 depicts the investment range as a function of the system's length and Figure 42 displays the cost component breakdown of repeaters and towers.

TABLE 33

MICROWAVE EQUIPMENT STUDY

Length of System (miles)	Total Investment (000) Low	High
25	$ 29	$ 55
50	62	104
100	119	188
200	233	357
500	576	865
1,000	1,147	1,711

Source: Before the FCC, Telpak Docket, op. cit., AT&T, Testimony of J. F. Magee (38 organizations were interviewed).

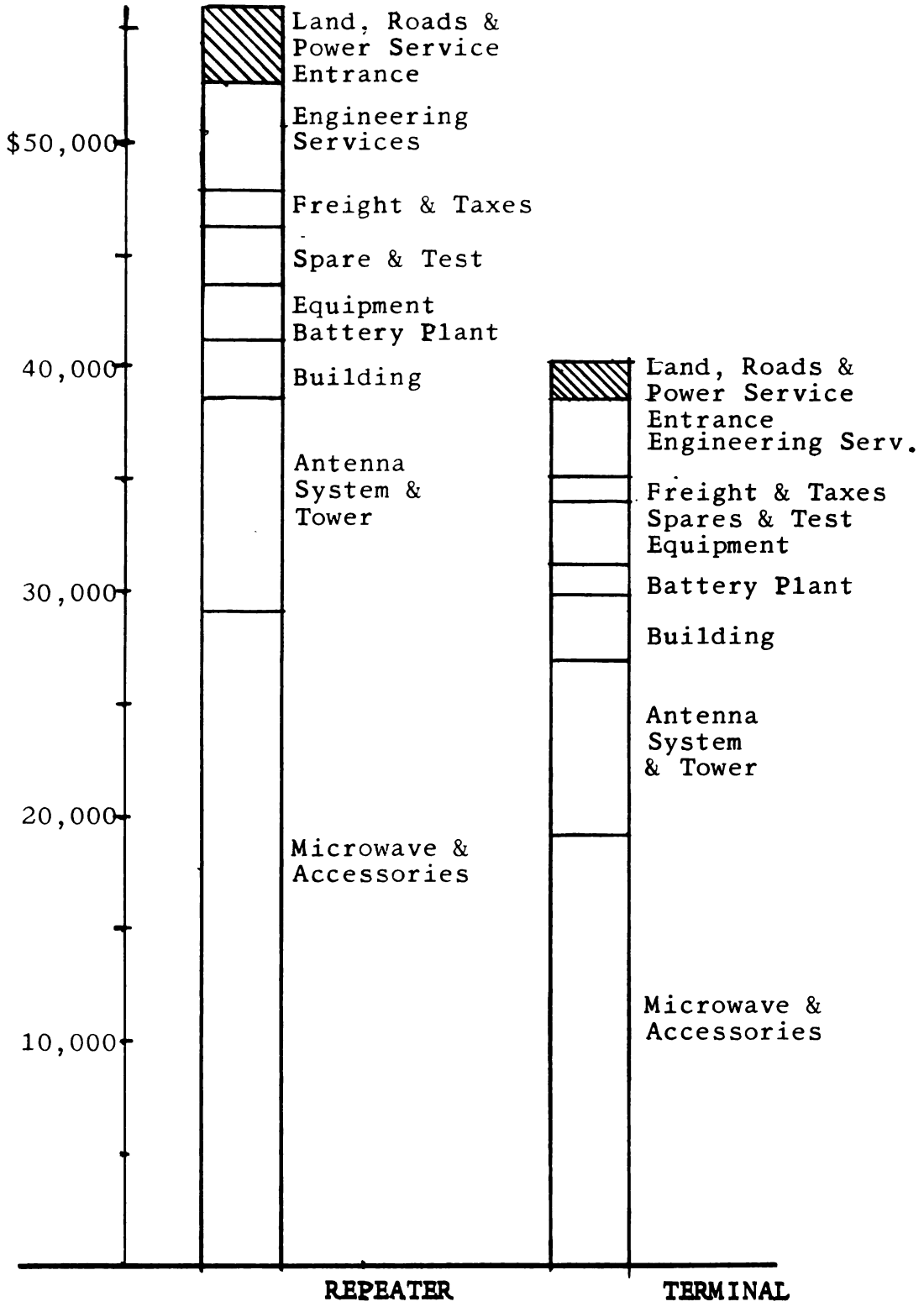

Figure 42. Cost studies.
Source: Before the FCC, Telpak Docket, op. cit., Motorola.

The option of owning was further stimulated by the possibility of firms banding together and sharing the cost and use of a private microwave system. Although this policy of sharing was not extended to the new frequencies (post-Above 890), the pre-890 policy enabled some firms to spread the burden of fixed investment and lowered the capital requirements of owning.

Three specific cases illustrate the comparative advantage of owning a private microwave system.

The J. L. Hudson Company, a Detroit department store, contemplated installing a private microwave system between its downtown store and its two suburban stores, Northland and Eastland. Though the system was to include several communication services, specifically it would enable the three stores to transmit credit approval signals.

If Hudson's leased an equivalent amount of telephone circuits from Michigan Bell, the estimated cost would be on the order of $10,000 to $15,000 per year.[1] If Hudson's decided to construct its own radio relay system, the system would cost $10,000 to $12,000 a year.[2] Thus, the cost of building a private microwave system would be roughly equivalent to the annual leasing rates charged by Michigan Bell. As one private microwave consultant observed:

> If the microwave equipment were amortized over a period of ten years, the annual cost, including maintenance and interest on the investment, would

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[1]Leo G. Sands, "Low Cost Industrial Microwave Systems," Industrial Electronic Engineering and Maintenance (January, 1961), 3:1, p. 8.

[2]Ibid., p. 8.

be around $2,000 or 20% of the cost of leased lines.[1] [Emphasis mine]

As a second example, the Southern Railroad system was confronted with the alternative of leasing its voice channels from the Bell System between Washington and Atlanta or constructing a microwave link. In leasing from the Bell System, Southern's cost would be $128,000 a month or $1.5 million a year.[2] Bell's facilities included 255 voice channels, but did not include certain VHF equipment desired by the railroad. Capitalizing the total bill, Southern estimated that its annual licensing charges would be $1,628,765 per year.[3]

If Southern constructed a microwave system between Washington and Atlanta, the cost would range between $3.6 million to $4.1million. This cost also includes the VHF equipment Southern desired as well as real estate costs. The railroad estimated that the annual cost per year, if it owned and operated this system, would be $730,000.[4] Breaking this cost into channel miles, the Southern Railroad estimated that electing to lease would cost it $2.00 per channel mile; electing to own would cost it 78 cents per annual channel mile.[5]

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[1] Ibid., p. 8.

[2] Before the Federal Communications Commission, in the Matter of American Telephone and Telegraph Company regulations relating to connections of telephone company facilities with certain facilities of customers, Southern Railroad System, Docket No. 12940, p. 27, 1960. (Hereafter cited as Railroad Interconnection Docket).

[3] Ibid., p. 27

[4] Ibid., p. 27.

[5] Ibid., p. 27.

A third indication of the comparative advantage of owning private microwave versus the cost leasing facilities is a study conducted by the American Electric Power System. This study is useful in that it illustrates the volume cross-over point where the advantages of owning facilities exceed that of leasing them. If the end-user consumes one to four voice channels then it is less expensive to lease channel facilities from the common carriers rather than own a microwave system. If the volume exceeds six to eight voice channels (Figure 43), then the cost advantages shift from leasing to owning. (It is appropriate to note that the bulk communication market to which the Telpak tariff is directed is defined by AT&T as six voice channels and above.) And, of course, as the voice channel volume exceeds twenty and as the system's distance increases, the economics of owning become pronounced.

What implication does the diminution of capital cost attending private microwave hold for the radio relay equipment market? In assessing the capital requirements of a nationwide coaxial cable system, it was apparent that the Bell System alone possessed the resources to undertake the capital expenditure inherent in such a system. And given AT&T's vertical integration, it is evident that Western Electric manufactured and supplied the cable to the Bell System.

The innovation of radio relay systems in the early post-war era and the fact that Western Union was not integrated

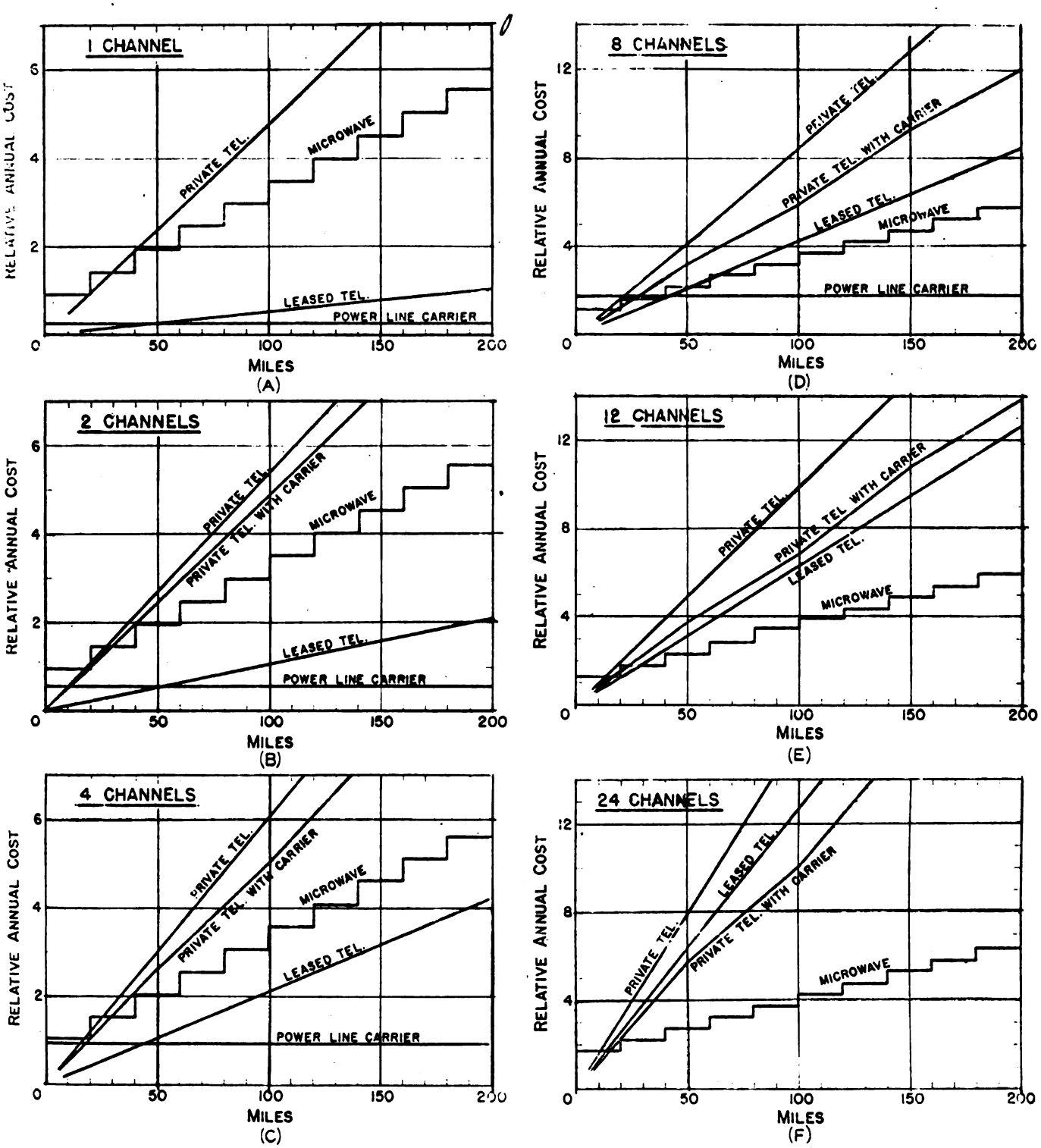

Figure 43. Microwave cost figures.
Source: S. C. Bartlett, "Microwaves and Their Use in Power System," Communications and Electronics, No. 46 (January, 1960), American Institute of Electrical Engineers, Transactions, Communications & Electronics, p. 1098.

into the equipment market offered one opportunity for heavy route relay suppliers (both Philco and RCA participated in this market). However, when Western Union encountered financial stress, this market outlet was foreclosed to the non-integrated supplier. Raytheon, of course, never got off the ground. As an equipment supplier, Raytheon's attempt to establish a nationwide radio relay system can be termed as the attempt of a non-integrated supplier to integrate forward. Given the magnitude of capital outlays relative to firm size, Bell System alone was successful in establishing a trans-continental microwave relay link--even subsequent to some rather hefty commitments made on the coaxial network. And again, Bell's TD-2 equipment as well as its TH and TL relay gear was manufactured by Western Electric. In short, Western Electric enjoyed preeminence in supplying heavy route radio relay apparatus. The one "break" in the domestic market appears to occur with the rejuvenation of Western Union's nationwide relay system fifteen years later. Perhaps it is too harsh to suggest that this system is largely underwritten by the Air Force; at any rate, Western Union's purchases have created one additional outlet for heavy route microwave equipment suppliers.

As emphasized earlier, the introduction of private microwave avails to the consumer in the product market an additional alternative of owning. Translating this option into the equipment market, if the consumer elects to lease, in effect, Western Electric receives the equipment order;

if the consumer elects to own his own system, then the non-integrated microwave supplier gets the order. It is apparent that the reduction in capital costs and the per unit savings of owning a private system have permitted greater market opportunities to the non-integrated equipment suppliers.

In recapitulating the legal and technological restraints attendant the communication equipment market, we offer the following conclusion.

First, the patent as a property right limiting the use and application of knowledge existed as one restraint in the communication equipment industry. This restraint has receded as a result of the ascension and impact of the public sector --particularly in the area of research, procurement, and the innovation of new technology.

Second, the availability and use of the frequency spectrum as dictated by the state of the art, effectively limited the application of commercial radio relay techniques. In the judgment of the FCC, sufficient spectrum in the microwave region now exists so that its rationing of these bands has diminished. This judgment was embodied in the "Above 890 docket."

Third, the capital requirements of both heavy route metallic and radio relay circuits effectively precluded application of these techniques. We have attempted to demonstrate that these restraints are tending to weaken, and in particular, that the end-user of bulk communications is now capable of investing in the ownership of his own relay system.

Finally, as the three restraints of patented knowledge, the frequency spectrum, and capital requirements have receded, the market potential to the nonintegrated firm has broadened. Thus, the patent no longer appears to inhibit his use and application of radio relay techniques, the availability of his raw resource is now established, and his equipment prices do not act as a prohibitive cost to the end-user in weighing the alternative to invest in (own) or lease multichannel communication services.

Market Structure

In addition to an assessment of restraints falling under the category of legal and technical barriers, a second classification to be analyzed is the market structure of the communication industry. Since the burden of Chapter II was to establish the existence of vertical integration, this chapter will deal with integration as it indirectly affects market entry. We will be concerned with two policies of the Bell System that, owing and the Western-AT&T structure tend to inhibit the market access of the nonintegrated equipment firms. The first policy is referred to as interconnection; the second, as pricing.

Interconnection

The discussion of interconnection will include an historical summary of the effect of such a policy, the application of the policy to television broadcasters, to rival common carriers, to railroads, to private microwave

systems, and finally a general assessment of interconnection and its relevance to the problems of market entry.

From the formidable patent position acquired on loading coils and telephone repeaters, it is evident that AT&T assigned a strategic value to the control and ownership of long distance telephone facilities. Once control of domestic long distance facilities was secured, a stringent policy of interconnection was invoked by the Bell System, i.e,, AT&T generally denied rivals access to the toll circuits by prohibiting them from interconnecting their apparatus, switchboards, lines, etc. to the Bell System. Bell's interconnection policy will be analyzed under the technology of metallic circuits and radio circuits. Metallic circuits will include new Bell telephone companies and chain broadcasting; radio circuits will include interconnection with common carriers, with the railroads, and with private microwave systems.

During the formative years of the telephone industry control of long distance facilities conferred to AT&T competitive advantages vis-a-vis the independent telephone companies. As a means of controlling the independents:

> Bell System refused to connect with independent telephone systems for the exchange of messages either in the local exchange area where duplicate facilities existed or for long distance service. Inasmuch as the Bell System was the pioneer in the long distance field, refusal to connect with independents confined them within the limits of the particular territory served.[1]

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[1] 1939 Telephone Report, op. cit., pp. 136-7. Also: John Reynolds, The U.S.I.T.A. Story--The Story of the United

Subscribers of non-Bell local telephone companies who desired to make long distance calls were required to purchase dual services; one equipment provided local exchange service, the other, Bell's, permitted access to toll circuits. There was the additional choice of simply taking complete telephone service from one company, namely, the Bell System. In exercising this option to avoid duplicate telephones, Bell's non-interconnection policy tended to retard the growth of the independent telephone companies.[1]

In 1912-13, under pressure from the Justice Department, AT&T revoked its policy of denying to independent companies access to its long distance facilities. The agreement, known as the Kingsbury Commitment, was hailed by the independent telephone carriers as a landmark in its relations with the Bell System. However, the interconnection privilege was granted to non-competing telephone companies only. However, as late as 1944, the Bell System denied toll access to an independent Philadelphia company, the Keystone Telephone Company. Thus dual service forced

> . . . many businessmen to have two phones. This became a hot political issue which subsided only when the Bell System bought Keystone for about 13 million.[2]

States Independent Telephone Association, USITA, 438 Pennsylvania Building, Washington, D.C.

[1]See Horace Coon, American Tel and Tel (New York: Longmans, Green and Co., 1939), p. 91 and N. R. Danielian, AT&T, The Story of Industrial Conquest (New York: The Vanguard Press, 1939), p. 46.

[2]"Independent Companies in Telephone Business Outpace Growth of AT&T's Bell System," The Wall Street Journal, XLII: 79 (February 5, 1963), p. 1.

Today, independent telephone companies enjoy interconnection to AT&T's long lines network.

A second instance of the value of AT&T's long distance circuits occurred in the struggle over broadcast chains in the early 1920's. Transmitting its programs via its toll facilities, Bell established the Red Network of twenty-six affiliated stations. The denial of toll access to rival broadcasters, particularly RCA, led,among other factors, to the cartellization of the broadcasting industry and the supplying of broadcast channels (there were even hints that the 1926 RCA-AT&T agreement extended into the television relaying field).[1]

Thus, in providing telephone or AM broadcasting channel, Bell's control of long distance metallic circuitry conferred leverage in protecting and delineating its market position.

AT&T and Broadcasters Radio Relay.--Confronted with applicants seeking to construct microwave relay systems capable of transmitting video signals, the FCC ruled that the interests of frequency economy dictated that the domestic common carriers only would be responsible for providing the intercity channels for television transmission. In 1948 microwave relays of AT&T and Western Union were available and both filed their respective tariffs with the FCC. The end-users of these services, represented by the Television Broadcasters Association (TBA), petitioned the FCC to suspend both Bell and the telegraph company's tariffs. Subsequently,

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[1]Telecommunication Reports, op. cit., p. 6.

Philco, and A. B. DuMont entered the preceeding and requested that the hearings be narrowed to the issue of interconnection rather than tariff rates. Philco and DuMont charged that Bell's FCC tariff No. 216 denied them the right to link their private relay channels to the channels of the Bell System. The FCC granted the Philco request and the hearings and decision became known as Docket 8963.

The point at issue in these hearings was the telephone company's interconnection policy relative to broadcasters providing their own relay systems. Bell's policy held that it would not furnish a customer video channels if those channels were linked "directly or indirectly" with video channels furnished by non-Bell facilities. Permission to interconnect was granted in those cases where Bell was unable to provide the facilities, but only for an interim period pending the availability of Bell facilities. Figure 44 exemplifies Bell's interconnection policy.

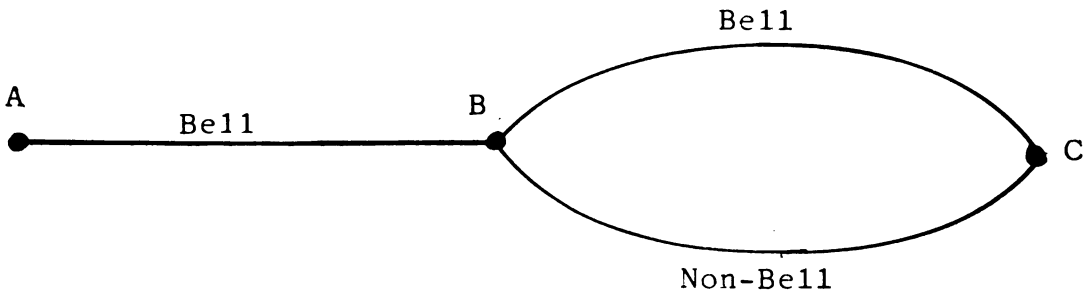

Figure 44. Bell-non-Bell interconnection.

If a broadcaster at B receives his video signal via Bell's facilities (A-B) and then elected to transmit the signal from B to C over non-Bell facilities (given B-C Bell's link) then the broadcaster would be denied Bell's A to B channels. In short, AT&T's command of the A-B link negated the broadcasters option in selecting other subsequent alternative routes. Bell's control of the A-B link, in effect, gave it control of the B-C link as well, a policy enforced by the denial of channel interconnection. The Philco link extended from B to C, paralleling the Bell route, and Philco sought to interconnect its radio relay system with AT&T at point B.

In defending her policy, the telephone company submitted legal, economic, technical, and administrative evidence to the FCC.

AT&T explained that unrestricted interconnection would duplicate facilities and result in an adverse economic effect on the investment of the common carriers. The burden of this argument was epitomized in the phrase "cream skimming"--a condition that existed when rival relay facilities would link the heavy traffic, low cost routes and leave the high cost routes to the Bell Company.

Permitting the common carriers to exist on "skim milk" while the broadcasters provided links over profitable routes would not only subsidize the private relay facilities of the broadcasters, but would discriminate against other video consumers. This would result from the fact that video channel

tariffs are an average based upon low cost and high cost routes. Delegating to the carriers the responsibility of providing service over the high cost routes would raise the average and hence result in discrimination against those broadcasters who did not provide relay systems.

In addition to cream-skimming, AT&T insisted that interconnection bred technical problems in matching equipment and the innovation of new equipment.

Administrative problems were also considered. Dividing responsibility between Bell and non-Bell routes was inconsistent with good service and efficiency, for

> no one can say how long it would take to develop the patchwork, part private, part common carrier, part regulated, part unregulated . . .[1]

Bell's case is best summarized by the contention that:

> . . . intercity video transmission service can best be furnished by a single common carrier and that the Bell System should be that carrier.[2]

The position taken by TBA, representing both broadcasters and equipment suppliers, was that AT&T's interconnection was both illegal and contrary to the public interest.

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[1]"Separation of the Interconnection--The Rate Issue of the Current FCC Proceeding of the Intercity Television Relay Services of the AT&T and Western Union," Telecommunication Report, 15:6 (October 9, 1948), p. 13.

[2]Before the Federal Communications Commission in the Matter of American Telephone and Telegraph Company and the Western Union Telegraph Company--charges and regulations for television transmission services and facilities, Docket No. 8963, Pike and Fischer, 1949, Vol. V, p. 652. (Hereafter cited as Docket 8963.)

First, Bell's policy hindered the development of a nationwide video broadcasting system since it reduced the incentive of a broadcaster in constructing video relay routes and that denial of interconnection discourages

> the construction of additional intercity TV relay facilities at a time when existing facilities are inadequate to meet the requirements of the industry and by deterring construction of new TV stations in areas where Bell System intercity video service is not yet available or planned.[1]

DuMont, a manufacturer of radio relay equipment contended that AT&T's

> . . . proposed expansion of intercity channels will consist largely of coaxial cables of 2.7 mc bandwidth which is alleged to be inadequate to meet the needs of the industry . . .[2]

As the owner of a radio relay link which was denied interconnection with Bell's coaxial and relay systems, Philco pressed the FCC for an expenditious decision declaring

> it is no good . . . if eighteen months from now the interconnection provision is found to be unlawful as meanwhile Philco is losing both time and money.[3]

Reinforcing its sense of urgency, Philco sought an injunction from the Federal District Court in Philadelphia prohibiting AT&T from exercising its denial of facilities. However, the court refused to issue the court order on the grounds that the FCC alone had jurisdiction.

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[1] Ibid., p. 654.

[2] Ibid., p. 655.

[3] Telecommunication Report, 15:4 (September 24, 1948), p. 24.

In attempting to determine a decision in this case, the FCC strained under two conditions. Previously, the Commission had decided that intercity television channels should be provided by the common carriers. In this regard the FCC observed that Bell was contemplating a nationwide system, but

> . . . it is recognized that the latter are not yet ready to afford the service required and that adequate facilities will not be ready for some appreciable interval of time.[1]

To bridge the gap between policy declaration and policy implementation, the FCC ordered that temporary connection between private relay systems and Bell's system be made.

> . . . until such time as common carriers have adequate intercity video channels available to meet the demands of the broadcasters for such channels.[2]

The mandate applied to private mobile radio pick-up equipment and direct pick-up and relay of video signals as well.

However, the Commission cautioned the broadcasters:

> The Commission desires to emphasize that this special provision for intercity TV relaying is a purely temporary measure designed to assist the TV industry until such time as a permanent common carrier facility is generally available and those broadcasters who venture into the business of relaying television programs in these frequency bands should plan to amortize their investment at the earliest possible date.[3] [Emphasis mine.]

AT&T and Western Union.--Having decided that interconnection between Bell and the Broadcasters' private video systems would be granted on a temporary basis, the FCC turned to the issue as to whether the facilities of rival common

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[1]Docket No. 8963, op. cit., p. 662.

[2]Ibid., p. 672F.

[3]Ibid., p. 663.

carriers should be interconnected. Western Union had requested that the FCC issue a generalized order covering the microwave relay systems of all common carriers. However, the FCC ruled that:

> . . . to adopt Western Union's position would permit the customer to do what the commission could not itself do without a finding, after opportunity for a hearing, that such action is necessary and desirable in the public interest.[1]

The effect of this decision was to reduce the question of common carrier interconnection to a case-by-case specific point decision. That is, each point of interconnection of two common carrier facilities had to be resolved separately by the Commission. Thus, the FCC initiated Docket No. 9539 to determine the feasibility of ordering AT&T and Western Union to interconnect their intercity video channels between New York and Philadelphia.

Although Western Union had embarked upon a nationwide radio relay network, the interconnection docket was crucial to the continuation of its system. In addition to the problem of the availability of construction funds already alluded to, there existed the problem of whether the broadcasters would subscribe to the Western Union system; and this decision, in turn, depended upon Western Union's ability

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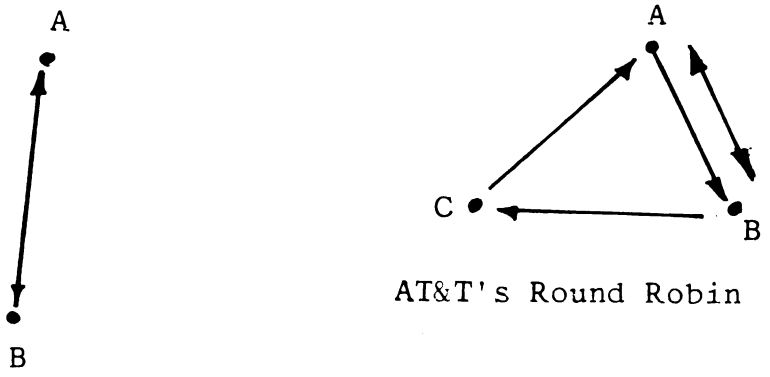
[1]Before the Federal Communication Commission in the matter of establishment of physical connections and through routes and charges applicable thereto, pursuant to Section 201A of the Communications Act of 1934 as amended, with respect to intercity video transmission service, Docket 9539, Pike and Fischer, 1951, Vol. VI, p. 1159. (Hereafter cited as Docket 9539.)

to tie in its relay channels with Bell's coaxial and relay channels. If Bell denied interconnection, broadcasters would be hesitant to relay programs over Western Union's video relay segment, and hence the telegraph company would be unable to generate income from its segmented relay system in order to construct extensions leading to a nationwide system.

In advancing its case for mandatory interconnection, the telegraph company cited both technical and economic arguments. The company stated that its system was capable of handling a 5 mc bandwidth as opposed to Bell's coaxial cable capacity of 2.7 mc. In addition, bandwidth of 8 mc could be supplied for either black and white or color video signals. "No technical limitations" restricted interconnection of Bell and Western Union's facilities since the noise and distortion performance of Western Union's equipment was adequate for video signals transmission.

The telegraph company advanced certain cost advantages inherent in its system. In the first place, the video channels were capable of being sent in both directions, but not simultaneously. This reversibility in utilizing less facilities was contrasted with the Bell System's "round robin" network. Assuming that the broadcaster at point B wanted to send a signal to point A, Western Union's reversibility permitted the transmission over the same facility, in contrast to Bell's routing from B through C to A; or through a separate facility to A. Western Union asserted that customer leasing rates would be lowered by the reduction of plant and equipment used in rendering video service.



Western Union's Reversibility

AT&T's Round Robin

Figure 45. Bell vs. Western Union video relay systems.

The telegraph company noted, in addition, that since its intercity channels would terminate on customer premises, the result would enhance the quality of the signal and reduce video rate charges to the broadcasters.

In attempting to establish a need for its video channels, the telegraph company stated that certain broadcasters had expressed an interest in the system. Later, ABC, NBC, CBS, and A. B. DuMont Laboratories testified as to their interest in the New York-Philadelphia link. A Western Union witness commented that the Columbia Broadcasting System had expressed interest in a one-year contract for service subject to cancellation,

> . . . in the event interconnection of video transmission facilities with the Bell System could not be obtained.[1]

CBS declined to subscribe stating that the

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[1] Ibid., p. 1174.

> . . . absence of clarification with respect to interconnection were in part responsible for failure to execute the contract.[1]

AT&T took issue with Western Union's presentation. The telephone company noted that it had in existence at the time of the hearing some 9,000 television channel miles linking twenty-six cities, and that it was completing its transcontinental video link by 1951. Bell reminded the Commission that Western Union's proposal was, in essence, a joint operation rather than a competitive operation of a video system. Furthermore, the Western Union facilities in connecting only New York-Philadelphia did not meet the requirements for total network service. The telephone company observed that a Commission order to interconnect AT&T video channels with Western Union would tend to inhibit Bell's extension of a nationwide system since AT&T would

> have to deal with the uncertain factors of Western Union plans as well as uncertainties of customer requirements.[2]

Although AT&T acknowledged that the technical problems attendant the interconnection of different equipment was "not insoluble," nevertheless complications existed in the following areas:

1. The problem of introducing new equipment and operating procedures.
2. Specification of points which equalization and other adjustments would be necessary.
3. Locating sources of trouble and placing of its responsibility.

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[1] Ibid., p. 1174. [2] Ibid., p. 1173.

4. Difficulty switching problems.

Turning to the cost advantages alleged by Western Union's channel reversibility, the telephone company stated that Western Union had not documented its cost savings. Bell explained that the transmission of video programs required two separate interexchange channels in the system, although it was possible to reverse programs if the customer gave up a channel for about an hour. Bell observed further that its double routes could carry two programs simultaneously while reversible channels could handle only one program at a time.

Finally, a "round robin" technique conferred the advantage of permitting any one station in a network to originate or receive programs.

Commenting on Western Union's termination of facilities on customer premises, Bell contended that

> Flexibility of operation would be impaired by termination of intercity channels on customer premises and that it is undesirable placing competing networks in the hands of the customer.[1]

Addressing itself to the question as to whether a sufficient need existed for video relay facilities, AT&T described its network between New York and Philadelphia. The company had constructed video channels available on coaxial cable and six channels on radio relay resulting in a total supply of thirteen channels; eight southbound and five northbound. The telephone company concluded that the adequacy of video channels between New York and Philadelphia argued

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[1]Docket 9539, op. cit., p. 1172.

hard against the interconnection of still additional facilities.

In rendering his decision, the hearing examiner asked, was there a clearcut need of Western Union's relay system? Thus, while commending the alleged advantages of reversibility, etc. of Western Union's system, the Commission concluded that:

> . . . such positive advantages in the absence of a showing . . . of a need for the operation of the Western Union channel do not justify an order for interconnection.[1]

On the question of video channel availability, the Commission cited Bell's thirteen channels and observed:

> There is no evidence in the record which indicates that such channels would not meet the present and foreseeable requirement of the existing and definitely contemplated television network for video transmission service between New York and Philadelphia.[2]

As to the interest expressed by the broadcasters, the FCC concluded that:

> none of the network witnesses showed any actual need for the New York channels and none stated a definite intention to utilize such facilities if interconnection were ordered.[3]

On the issue of competition among common carriers, the FCC declared that:

> Lack of competition in the field, while a factor to be considered, is not in itself sufficient to require a finding that interconnection would be in the public interest, and no reasonable proposal to establish competitive facilities on an interconnected basis in the public interest has been made.[4]

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[1] Ibid., p. 1177.
[2] Ibid., p. 1178.
[3] Ibid., p. 1158.
[4] Ibid., p. 1157.

In sum, the FCC decided not to order interconnection since such a determination must be based upon ". . . definite facts and not uncertain probabilities."[1]

In dissenting from this decision, Commissioner Hyde observed that the effect of Docket 9539 was to grant the Bell System a monopoly in the rendition of intercity video channels. Hyde examined the alternatives and observed:

> . . . in the absence of interconnection and in the absence of a service substantially paralleling the existing Bell System, no common carrier can compete with Bell in the intercity video transmission field.[2]

Thus, without interconnection, Western Union had an all or none option in radio relaying facilities. Recalling the financial position of the telegraph company, it was evident that Western Union could not easily duplicate AT&T's investment in facilities.

Directing himself to the future implications of the No. 9539 decision, Commissioner Hyde observed that:

> By failing to order interconnection of an existing and competing facility in an area where the traffic is of such magnitude and with an even greater potential and by failing to indicate expressly on what basis it would order interconnection of any transmission link in the future, the Commission is establishing a precedent which cannot but have the effect of discouraging from all time competition in this vital television relay field.[3] [Emphasis mine.]

AT&T and the Railroads.--Early common carrier pole lines did not extend along or follow railroad rights-of-way

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[1] Ibid., p. 1157.

[2] Ibid., p. 1180.

[3] Ibid., p. 1182.

since often the roads penetrated thinly populated rural areas. The dependence of the railroads upon communication prompted them to construct telegraph pole lines along their right-of-way, and with the advent of telephone circuits and switchboards railroad facilities were tied into the common carrier facilities. The link between railroad private circuits and the Bell exchange and toll network was the switchboard (PBX-private branch exchange switchboards). Unlimited interconnection privileges were granted to the railroads on the condition that Bell-owned switchboards were to be leased by the railroad. Contracts governing the Bell System interconnection policy with the railroads were known as standard operating agreements--some of which had been in effect for over half a century.

As common carrier facilities expanded and became available to everyone, the Bell System recognized that it could now provide the communication needs of the railroads by leasing services to them. The railroads, however, expressed the view that ownership of its communication network was essential to the overall operation of their system and access of their system to the Bell telephone long distance circuits was uniquely justified. In fact, rather than electing the option to lease their communication channels from the Bell System, the railroads were tending to own more of their circuits as they engaged in transferring their communications plant from wire and cable to microwave relay systems.

The innovation of microwave by the railroads prompted Bell to reappraise its policy of granting the railroad access to the telephone company's toll and local circuits. The impact of microwave altered, as far as Bell was concerned, the traditional interconnection policy extended to the railroads.

Under metallic circuits the railroads' pole lines extended along their circuitous rights-of-way. In a sense, the communication facilities were confined along discrete ribbons of railroad property. However, microwave, with its line-of-sight characteristic no longer required that communication circuits be confined along railroad right-of-way. Thus, not only was the interconnection policy accorded the railroads permitting them to circumvent the toll charges of the Bell System, but the trucking industry was clamoring for like treatment. As the latter contemplated plans for constructing microwave systems, trucking firms expressed the need of interconnecting their system to Bell's.

On July 15, 1959, AT&T filed before the FCC a revision of its old tariff governing connection of internal communications of customer-owned facilities and interconnection governing through telephone exchange or message toll service of customer-owned circuits. Three provisions of the new tariff revised the unlimited interconnection policy extended to the railroads.

First, interconnection of railroad-owned communication plant and the telephone exchange and toll facilities would occur:

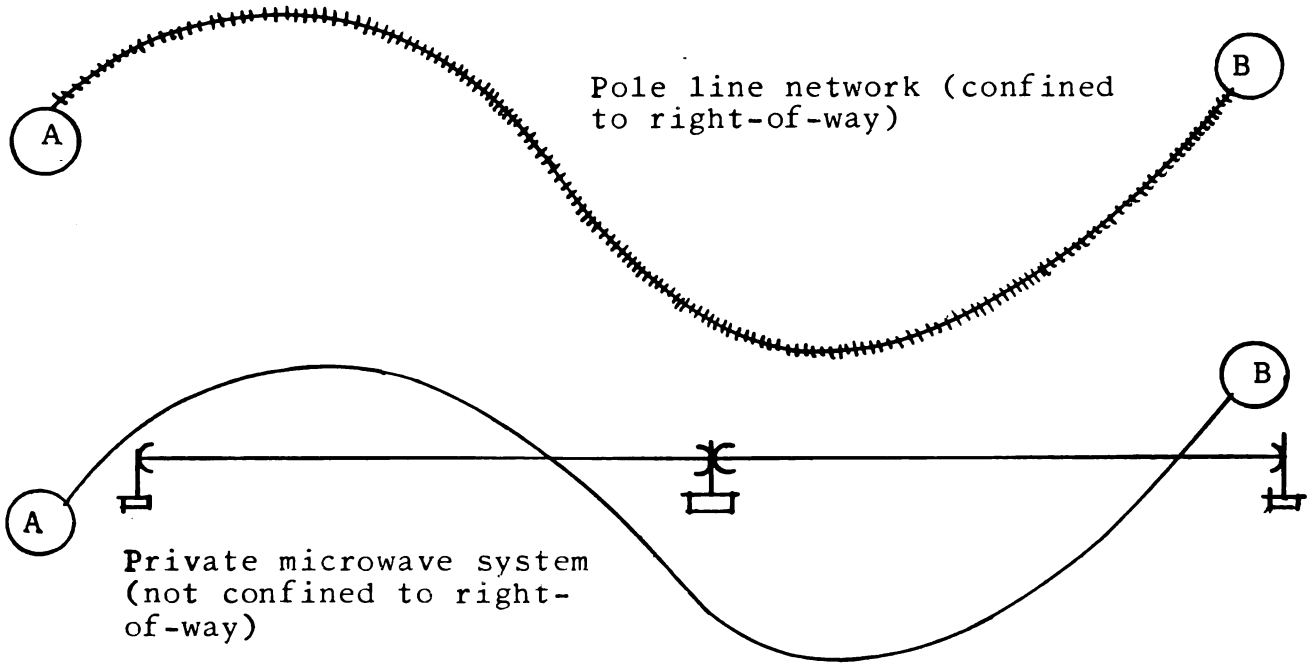

Figure 46. Railroad pole lines vs. private microwave.

a) In cases of emergency involving safety of life or property.
b) In cases where the customer facilities serve locations where it is impracticable because of hazard or inaccessibility for the telephone company to furnish its facilities.[1]

Second, unrestricted interconnection would be granted to railroad-owned circuits in existence prior to July 15, 1959.

Third, interconnection would be granted to existing circuits where:

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[1]Before the Federal Communications Commission, Railroad Interconnection Docket, op. cit., American Telephone and Telegraph, Long Lines Department, Tariff FCC No. 134, Ninth Revised, p. 10f.

a) A circuit of one type is substituted for another circuit of the same type along the same right-of-ways.

And where:

c) An intermediate segment of one type of circuit is replaced, for maintenance or other operational reasons, by a segment of another [microwave] type of circuit, providing that such segment together with any other similar segments shall not total more than half the distance between the terminals of the circuit . . .[1] [Emphasis mine.]

By way of explanation, the first provision reduced previously unlimited interconnection accorded the railroads to the limited cases of emergencies, matters of safety, etc. The second provision established July 15 as the cut-off date in which unlimited interconnection would be granted prior to that month and limited privileges extended subsequent to that month. This clause became known as the "grandfather clause." The third provision applied to the type of circuit in the "grandfather" circuits eligible for interconnection for Bell's facilities; namely, if 50 per cent of a circuit was wire, then interconnection would continue. Stated alternatively, if the railroads replaced more than 50 per cent of their metallic circuit plant with private microwave systems, interconnection of their equipment would be denied by the telephone company. A fundamental issue rested upon how valuable the railroads regarded the interconnection privilege and whether they would be willing to forego this privilege in shifting their communication plant from wire to microwave.

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[1] Ibid., p. 10fa.

Of course, it was Bell's contention that the railroad need not face that dilemma. They could simply lease all their circuits from the telephone company and acquire interconnections to toll and exchange facilities.

Of the reasons advanced in explaining the new policy, the telephone company cited as most important its public obligation to provide high quality telephone service. It followed that:

> In order to meet their responsibility to the public and to the regulatory authorities for furnishing adequate, efficient and reliable telephone service, the telephone companies must select and provide the facilities by means of which their service is rendered, and must have full control over the design, installation, operation and maintenance of such facilities. Division of the telephone companies responsibility with others is generally detrimental to telephone service to the public.[1] [Emphasis mine.]

The telephone company illustrated the complexity of modern telephone plant by a recitation of the number of components in the system, the number of connections, the number of station equipment, of PBXs, and of central offices, etc.

The division of responsibility thesis was extended to innovating new equipment. Private users would tend to retard the introduction of new facilities to the detriment of plant modernization. Further, there existed the problem of repair and malfunction with the attendant issue of the telephone company receiving the blame for problems beyond its control--if customer-provided equipment was at fault.

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[1]Before the Federal Communications Commission, Railroad Interconnection Docket, op. cit., Joint Petition for Termination of Proceeding, pp. 129877-11 and 129877-12.

As to the quality of customer-owned equipment, Bell engineers testified that when the railroads did not use special terminal equipment in the operation of intercity routes, certain design deficiencies resulted in a two-thirds reduction of speech power.

Again, Bell reminded the Commission of potential cream-skimming of revenues inherent in interconnection. The ability of private systems to pick and choose the points of interconnection would permit them to route their circuits over low cost lines, leaving the high cost lines to the common carrier. Since this cost would be reflected in higher rates, the burden

> . . . would fall largely on the smaller users who are unable to provide facilities of their own.[1]

If Bell System "discriminated" against the small user by permitting railroad-owned systems access to Bell's toll circuits, the solution lay in

> . . . cutting back that discrimination or preference and not by extension of the privilege to everybody else.[2]

The telephone company's case was summarized by Mr. Best of AT&T, who stated that:

> . . . because the telephone company goes everywhere now, they [Bell] want railroads to use telephone company facilities if the railroads are to have interconnection privileges.[3]

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[1] Ibid., p. 9.

[2] "FCC Interconnection Hearings Over," Railroad Signaling and Communications (June, 1960), 54:6, p. 48.

[3] Ibid., p. 52.

The railroads agreed with AT&T that interconnection of private and "public" circuits originated when common carrier facilities did not parallel railroad rights-of-way, but they cited a sixty-year precedent of the unlimited interconnection policy.

Referring to communications as the nervous system of the railroad operation, the railroads emphasized the uniqueness of their operation and the necessity for safe, continuous, and reliable service. Railroad rights-of-way, including rails, crossties, roadbeds, signaling systems, grade crossings, etc. required steady maintenance. Chesapeake and Ohio commented that:

> Maintenance men and other personnel on line cannot afford to lose the valuable time required to locate a Bell telephone at somefilling station or farmhouse before they can talk to their supervisors.[1]

The railroads were particularly vehement in commenting on the 50 per cent limit imposed on microwave circuits. The railroads offered several reasons for shifting from pole line facilities to private microwave. Microwave circuits were more dependable, provided better quality signals, offered greater channel capacity, and because pole lines were susceptible to washouts, sleet, snow, and other damage, microwave reduced maintenance costs.

The railroads, in general, argued that interconnection premised on the requirement that 50 per cent of the railroad

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[1]Preliminary Statement, Chesapeake and Ohio Railroad Company, Draft 8460 applicable to Railroad Interconnection Docket, p. 23.

circuits be "metallic" had the "effect of discouraging the railroads from modernizing their plant" and that maintaining wire plant was "wasteful and inefficient." Chesapeake and Ohio testified as to the 50 per cent limit.

> The net effect . . . is a means of destroying the use of microwaves by the railroads.[1]

And some railroad witnesses inverted the cream-skimming argument by declaring:

> Having fostered interconnection at a time when it was beneficial to its Bell System companies, AT&T now wants to take over this important segment of railroad communications and provide the service itself except where hazardous or inaccessible--(costs too much)--this AT&T wants to leave to the railroads.[2]

Mr. Brosnam of the Southern Railroad declared that the tariff:

> . . . in my judgment is designed to make our private systems completely unworkable and in the end force us to come around to leasing all of our communications from the telephone company.[3]

In considering the option of leasing facilities and equipment from Bell, the railroad appeared less than enthusiastic. The problem was cost. Mr. Marsh explained that:

> We can provide and maintain our plant at considerable less cost than we can take it from the telephone company.[4]

> We would be paying the telephone company twice or more for the service than one can provide it for

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[1] Railway Signaling and Communications, op. cit., p. 58.

[2] Preliminary Statement, Draft 8460, op. cit., p. 11.

[3] Railway Signaling and Communications, op. cit., p. 58.

[4] "FCC Interconnection Hearings Over," op. cit., p. 40.

ourselves.[1]

Adding that, the railroad has no legal right to "dissipate" its funds:

> We have the choice of renting facilities from them at a price very much higher than we can provide those facilities for ourselves.[2]

The Commission made no decision in this case since on April 24, 1961, both parties filed a joint petition for termination of the interconnection proceeding. AT&T inaugurated a new tariff permitting the interconnection of railroad-owned plant with Bell facilities at both ends of a through route for emergency calls and:

> At either end, but not both for calls related to the safety, continuity or reliability of railroad service . . .[3]

The new Bell tariff eliminated both the "grandfather clause" and the 50 per cent ceiling on radio circuits. Except for some minor alterations, the railroad had retained the right to introduce private microwave and yet retain access to AT&T toll circuits. In addition, the railroad market had not been foreclosed to the private microwave equipment supplier.

AT&T and Private Microwave Systems.--One of the issues broached by the FCC in the "Above 890 MC" docket in

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[1] Preliminary Statement, Draft 8460, op. cit., p. 11

[2] Ibid.

[3] "Interconnection: AT&T; RR Agree," Railway Signaling and Communications, 54:6 (June, 1961), p. 30.

determining whether to liberalize private microwave systems was the problem of interconnecting private systems with the Bell toll terminals and long distance lines. AT&T asserted its right to deny interconnection of its facilities with private system; while users and microwave equipment suppliers demanded interconnection. The Commission in its report concluded:

> It is clear from the record that from a technical standpoint, interconnection of private systems with common carrier systems is feasible where compatible and adequate transmission standards are maintained.[1] [Emphasis mine.]

The lack of any technical barriers to linking private microwave with public facilities is reinforced by the fact that AT&T purchases microwave equipment from the non-integrated suppliers (35%) and then integrates the equipment into its own common carrier network.

Furthermore, the Bell System must tie into and interconnect with some 3,000 independent telephone companies; companies that procure their microwave relay facilities from the non-integrated equipment firms. In short, the Commission stated the absence of any engineering obstacles to interconnection of common carrier and non-common carrier facilities.

Again, interconnection policy was raised during the second series of the "Above 890" hearings and again the Commission noted:

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[1]Before the Federal Communications Commission, The Above 890 Report and Order, op. cit., p. 397.

> . . . AT&T, Western Union and General have indicated that they have no intention of relaxing existing tariff restrictions on interconnection with facilities of others. They suggest that if the Commission's report and order is finalized as now proposed then it will be necessary, for their own protection, to adopt more stringent interconnection policies.[1]

Following the FCC's decision in the "Above 890" case, the Bell System introduced a new "competitive" private line tariff. The tariff, called Telpak has resulted in a substantial reduction in leasing costs to the volume users of private line services. In addition, the tariff permits Bell customers to secure access to both local and toll circuits of the AT&T system. This privilege stands in contrast to the user of private microwave systems in that duplicate phone equipment, switchboards, etc. are required to convey access to public facilities. One set of equipment is employed for intracompany service, the other set, Bell's, permits access to the toll circuits. In emphasizing the advantages of end-users subscribing their communication needs from the common carriers, the Florida telephone industry, of which Bell is a member, submitted a communication system proposal to the Minute Maid Corporation. The proposal stated:

> relieves limitation of private communication systems --you will have complete interconnection to telephone service in general.[2]

Citing this advantage of the common carriers, Motorola

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[1]Before the Federal Communications Commission, The Above 890 Report and Order, op. cit., p. 833.

[2]Before the Federal Communications Commission, Telpak Docket, op. cit., AT&T Testimony, Appendix No. VI, p. 5.

submitted that private microwave systems should be able to obtain "equal rights" of interconnection and that:

> . . . the prospective users of private microwave facilities meeting reasonable criteria should have such rights under the tariff without the burden of a large number of "case-by-case" hearings.[1]

In short, Motorola contends that if AT&T permits interconnection of "bulk" and "non-bulk" users with each other, it, too, should be able to offer the same privilege. Motorola observed that:

> Moreover, the common carriers' prohibition against interconnection of their facilities with private systems has been a significant deterrent against operation of private systems.[2]

Western Union, in the hearing on the Telpak tariff, also alluded to the impact of the common carriers' ban on interconnection.

> . . . the absence of interconnection with common carrier facilities is a factor which must be given very substantial weight when considering whether the entire bulk communications market is available to private microwave. Obviously, the inability to connect private systems with common carrier facilities is a highly signficant fact--a fact which, in and of itself, would make it uneconomical for many users to build their own private systems.[3]

Because of AT&T's vertical integration, Bell's non-interconnection policy holds implications applicable to the structure of the microwave equipment market. Take the

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[1]Before the Federal Communications Commission, Telpak Docket, op. cit., Motorola, p. 54.

[2]Before the Federal Communications Commission, Telpak Docket, op. cit., Western Union, p. 44.

[3]Before the Federal Communications Commission, Telpak Docket, op. cit., Proposed Findings of Fact and Conclusions, Western Union Telegraph Co., pp. 15-6.

first case involving the interconnection of Bell's video channels versus the broadcasters video channels. Nonintegrated suppliers of heavy route equipment were accorded the potential of market access when broadcasters began constructing their own video links. However, when the FCC announced that interstate video channels where to be provided by the common carriers, and that broadcaster relay systems were to be disbanded in the event that Bell's video channels became available, the impact upon the equipment market was crucial. Nonintegrated equipment employed by the broadcasters was to be rapidly amortized pending the introduction of Western Electric's equipment. Whatever incentive existed for the nonintegrated firm to manufacture heavy route equipment, their incentive was diminished by FCC's interstate video channel policy.

Again, the market for heavy route equipment was foreclosed to the nonintegrated supplier when the FCC refused to order interconnection between Western Union's video channels and AT&T's video channels. This decision, in effect, permitted Western Electric equipment to dominate the heavy route segment of the equipment industry.

The railroad interconnection case illustrates Bell's attempt to prevent the adoption of thin route private microwave systems. In this respect, the testimony of certain nonintegrated suppliers on behalf of the railroads is indicative of the value they placed upon the railroad industry as one market outlet for their systems. Although AT&T failed to invoke its policy of non-interconnection of Bell channels

with non-Bell channels, it is clear that the thrust of Bell's railroad case rested in its attempt to inhibit the railroads in their adoption of private microwave systems. If Bell had been successful in imposing the 50 per cent limit on the rails' use of "nonmetallic" circuits, and if the railroads had determined that interconnection was too valuable a privilege to forego, then the market potential of the non-integrated manufacturer would have contracted concomitant with Western Electric's market expansion.

Finally, interconnection exercises its influence in the "new" private microwave market expanded under the Above 890 decision. If the end-user values the interconnection privilege, then the option to lease from Bell is favored over the option to purchase a private relay system. Again that option is translated into the equipment market.

In short, because of Western's vertical tie-in with the Bell System, the manufacturing concern automatically preempts in the factor market what the operating companies win in the service market. This is not to argue that AT&T should be subjected to a policy of mass interconnection with all radio relay systems, but only to suggest that because Western is integrated the interconnection privilege tending to favor the leasing option confers to Western Electric market power not accorded its nonintegrated rivals.

Pricing

In addition to AT&T's interconnection policy, the Bell System has attempted to compete with private microwave systems through tariff reductions for its private line service. Three tariffs are relevant in assessing the impact of price competition between the Bell System and the nonintegrated suppliers. The first is the multiple channel tariff; the second, The Telpak (original) tariff; the third, Telpak (revised).

Price competition first manifested itself between the common carriers and the private microwave suppliers in September of 1955. It will be recalled that prior to the "Above 890" docket on frequent allocation, only specified consumers could obtain frequency licenses, the common carriers and certain right-of-way and public safety groups. In 1955, manufacturers for the first time filed applications before the FCC to liberalize the Commission's licensing of the microwave frequencies--applications that prompted the Commission to reappraise its allocation policy in Docket 11866 or the "Above 890" case.

In September of 1955, AT&T filed a private line tariff known as the multiple channel tariff. The tariff did not apply to users of private line services across the board, but affected only those who leased a given volume of channels. To those volume users the telephone company offered a price discount of up to 28 per cent.[1]

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[1]Before the Federal Communications Commission, Private Line Docket, op. cit., p. 76.

Inasmuch as the tariff applied to the volume segment of its private lease market, AT&T contended that volume users constituted a "distinct and separate" market that existed apart from regular private line customers. As a distinct market and eliciting a distinct need, the telephone company sought to meet that need with its multiple channel tariff. Furthermore, AT&T noted that the tariff was prompted by the competitive necessity of meeting the services offered by private microwave suppliers; and as a matter of fact, Bell alleged that it lost approximately $9 million as a result of end-users electing to use private microwave.[1]

Another factor prompting the innovation of the multiple channel tariff was its impact upon the size of the private line market. AT&T observed that quantity discounting would tend to stimulate greater use of the leasing market and the use of telephone plant used in rendering private market service.

Western Union objected to the private line quantity discount and some six years of hearings, study, and adjudication elapsed on what came to be known as the Private Line Docket (16464-5).

In 1961 the Commission issued its initial decision of the Private Line case, and in its evaluation of the multiple channel tariff touched on the following points.

On the nature of the volume private line service, the FCC stated that of all the customers, the government stood

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[1] Ibid., p. 78.

as the largest user. Since it was government policy that it would not operate its own microwave systems but take its services from the common carriers, there was hardly any "competitive necessity" in retaining government business.

If AT&T intended that the tariff be directed to the non-government consumer, then the FCC asserted that the telephone company was under obligation to submit cost studies as to the construction, operation, and maintenance of private microwave systems. Since Bell had not submitted any cost studies, the Commission could not make any valid comparison in order to assess the "competitive necessity" of the multiple channel tariff. Furthermore, the Commission expressed doubts as to whether the quantity discount pricing would appreciably affect the option of an end-user in deciding whether to lease or build radio relay systems.

However, the Commission's most crucial evaluation of the multiple channel tariff rested upon its cost analysis, and here the FCC declared:

> There are no significant differences in the carriers' cost in furnishing a multiple number of channels to a single customer between a given pair of points as compared with the furnishing of the same number of channels to different customers between the same points.[1] [Emphasis mine.]

In short, the Commission concluded that under the multiple channel tariff, AT&T would be levying different charges for like services, resulting in a tariff that discriminated against the small volume user and favoring the large volume

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[1] Ibid., p. 77.

user. Further, FCC could find no evidence that suggested that the tariff was reasonably designed to meet competition, nor could it determine that the tariff would stimulate the use of facilities in rendering the service. Fundamental to the FCC's decision to invalidate the tariff was its conclusion that no significant cost differences existed between service to the large and small consumer.

During the interim of the Private Line case, the FCC rendered its decision in the "Above 890" MC docket (1959-60) --and had decided to expand private microwave eligibility.

Thus, in its rebuttal to the Private Line initial decision, AT&T commented on the competitive impact of the "Above 890" decision. Bell asserted that not only did a volume or bulk market exist in private line communications, but that the Commission's decision to let "almost anyone" use private microwave added paramount urgency to the necessity of meeting competition with a rate to meet potential microwave system users.

However, the thrust of Bell's rebuttal rested not against the decision as such, but against the means by which the Commission had reached its decision. The Commission had taken the position that common carrier tariffs could be justified only on fully allocated costs (average cost pricing). While AT&T insisted that <u>total revenues</u> should meet joint and marginal costs thus providing a reasonable rate of return,

> . . . rates for individual services and their components need not yield identical markups over allocated cost. Marginal cost should be borne by the service to which they are attributable, but joint costs should be distributed among the individual services in relation to the realities of the market.[1] [Emphasis mine.]

AT&T further contended that the FCC was attempting to reduce a complex rate matter to an "arbitrary mathematical formula" based upon fully allocated costs. In its objection to rates based upon average cost pricing, AT&T queried:

> What sense does it make to establish a requirement that regulatory bodies uses and the carriers should be burdened by expensive and time-consuming studies arrived at determining the cost of producing a segment of service when that achievement is in fact impossible of attainment?[2] [Emphasis mine.]

However, in the Telpak tariff hearings, Bell attempted to justify the tariff by such cost segmenting.

Telpak Original

> Now that the Commission has determined in the above 890 case that users should have freedom of choice between common carriers and private microwave service it is important that the choice be a realistic one.[3]

With this prelude, the Bell System initiated a new private line tariff two months after FCC's final decision to

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[1]Before the Federal Communications Commission, Private Line Docket, op. cit., Brief in support of exception of the Bell System companies to the Initial Decision released July 14, 1961, p. 7.

[2]Before the Federal Communications Commission, Private Line Docket, op. cit., AT&T Brief, p. 15.

[3]Before the Federal Communications Commission, Telpak Docket, op. cit., AT&T, Appendix I, p. 3.

liberalize private microwave (August, 1960). The tariff, called Telpak, was to take effect on February 16, 1961.

As a new private line service, Telpak consisted of:

> . . . communication paths of different bandwidth (Telpak channels . . . much like different size roads . . . which are capable, to different degrees of transmitting all forms of electrical communication required by business . . .[1]

The tariff includes two components, a flat monthly rate per mile for transmission and monthly rates per channel terminal. Telpak was classified into four types ranging in increasing bandwidth capacity.

TABLE 34

TELPAK CLASSIFICATION[2]

Classification	Kilocycles	Voice circuits	Rates per airline mile per month	Rate per circuit mile
Telpak A	48	12	$15.00	1.25
Telpak B	96	24	$20.00	.833
Telpak C	240	60	$25.00	.417
Telpak D	1000	240	$45.00	.187

(Note particularly the reduction in the rates per circuit mile, i.e., decreasing costs.)

[1] Ibid., p. 4.

[2] Before the Federal Communications Commission, Telpak Docket, op. cit., Brief and proposed findings and conclusions of Bell System respondents, pp. 17-8; also AT&T testimony, Appendix No. VI, an Intercity Private Line Communications Safety Proposal for Minute Maid, submitted by: The Florida Telephone Industry, p. 4.

These charges represented a reduction in private line rates by as much as 80 per cent over previous rates. An appreciation of the relative decline of Telpak over previous private line pricing is seen in Figures 47 and 48.

In addition to the Telpak classification, AT&T provided that Telpak channels would be subdivided into channels of lesser bandwidths, called derived channels.

In effect less than one month, the Telpak tariff was challenged by Western Union in a letter to the FCC. Western Union alleged that AT&T was violating its own tariff and this contention touched off a controversy regarding the nature and type of facilities used in furnishing the new private line service.

Two methods exist from which a multiplicity of voice channels can be derived. A first method uses discrete or microwave facilities (also coaxial cable if it exists); the second employs diverse or wire and cable facilities (telephone lines).

Under the assumption that discrete facilities provide the bandwidths, a single communication path is generated between two points. From the wideband path, voice channels of lesser bandwidths are derived by channelizing equipment. In short, the source of channels of lesser bandwidths come from a single broadband signal.

A second method of deriving or supplying a number of voice channels is to use the diverse facilities of wire and cable and "add up" these facilities in providing a given

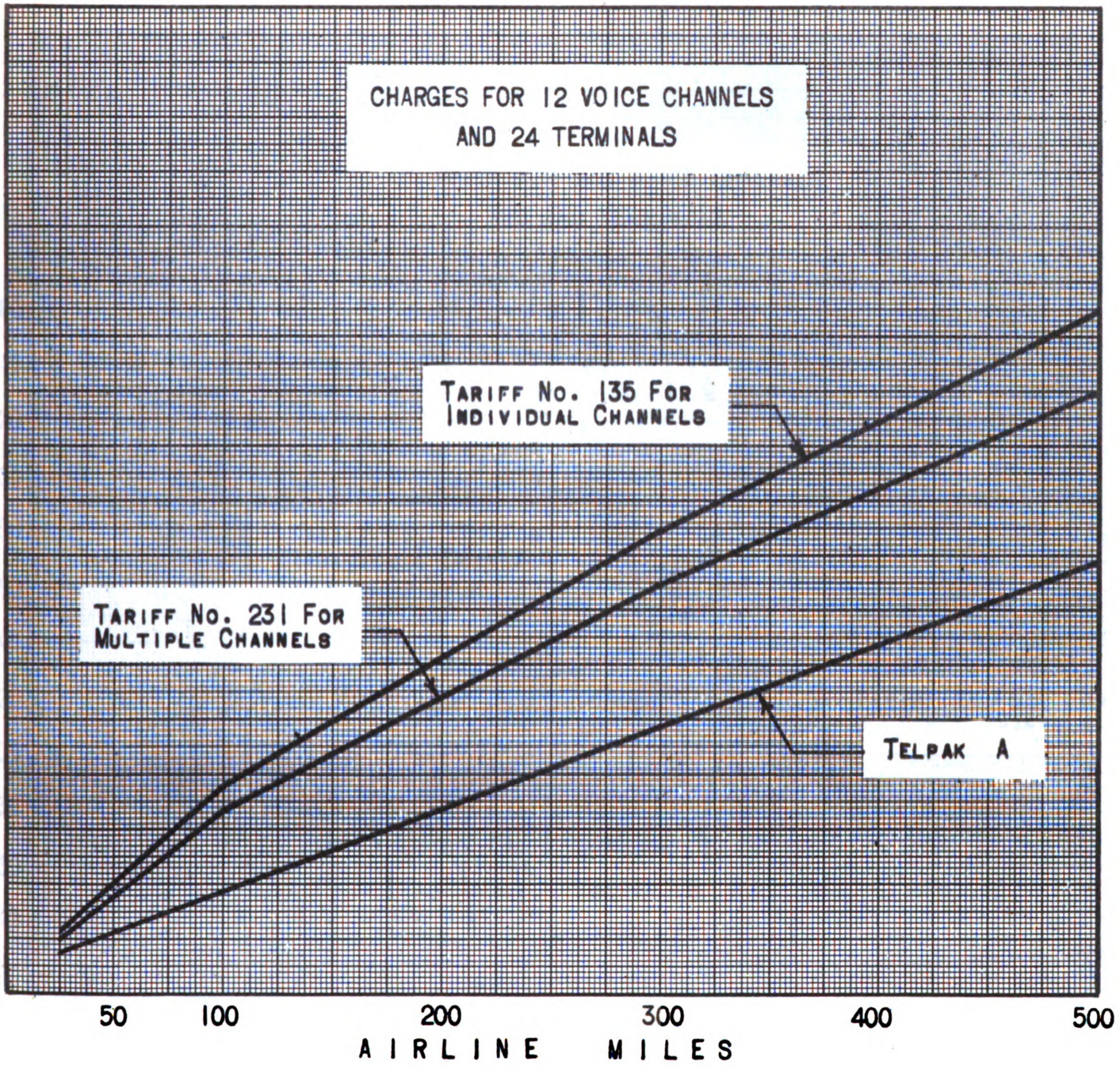

Figure 47. Charges for 12 voice channels and 24 terminals. Source: Before the Federal Communications Commission, Telpak Docket, AT&T Appendix No. 11.

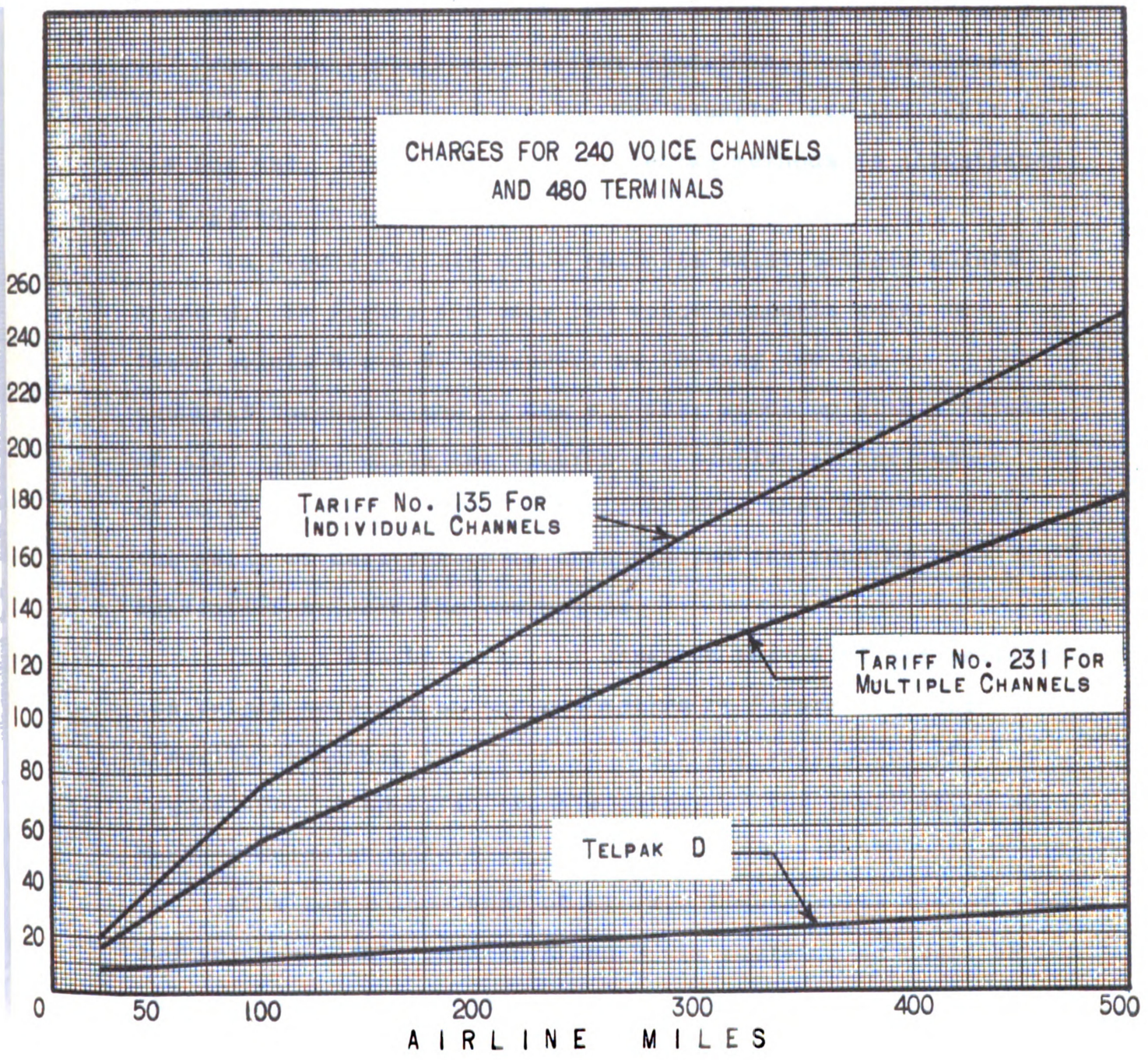

Figure 48. Charges for 240 voice channels and 480 terminals. Source: Before the Federal Communications Commission, Telpak Docket, AT&T Appendix No. V.

quantity of specified bandwidths. The consumer is not only indifferent, but unaware that his voice channels are provided by "subtracting" the channels from a single signal or "added up" from a multiplicity of lesser bandwidths. All he knows is that his six voice channels, for example, are available to him for use. The difference in the two methods is illustrated in Figures 49a and 49b.

In Figure 49a six voice channels exist between points A and B. In Figure 49b only two voice channels exist between points A and B. However, by routing two voice channels through C and D, the end-user winds up with a total of six. Thus, while the figures are similar in the number of voice channels leased to the consumer, they differ as to the means of deriving those channels and the routing of facilities between the two points.

The Western Union letter asserted that AT&T was selling its Telpak services on the assumption of Figure 49a, but actually rendering the services under the assumption of Figure 49b. A specific example points up the implication of Western Union's contention.

If a low volume user of private line service leased two voice channels between A and B via route D, he would be charged by the telephone company the distance from A to D and from D to B. A large volume user of six voice channels would actually have two of his circuits routed through the multiple points of A, D, B, but he would be assessed under the Telpak tariff only between points A and B; no extra charge would be

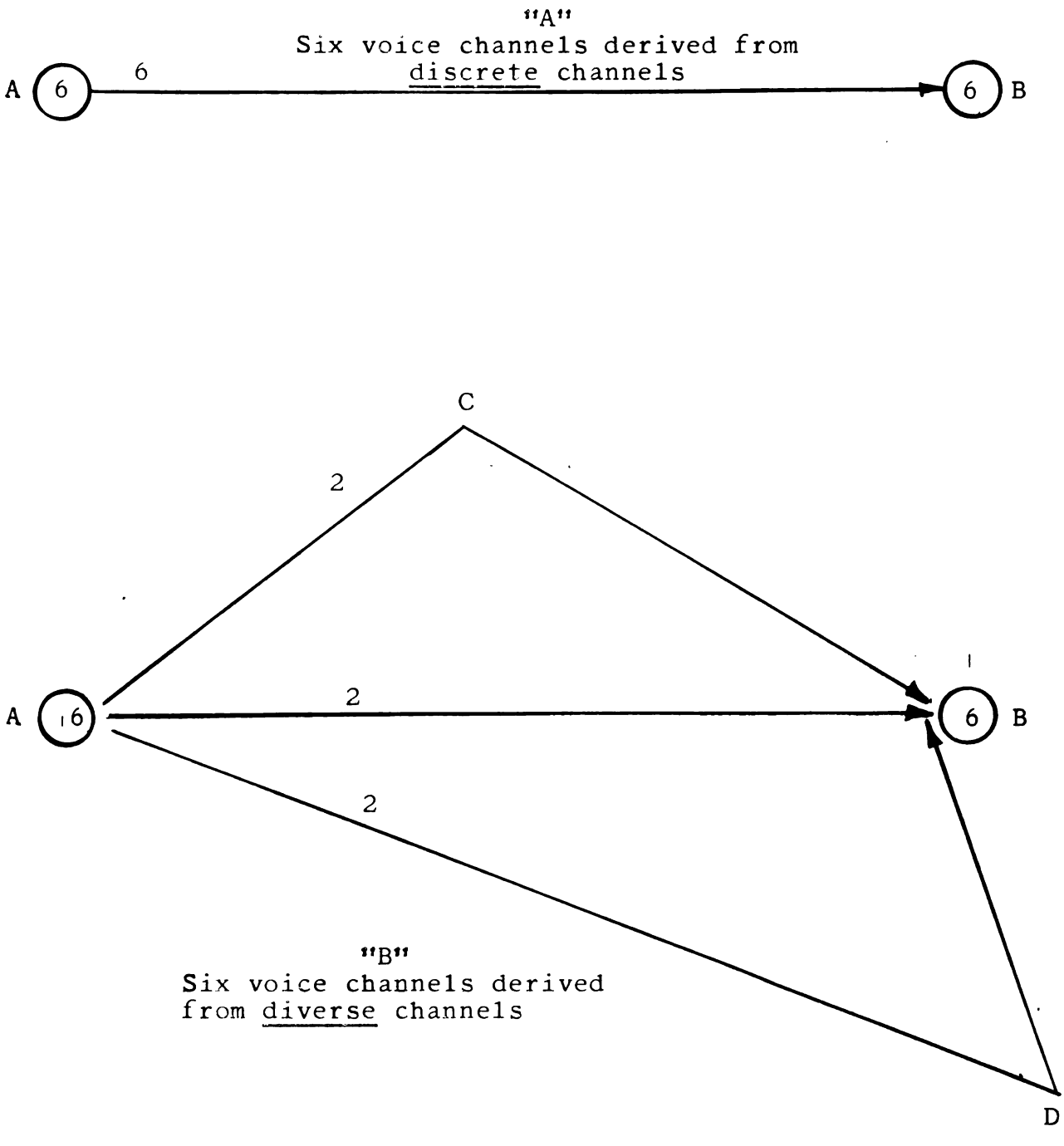

Figure 49. Discrete vs. derived channels.

levied for the point D routing.

Three days after the Western Union letter, the Commission sent an inquiry to the telephone company questioning its use of telephone lines or narrow bandwidth facilities (diverse) in deriving Telpak channels. The FCC noted that in the past, customers were billed on the basis of multi-channel points and were billed separately for each route. AT&T defended its diverse routing by observing that under all private line services, the telephone company selects the routing and facilities with which to render the service. In cases where channels were derived from diverse facilities, such derivation served the purpose of "efficient utilization of plant."

Furthermore, according to Bell, Telpak described a service; it was not intended to describe plant facilities used in rendering that service.

> It is essential for the telephone company to retain the choice of routes and facilities for efficient use of plant and prompt furnishing of service.[1]

However, in a memorandum opinion and order on April 12, 1961, the FCC ruled that AT&T could not apply Telpak rates over diverse facilities. Telpak rates were applicable solely over single broadband channels subdivided into lesser bandwidth channels. The Commission observed that furnishing a

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[1] Bell System Comments on Organization and Administration of the Federal Communications Commission, Booz-Allen and Hamilton, July, 1962. AT&T letter to FCC, March 10, 1961, Attachment B, p. 5.

multiplicity of channels from different facilities over diverse physical routes was not a "communication path," a "Telpak channel," or a "broadband transmission medium." Such operations did not consist of subdividing a Telpak channel by means of channelizing equipment. The Commission concluded that Telpak service rendered over diverse physical telephones did not distinguish it from the other private line services that Bell offered.

Although AT&T filed a petition requesting reconsideration of the FCC's decision, the FCC denied the petition, and on July 21, 1961, AT&T wrote the Commission that existing Telpak services had been transferred to

> single carrier spectrum assignments wherever this could be done without new construction and there remained 285 Telpak sections which were still on diverse facilities pending new construction.[1]

Confronted with the FCC's decision that it had violated its own tariff, the Bell System attempted first to challenge the decision with A Petition of Reconsideration; however, on August 3, the telephone company avoided the effect of the Commission's decision by revising its definition of Telpak. Telpak revised read that AT&T could render its service via discrete (microwave) channels or via diverse (telephone line) channels supplied at the discretion of the telephone company. It was on the basis of the new tariff that the FCC initiated hearings on the issue of lawfulness of Bell's attempt to meet competition of private microwave systems.

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[1]Letter from C. F. Nelson to FCC, July 21, 1961, Attachment B, p. 9.

The revised Telpak was scheduled to go into effect on September 8, 1961. However, the Commission suspended the tariff for the statutory limit of three months (after which a tariff automatically goes into effect) and meeting en banc, attempted to decide on Motorola's petition. Motorola had requested expedited proceedings to adjudicate whether the suspended tariff represented unjust price discrimination.

On December 6, the Commission held that it could not make a determination as to the lawfulness of Telpak without "full consideration of all pertinent factors"; thus a hearing examiner was appointed and hearings initiated.

In stating the substantive issues of the hearing, a general summation of the adversaries' position will be made, followed by an evaluation of the cost criteria employed to justify Telpak pricing.

Of the many substantive issues embroiled in the hearing, three appear to be relevant; first, what is the definition of Telpak; second, what is the size and importance of the market it affects; and third, what is the proper cost criteria in determining whether Telpak is compensatory or non-compensatory in pricing.

As to the issue of definition, the Bell System asserted that Telpak is a new service based upon a need for volume of bulk communication channels. The bulk market owes its origin to three trends in the transfer of information. First, the continued automation of data processing necessitates wideband channels to handle the rapid dissemination

of both record and voice signals. Second, business is tending to decentralize operations, both in the private as well as the public sector, and this decentralization means more reliance on communication as a means of coordination. And third, the bulk market is stimulated by the need for flexibility. That is, end-users desire to use larger channels that will permit them to hook up television equipment, teletype, telephone facsimile, computers, etc. One company, for example, will employ its channels during the daytime for telephone or facsimile purposes, etc., then hook into and run computers at night. Since the trend in business data processing is growing rapidly, and the need for a hierarchy of different sized voice channels needed, the Bell System is attempting to meet that need with its Telpak service.

Western Union's definition of Telpak, in differing from the Bell System's concept, alleges that Telpak is nothing more or less than the old multiple channel service dressed up in different terminology.

> The two services are indistinguishable in purpose as well as in operation.[1]

Furthermore, Western Union insisted that since the Bell System can use existing physical plant in rendering the service, the Telpak service reduces itself to quantity discount pricing for volume private line users.

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[1]Before the Federal Communications Commission, Telpak Docket, op. cit., Western Union, Proposed Findings of Fact and Conclusion, p. 21.

Reasserting its position taken in the diverse versus discrete facilities controversy, the telegraph company maintained that Bell is charging different rates for like communication between two points.

Similar to Western Union's position, Motorola argued that Telpak, rather than a new service, was a form of "discount pricing." Motorola referred to the new private line tariff as a "bundling price arrangement" over the same physical routes that AT&T offered its other private line services.

Figure 50 illustrates Motorola's position. In part A two voice channels are leased from Newark to New York City, and four channels are leased from Boston to New York city. Under the traditional private line tariff (No. B5), each end-user is billed for using two- and four-voice channels, respectively. However, Telpak users can get together and jointly lease or share Telpak channels. Thus, if the New Jersey customer and the Boston customer join with a New York customer, all going from New York to Baltimore, then a total of twenty-one leased channels qualifies them for Telpak rates.

However, Motorola contends that this bundling exists for pricing purposes only. In Part B, the actual physical routing of Newark and Boston may not connect with New York, but be routed directly to Baltimore. In short, Telpak is nothing but an invisible hand that, by clutching (in Part B) and grouping the two, fifteen- and four-voice channels

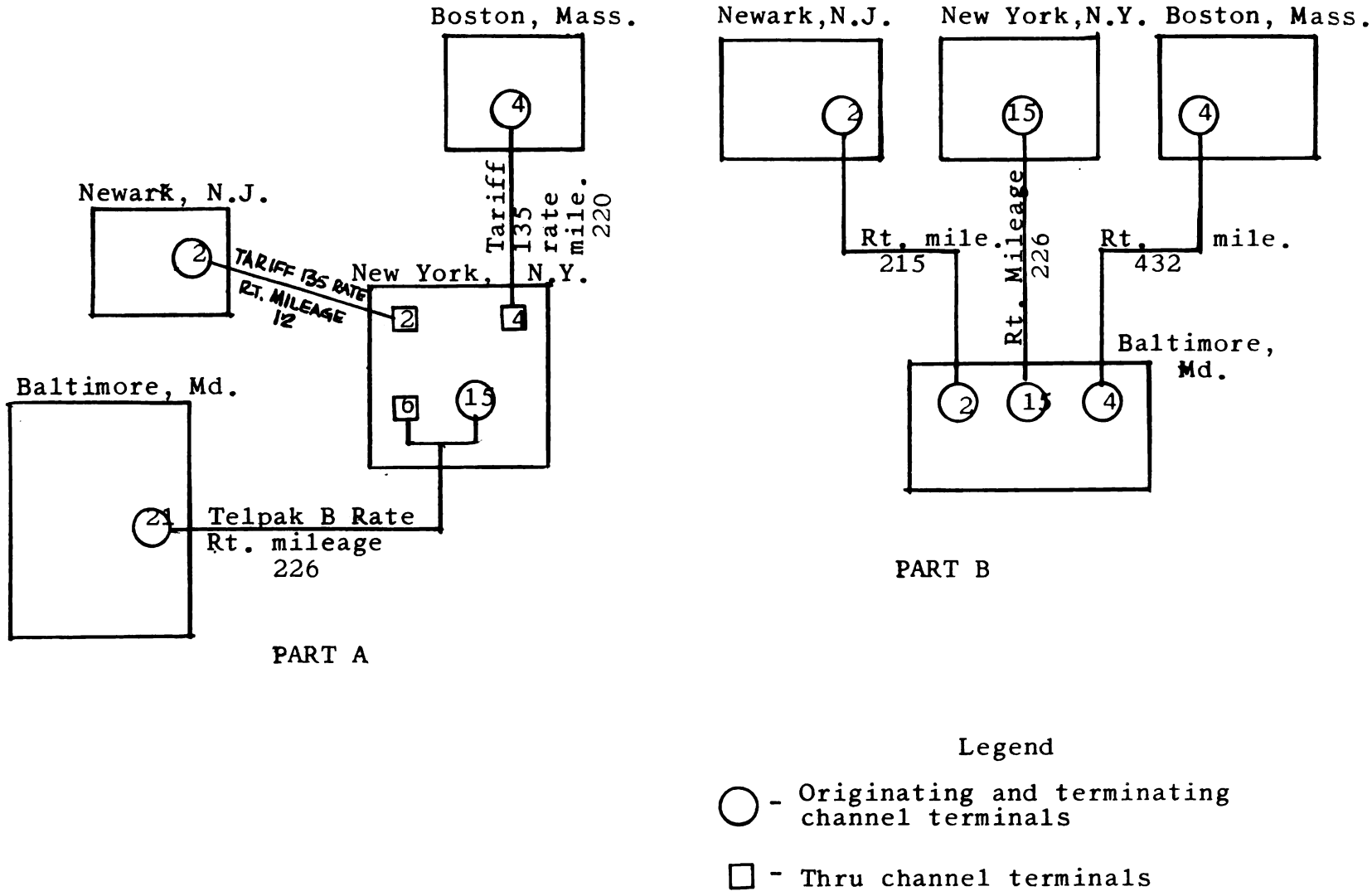

Figure 50. Motorola's concept of Telpak pricing.
Source: Before the Federal Communications Commission, Telpak Docket, Motorola, Proposed Findings and Conclusions of Motorola, Inc., p. 14.

confer a discount private line rate.

Thus, both Western Union and Motorola, in defining their concept of Telpak, concentrated on the physical routing of the service.

A second point at issue among the adversaries is the size and nature of the market to which Telpak is directed. The Bell System retained The Arthur D. Little, Inc. for the purpose of assessing the size and trend of the bulk communications market. The study revealed

> a substantial and increasing demand for bulk communications.[1]

As cited earlier, the bulk market is expected to grow from its base of about 85 million in 1961 to between 175 to 200 million by 1970.

Private microwave systems are amenable to the bulk market consumer and Bell expressed the apprehension that if it did not offer a

> . . . service comparable in form and price to private microwave systems, both existing and future business will be diverted from the common carriers in ever increasing proportions.[2]

Furthermore,

> A customer who turns to private microwave must make a substantial investment in long-life facilities. Once he has acquired his own system, the customer can make additional use of it at comparatively small cost. Thus, once a customer has elected private microwave, his bulk communications business is

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[1]Before the Federal Communications Commission, Telpak Docket, op. cit., AT&T Appendix No. 1, p. 1.

[2]Before the Federal Communications Commission, Telpak Docket, op. cit., Bell System Respondents, p. 14.

> effectively lost to the common carriers for the foreseeable future.[1]

AT&T added that the Telpak tariff will stimulate the addition of new, low cost plant,[2] an investment that will induce economies to all customers of the telephone company. In sum, the Bell System observed that given the FCC's "Above 890" decision permitting private microwave even where the common carriers provided facilities, Telpak was necessary to meet private microwave competition in the bulk market.

Again Motorola and Western Union took a different tack in assessing the market for bulk communications. In viewing the components of the market, Motorola noted that the government component substantially outweighed the non-government component.

In 1961, the Federal government accounted for 88 per cent of the bulk market; in 1965, 84 per cent; and in 1970, 78 per cent.[3] Since the government is the largest consumer of the bulk services and the military accounts for over 50 per cent of the government's demand, Western Union quoted the Department of Defense's policy as to whether it elected

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[1]Before the Federal Communications Commission, Telpak Docket, op. cit., AT&T, p. 28.

[2]Before the Federal Communications Commission, Telpak Docket, op. cit., AT&T Brief and Proposed Findings, p. 49. "Moreover, Telpak stimulates the introduction of new, low cost facilities and accelerates the downward trend of the average unit costs of interexchange plant, thus benefitting the users of all interstate services.

[3]Before the Federal Communications Commission, Motorola Final Brief, op. cit., p. 49.

to build its own microwave system or take the needs from the common carriers (DOD stated that it intended to rely on commercial services because it would avoid substantial investments in government-owned facilities).[1]

Both Motorola and Western Union concluded that since the common carriers had no fear that the government would not use their facilities, the only component of the bulk market susceptible to private microwave competition was the non-government component (12 per cent in 1961). It was Motorola's position that this percentage hardly justified the competitive necessity of Telpak, and its impact upon accelerating new plant investment would be minimal.

The heart of the Telpak case, however, centered upon its pricing; that is, whether Telpak rates were justified by the costs incurred in rendering bulk communication channels. On this issue the adversaries stood at polar extremes; AT&T insisted that the tariff was based on fully allocated costs and hence compensatory.

In attempting to establish the validity of Telpak pricing, AT&T advanced evidence on the theoretical front as well as on the empirical front. Bell's theoretical discussion focused on the relevant criteria of incremental pricing.[2] As opposed to rates determined by average cost

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[1]Before the Federal Communications Commission, Telpak Docket, Western Union, op. cit., p. 16.

[2]Bell, last year, in comments to NASA, appeared skeptical as to the value of the incremental price standard. Thus, "considering incremental costs is valid (if at all)

pricing (rates including both variable as well as fixed costs in rendering the service), AT&T insisted that the relevant guide was the additional amount of cost incurred by the telephone company in rendering an additional unit of service.

Two cases were cited as evidence in attempting to establish the criteria of incremental pricing. The first case drew attention to the plight of the railroad industry with specific reference to the problem of pricing. The central theme advanced by AT&T was that the railroads exhibited high costs and redundant or excess plant capacity. As the price elasticity of demand increases because end-users are given the additional options of water carriers, motor carriers, airplane carriers, and the automobile, the railroad increasingly suffer from serious underutilization of plant. In order for the railroads to compete with other carriers, fixed costs cannot be included in their rate bases. That is, "excessive averaging" or "fully distributed" costs are not a viable policy alternative for railroad pricing:

> . . . the fully distributed cost doctrine does not reflect valid principles of pricing, where fixed costs are significant.[1]

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only until capacity of existing system reached," p. 93a. Bell System Comments on Rand Corporation Memorandum RM-2845-NASA, October, 1961. Communications Satellites and Telephone Rates: Problems of Government Regulations, Leland L. Johnson, The Rand Corporation.

[1]"The Role of Cost in the Minimum Pricing of Railroad Services," Journal of Business, University of Chicago, XXXV: 4 (October, 1962), p. 364.

A second cost study involved the air cargo transportation industry--a study sponsored by the Civil Aeronautics Board. This study, as in the railroad case, took cognizance of competition existing between the nation's air cargo carriers and other forms of carriers. In advising the CAB on a policy of pricing, the report stated:

> To preserve the inherent advantages of air cargo transportation vs. other competition . . . emphasis should be directed toward determination of minimal marginal costs or marginal costs of efficient carriers over the long run.[1]

Emphasizing the role of marginal cost pricing, the report concluded:

> . . . as long as long-run marginal costs for the particular shipments concerned are covered and as long as the overall rate structure will recover total cost . . .[2]

Thus Bell's theoretical argument concludes that:

> . . . the detemination of the costs of a competitive offering on an incremental or additional cost basis has long been recognized as proper. Competitive rates are compensatory and do not place an undue burden on other users of a carrier service if the rates cover incremental costs.[3]

Before spelling out the empirical evidence submitted by AT&T in justifying its Telpak tariff, it might be well to survey the total plant classification of facilities that the telephone company uses in rendering the communication services.

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[1]The Cost of Air Cargo Service, prepared for the Civil Aeronautics Board, Systems Analysis and Research Corporation (June, 1962), Vol. I, Technical Report, pp. 33-4.

[2]Ibid., p. 34.

[3]Before the Federal Communications Commission, Telpak Docket, AT&T Brief and Proposed Findings, op. cit., p. 41.

What is relevant to our discussion is the variation in average cost per route mile between radio relay and other interexchange facilities; here Bell included three cost studies as evidence in supporting Telpak pricing.

TABLE 35

AT&T TOLL LINE FACILITIES

Types of Channel Facilities	Long Line Average Book Cost per Route Mile
1. Voice frequency open wire	$174.70
2. J + O open wire carrier	90.58
3. Other open wire carrier	199.15
4. Voice frequency cable	129.14
5. K carrier	44.82
[6. N + ON carrier	87.55]
[7. Coaxial cable, L carrier	29.40]
[8. Microwave radio	19.20]

Source: Before the Federal Communications Commission, Telpak Docket, Proposed Findings and Conclusions of Motorola, Inc., op. cit., p. 101.

The first study submitted to the Commission, entitled the current cost approach, assumed that while existing plant would be used in providing communication services, Telpak would be priced on the current cost of additional plant--plant not as yet constructed, but whose construction is pending. Furthermore, Telpak pricing was to be based not upon all plant facilities to be constructed, but only broadband facilities. This included microwave radio, some coaxial L carrier and some N and ON carrier. Current cost pricing

was defined as today's prices if the plant was being constructed currently. In explaining why Telpak service was priced on future investment, the telephone company observed:

> . . . assignment to existing plant achieve economy service they frequently avoid the cost of unnecessary special construction in advance of the time when construction would otherwise be needed.[1]

Furthermore, existing plant would provide quicker service.

Thus, in taking the current costs of additional broadband plant and adding on an 8 per cent rate of return (after taxes), AT&T asserted that the resulting tariff was "substantially" higher than a pure incremental pricing approach and, hence, compensatory.[2]

The second cost study submitted by AT&T was similar to the first in that existing plant capacity would be employed in providing bulk service. The study differed, however, because it was based upon historical rather than the current costs of constructing broadband facilities. The second study, called the in-plant cost approach, provided an 8 per cent rate of return when costs were compared with the Telpak revenues. A return, in AT&T's observation "well beyond" the requirements of the incremental cost criteria.

A third cost study submitted by the Bell System was an

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[1]Before the Federal Communications Commission, Telpak Docket, op. cit., AT&T Brief and Proposed Findings, p. 45.

[2]It is difficult to reconcile AT&T's position that incremental costs be used only for underutilization of plant capacity as in footnote 2, p. 232, versus incremental pricing as a standard for additional plant capacity as it appears in the above argument.

"in-plant" cost approach based upon Telpak services conveyed through existing plant. This study originated as a result of an FCC letter requesting the cost of furnishing Telpak over existing plant facilities in effect as of October 1, 1961. No inventory of actual plant facilities was submitted by AT&T

> because of the time and effort involved and the fact that information as of that date would not be representative of normal plant assignments . . .[1]

In lieu of an inventory of actual plant utilized in rendering bulk communication service, Bell submitted a cost study utilizing airline sections of the service in effect. Again, Bell concluded that Telpak pricing was compensatory using this "traditional, fully allocated cost basis." In this study, subtracting cost from Telpak revenues gave a rate of return of 6.5 per cent.

In criticizing the Bell System cost approach, both Western Union and Motorola stood in substantial agreement. On the theoretical front, both asserted the validity of average cost pricing rather than incremental cost pricing in determining private line rates. Pursuing the theme that tariffs should be based upon fully allocated costs, Motorola attacked the current and historical cost studies as being biased toward the low cost broadband facilities. Motorola insisted that:

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[1]Before the Federal Communications Commission, Telpak Docket, op. cit., AT&T brief and proposed findings, pp. 92-3.

> all types of existing facilities are currently being used to furnish private line service at Telpak rates.[1]

In fact, Motorola's allegation that the Bell studies were biased toward the low cost facilities when, in effect, all facilities were being employed was amplified by its submission of AT&T testimony which stated:

> Virtually every type of Bell system facility is a candidate for use in furnishing voice service and the presently effective Telpak tariff. Therefore, a list of the facilities that are suitable would be nothing more than a list of facilities in use.[2]

Since even Bell admitted that all eight interexchange facilities were "candidates" for use, Motorola insisted upon all eight being included in the cost base.

Motorola's rebuttal of the AT&T's third study included several points. First, the equipment supplier suggested that rather than using the associated company's facility mix, Bell included only the Long Line plant mix which allegedly was of lower cost. Second, Motorola insisted that even given this mix, AT&T weighed the average toward the lower cost plant. Finally, Motorola disputed the Bell's ratio of physical routes to airline pricing miles (a ratio so that costs can be compared with rates) so that Bell understated its costs in order to justify its Telpak rate.

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[1]Before the Federal Communications Commission, Telpak Docket, op. cit., Western Union Proposed Findings, p. 60.

[2]Before the Federal Communications Commission, Telpak Docket, op. cit., Motorola Final Brief, p. 100.

In summary, Motorola's criteria in judging the adequacy of tariff rates is that rates should be determined by fully allocated costs based upon all existing plant used in rendering Telpak service.

AT&T's position is that tariff rates can be determined by incremental costs based upon plant capacity that is expected to be constructed in rendering Telpak service. As of this writing, the status of the Telpak tariff awaits the FCC decision. In the meantime, the tariff is in effect and the Bell System can solicit customers under this new service.

Associated with the Telpak tariff is a recent policy inaugurated by the Bell System. In September, 1962, one periodical reported:

> Mountain States Telephone and Telegraph Company is making an extensive effort to obtain complete information on the extent and operation of electric utility communications systems in the West. Field crews have made complete inventories of the facilities of both Montana Power Co. and Idaho Power Co., and it is understood that similar evaluations will be made at Utah Power & Light Co. and Arizona Public Service Co.
>
> Reports indicate that no detail is too small to be investigated and a large amount of manpower is being used. According to MSTAT representatives, the information obtained will be studied to determine the feasibility of their supplying all of the utilities communications requirements. If found satisfactory, a proposal will be made to the utility, they say.[1] [Emphasis mine.]

And as recently as March, 1963, some power utilities have observed that:

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[1]"Utility Evaluations," Electrical West, 129:3 (September, 1962), p. 30.

> there has been a "concerted effort" by Bell System representatives to "buy up" some of the private microwave systems in the power utility field.[1]

Apparently Bell associated companies are purchasing private microwave systems from their owners and then releasing them back. Presumably, the Telpak tariff reduction is such that the owners of a private microwave system find it advantageous to sell their systems and then rent them from AT&T. It must also be noted that the end-user receives the interconnection privilege accorded Bell's customers when he elects the leasing option.

Turning to the factor market, it was observed in Chapter II that the Bell System, through Western Electric, purchases 35 per cent of its radio relay equipment and apparatus from outside the Bell System. Although the non-integrated suppliers assume the status of subcontractors relative to Western Electric, this outlet is very important to them as revealed by Motorola's equipment distribution to the carriers (some 50 per cent sold to the Bell System). Confidential interviews reveal that the AT&T is attempting to discipline the more recalcitrant nonintegrated firms by shifting its procurement mix away from them in the factor market. One independent supplier asserts that in four years his share of the common carrier market has dropped from 70 per cent to about 1 per cent. Thus, the apprehension as to the market authority accorded vertical integration

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[1] Telecommunication Report, "Operational Fixed Microwave Council to Turn to Frequency," 29:18 (March 25, 1963), p. 35.

becomes apparent in summarizing AT&T's pricing and purchasing policy. In the product market, the Bell System has introduced Telpak and is purchasing and releasing private microwave systems. Not only has the leasing option become more favorable, but it is further endowed with the privileges of interconnection to Bell's local and toll facilities. A second squeeze is occurring in the factor market. AT&T is able to exert pressure on aggressive independents in the product market by denying them access to a considerable segment of the factor market.

Sufficient empirical evidence suggests that the non-integrated firm is being subjected to the double squeeze associated with disproportionate vertical power. Figure 51 summarizes the implications of this form of market leverage.

A recapitulation of the telephone company's pricing policy reveals that the multiple channel tariff was the first of a series of tariffs directed to meeting private microwave competition. This tariff was struck by the Commission on the grounds that the volume discounts granted by AT&T were not cost justified. Subsequent to the FCC's decision to expand private microwave use, the Bell System introduced what this study has called Telpak original--a tariff permitting the end-user to lease increasing sizes of bandwidths for simultaneous use of voice and record. This tariff also was struck by the Commission on the grounds that the telephone company was rendering service over diverse facilities (telephone lines); whereas, the tariff implied service was to be

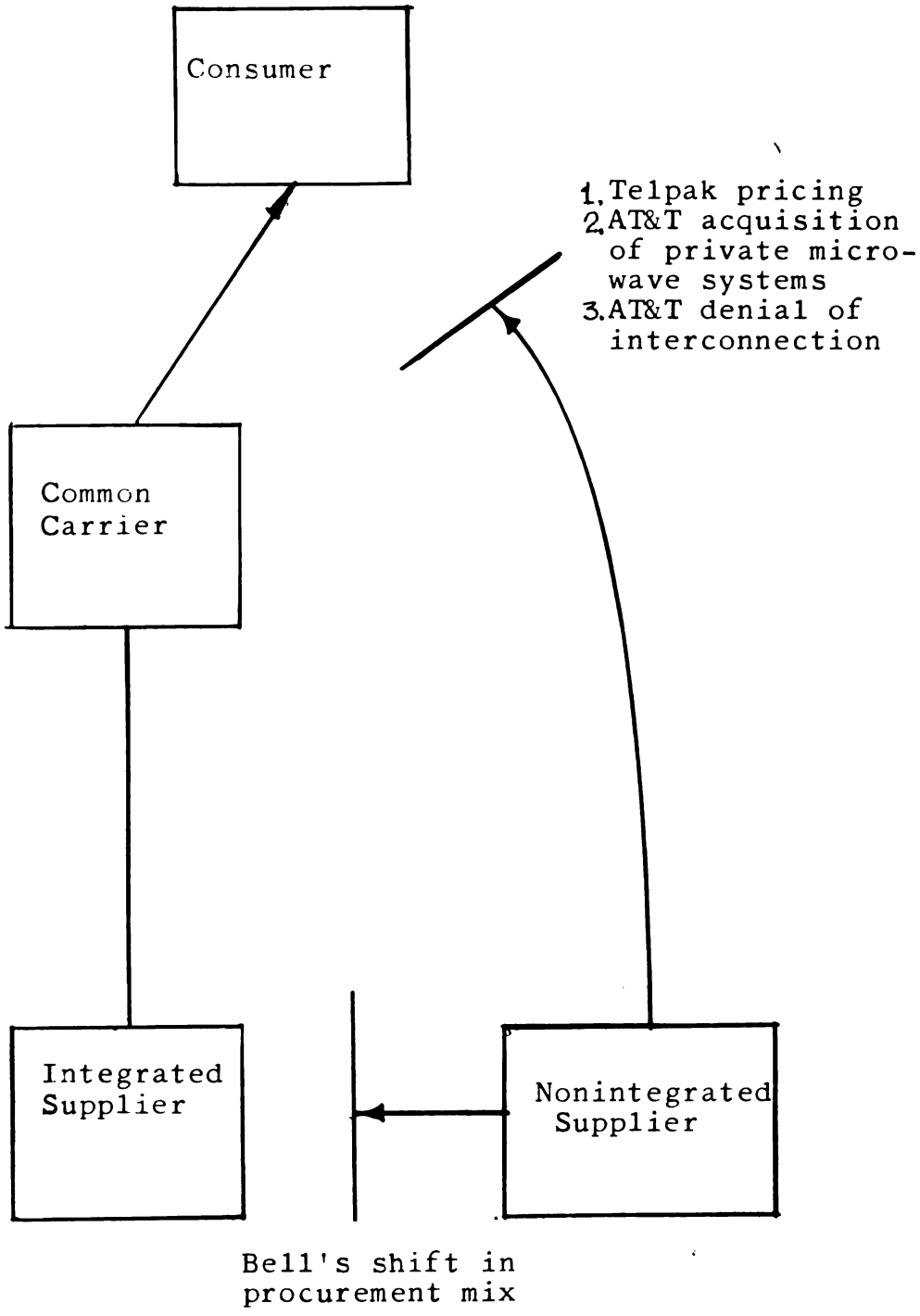

Figure 51. Leverage of vertical integration.

rendered over discrete facilities (microwave). At first, the telephone company attempted to lif its customers from diverse to discrete facilities. However, in August 1961, AT&T filed a new form of Telpak (Revised) which included both diverse and discrete facilities in the rendition of this broadband service. Finally, the telephone company has embarked on a policy of purchasing private microwave and then releasing the system to the end-user presumably under the Telpak tariff. Telpak is currently being considered by the Commission in examining the charge that this form of tariff embodies noncompensatory pricing or pricing below cost. The outcome of this decision may very well determine the future existence of nonintegrated commercial firms in the microwave industry.

The general feeling among private non-Bell microwave manufacturers is that Telpak is devastating the private microwave market. The number of construction permits issued to commercial users since the "Above 890" decision has fallen precipitously,[1] which is due in no small part to the severity of Telpak's price cut. One commercial firm, for example, estimated that its pre-Telpak communication bill to the Bell System was some $16,000 monthly; its post-Telpak bill is around $6,000. Needless to say, the company has abandoned its plans for a private microwave system. Another

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[1] "Only one private microwave system operating in an area competitive with Telpak has been licensed to operate as a result of the Commission's Above-890 decision," Telpak Docket, Motorola Proposed Findings and Conclusions, p. 42.

indication of Telpak's reduction is in the savings accorded the U.S. government of around $13 to $15 million.[1]

Not to be forgotten is the combination of Telpak pricing coupled with free interconnection to those subscribers of the Bell System. Finally, like industries can band together and share Telpak channels--an advantage that was not accorded private microwave users in the Above 890 decision.

There are several additional implications surrounding the telephone company's recent policy versus private microwave suppliers.

The first crucial advantage of the Telpak tariff is time; for as the FCC adjudicatory process unfolds, the telephone company is able to solicit bulk customers with its Telpak offering. Since the bulk consumers are highly concentrated, conceivably the market could easily be preempted. Time is also crucial in that it permits the telephone company to shift its plant mix from higher cost facilities to lower cost microwave.

In the second place, if the telephone company's interconnection policy acts as one restraint to consumers in choosing to own private microwave, interconnection, coupled with Telpak, shifts the comparative advantage to leasing even further.

In the third place, Telpak may have possible consequences reaching into the reallocation of frequency bands to private microwave; for if Telpak stunts the growth of

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[1]Before the Federal Communications Commission, Telpak Docket, op. cit., testimony of the Administrator of General Services, p. 5.

private microwave, it is not inconceivable that the Above 890 frequencies will be reallocated away to the more rapidly growing needs of the common carriers.

In the fourth place, the new Bell policy of purchasing private microwave systems may force the nonintegrated firms to expand the leasing of their equipment in order to protect their markets. This tends to shift the burden of fixed cost from the consumer to the manufacturer. Further, AT&T's purchase and lease policy reaches into the traditional or the pre-Above 890 market of the private relay suppliers, as well as corrals the future expansion of existing microwave systems.

In the fifth place, Bell's predominance purchaser of private microwave accords it the power to discipline its competitors by shifting procurement mix between suppliers.

Finally, in a market with few close substitutes, the telephone company advocates the criteria of average cost pricing. In a market, in this case the bulk market, where the availability of substitutes exist, AT&T adopts the criteria of incremental pricing.

The total impact of the Telpak tariff, without judging the merits of compensatory or noncompensatory pricing, is that perceptible evidence exists suggesting that owning private microwave is considerably less advantageous than leasing channels from the carriers. It follows that Western Electric, owing to its integration, will have increasing proportions of the microwave equipment market "thrust" upon it.

Appendix to Telpak

In assessing the implications of incremental pricing as a criteria for competitive tariffs, three assumptions have to be dealt with. First, what is the nature of the runs; second, what is the nature of the telephone company's average cost curve; and finally can we equate incremental pricing with the economic concept of marginal cost pricing?

An indication that the telephone company is viewing its problem as a short run phenomenon is found in Bell's citations in the Telpak hearing.

For example, AT&T alludes to the problem of the railroad industry with its underutilization of existing capacity, and its employment of incremental pricing in attempting to resolve this problem. That is, the problem centers around the unused capacity of existing plant investment. Given the short run problem, the railroad seeks

> . . . the need for cost determinations which are "tailored" to specific situations instead of the commonly used general measures which are vitiated by excessive averaging.[1] [Italics mine.]

Other evidence indicating that AT&T is concerned with a short run problem is the fact that Telpak service is being provided via existing plant facilities. This suggests that excess plant capacity must have existed prior to Telpak.

Yet, there is some indication that Bell views its problem as a long run phenomena. In citing the air cargo study, the CAB report refers to "marginal cost over the

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[1] "The Role of Cost in the Minimum Pricing of Railroad Services," The Journal of Business, 35:3 (July, 1962), p. 362.

long run" in attempting to argue for an incremental pricing approach. Furthermore, Bell's assumption of pricing on the basis of plant to be constructed is essentially a long run phenomenon, as is Bell's assumption that Telpak pricing will generate new broadband plant.

Nevertheless, we shall assume that the telephone company is concerned with the short run. In this assertion, we are guessing that AT&T views the railroad situation as more applicable to its own competitive problem; further, the telephone company itself, has noted that incremental pricing is valid only when excess capacity exists (see footnote 1, page 16). Finally, the ability of the telephone company to absorb customers on existing facilities argues hard that excess capacity must have existed prior to Telpak.

The second problem relates to the nature of AT&T's average cost in the short run. Are they increasing constant or decreasing cost? Again, there is some indication that the private line market is subject to decreasing costs since toll exchange facilities are being utilized.[1] If the private line service was concentrated on local exchange facilities, then telephone service would be subject to increasing costs.[2] The assumption will be advanced that Telpak or the bulk communications market will be subject to

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[1]Letter from FCC to Mr. Richard Dashbach, March 14, 1963 (Senate Small Business Committee).

[2]Ibid.

decreasing costs to scale.[1] Certainly, private microwave systems are decreasing costs systems.

A third problem relates to incremental pricing. We will make the heroic assumption that incremental pricing is a working definition of marginal cost pricing. If it can be granted that the market under consideration is the bulk communications market, that the toll facilities used in rendering bulk services are subject to decreasing costs, that we are concerned primarily with the short run adjustments of the telephone company, and that incremental pricing is equivalent to marginal cost pricing, what are the implications of this price standard or criteria?

In Figure 52 the bulk market, P_1, represents the firm's price without any regulatory restraints placed upon it. Thus, the firm pricing where MC = MR would set P_1 as price, produce output OX_1 and enjoy total profits of (OX) (C_1P_1). If the firm's prices are determined by a regulatory commission, presumably where total costs will equal total revenues (average cost pricing), then P_2 will represent the bulk market price. No profits exist at P_2 (although P_2 would include a reasonable rate of return). If the utility sets prices on the basis of marginal cost pricing, i.e., where MC = AR, then under conditions of decreasing cost, AR will fall below AC and the firm will encounter a loss equivalent to $C_3P_3 \times OX_3$.

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[1] Before the Federal Communications Commission, Telpak Docket, op. cit., Bell System Exhibit No. 5, Attachment A, Table 1, p. 18.

TABLE 36

COMPARISON OF TELPAK CHARGES,
PRIVATE MICROWAVE COSTS AND TELEPHONE COMPANY COSTS

TELPAK A
Equipped for 12 Voice Channels
(Per Month Per System Mile)

	System Length (Miles)				
	50	100	200	500	1000
Private Microwave Costs (Low-High Range)	$18.30-57.30	$16.30-49.80	$15.25-46.05	$14.70-43.80	$14.50-43.05
TELPAK Charges	22.20	18.60	16.80	15.70	15.35
Telephone Company Costs	18.40	11.05	6.10	4.15	3.55

Note: All amounts rounded to nearest 5 ¢.

Source: Bell System Exhibit No. 5, Attachment A, Table 1, p. 18.

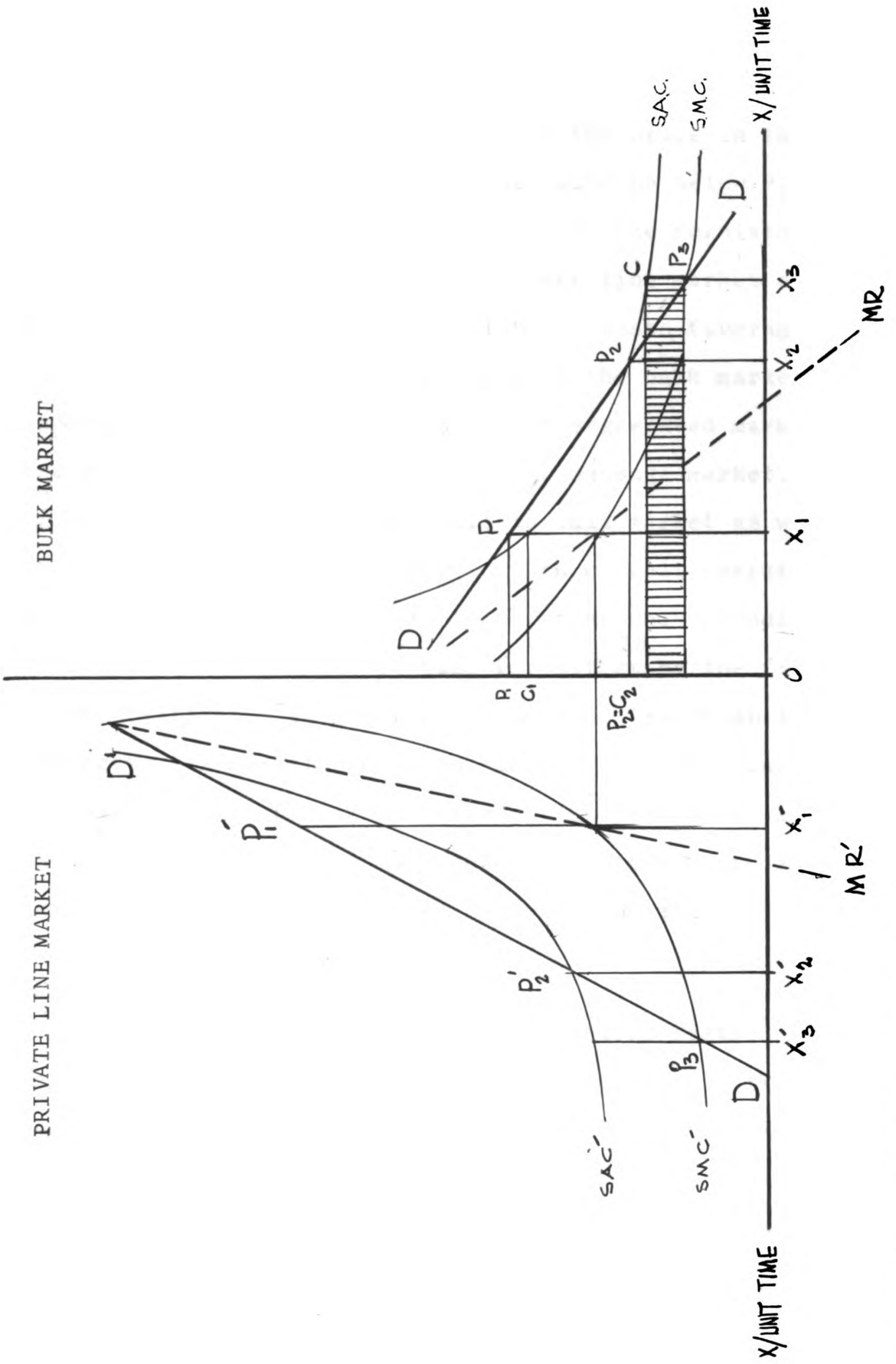

Figure 52. Marginal cost pricing.

This deficit must be covered by another market of the firm, in this case the Private Line market. Thus, a profit over and above a reasonable rate of return at P_2' must subsidize the bulk market. Necessarily the price in the private line market must be above P_2', but could be below P_1'.

If, however, both the utility and the regulatory agency assert that the tariff for the private line market exists at P_2 in which total revenues equal total costs (average cost pricing) then the deficit incurred by the bulk market pricing must be covered by still another segregated market of the utility--in this case the public message market. Finally, if average cost pricing prevails in this market as well, then the utility must exhibit a deficit in overall operations. Marginal cost pricing in firms operating under conditions of decreasing cost must be paid for either by the firm or by the taxpayer. In the former case the firm's ability to segregate its markets would enable the deficit incurred in one market to be underwritten by excess profits in another. In the latter case, the firm would have to receive a direct tax subsidy or become subject to public ownership.

Policy Decisions

We have seen that the legal-technical restraints to market entry have tended to diminish over time. It also has been noted, however, that given the market structure of the communication industry, the interconnection and pricing policies of the Bell System continues to exert a major

influence in barring market access. Finally, what has been the impact of the third variable affecting market entry; that is, policy decision with the public sector. We will examine first the Department of Justice and then the Federal Communications Commission.

Department of Justice.--Any historical view of the structural evolution of both equipment and carrier market reveal that patent concentration stands paramount among the causative factors contributing to the present bilateral monopoly complex. The Justice Department came to this conclusion and it was a very natural one. The strategic role of the patent was further amplified by the 1939 telephone investigation conducted by the Federal Communications Commission. In fact, it is generally acknowledged that the findings of the 1939 telephone investigation, following an interruption of the second World War, provided the basis for the Department of Justice's antitrust suit ten years later. The prayer of the government suit sought to divest Western Electric from the Bell System and to separate Western further into three competing suppliers. In 1955, however, the Department's divestiture policy was displaced by a consent decree compelling AT&T to license its existing and future patents.

Very simply, the Justice Department concluded that if patent concentration had induced market concentration, then the problem of policy was to address itself to Bell's patent portfolio.

Several factors have tended to suggest that the Justice Department pursued a policy quite irrelevant to the issue of competitive entry.

In the first place, while it is true that patent concentration contributed to the preeminence of Bell's market structure, it does not necessarily follow that reversing the cause-effect relationship will lead to competitive results. In a sense, the market structure has risen above and become autonomous from its causative source. Integration now exists independent of its patent sire. Hence, market integration has developed an immunity to any policy directed toward the decimation of patent concentration.

In the second place, it is the assertion of this study that forces originating with World War II have tended to diffuse knowledge and technology beyond the traditional province of the existing common carriers and their subsidiaries. The most fundamental erosion of patented knowledge appears to be the displacement of research and development funding from the private sector to the public sector and the concommitant shift of research and development performance from the public to the private sector. Furthermore, government research and development as an increasing percentage of GNP has tended to increase the rate of technological change--tending to shorten the useful life of a patent.

Apparently recognizing that the era of absolute patent dominance was ending, the Bell System, after World War II, embarked on a general policy of patent licensing in order to

acquire the patented knowledge of others.

Thus, when the Justice Department, in 1956, announced a consent judgment which subjected Bell's patent portfolio to compulsory licensing, the judgment was, in a real sense, an anachronism. The patent barrier had succumbed to the barrier of market integration. Non-integrated suppliers were not granted market access for their products since the Bell operating companies continued to pursue a policy of procuring most of their equipment needs from Western Electric. Compulsory patenting did not disturb the Western Electric-Bell operating company's bilateral monopoly.

The irony of the Justice Department's decree becomes more forceful with the realization that it was concerned largely with the issue as it existed in the 1930's. However, events had bypassed the technology of metallic circuits and the attendant equipment thereof. Radio relay circuits offered a competitive alternative to wire and cable and non-integrated microwave suppliers were attempting to compete with integrated Western Electric. Thus, as the struggle between radio and metallic technicology ensued and as the existence of vertical integration became more formidable to non-Bell equipment suppliers in the 1950's, the Justice Department announced a policy hardly germain to the issue of market entry.

The Federal Communications Commission.--In 1934 the Communications Act created the Federal Communications

Commission. Among other functions, the Commission was charged with regulating the rates of the telephone common carriers. The FCC was confronted with the Bell System's integration and, although the Act stated that "the manufacturer and sale of and trade in radio apparatus" was subject to the anti-trust laws, the enforcement agency was not the FCC but the Justice Department.

In assessing the series of FCC policy determinations, it is clear that given the integrated structure of AT&T, the communications equipment market cannot escape involvement in decisions presumably directed at the common carriers alone.

Take the first case in which the FCC had to decide who would provide radio relay systems capable of transmitting television. When IBM and General Electric applied for licenses to render intercity television service, the Commission, in rejecting their application, asserted that no policy decision regarding entry into the intercity video channel field had been determined. Subsequently, the FCC announced that common carriers only would be licensed to transmit intercity video channels. With Western Union's collapse, only one nationwide radio relay system existed--the Bell System. Furthermore, narrowing market participants on the horizontal level effectively narrowed the number of participants in the manufacture of heavy route microwave relay equipment.

If we look at the FCC's broadcasters decision, the same pattern emerges. As the demand for television mushroomed at the end of the war and as facilities were unavilable, the broadcasters embarked on constructing their own radio relay links. Again the FCC declared that the intercity relaying of video channels fell within the province of the common carriers. The broadcasters could construct their own links under the precaution that they had better write them off quickly since these facilities would have to be abandoned when the common carrier facilities became available. Again the implications on the potential market outlet for the non-integrated radio relay equipment suppliers was hardly strengthened by this decision. In effect, the nonintegrated suppliers were reduced to the role of subcontractors to Western Electric since the Bell operating companies provided most of the video service.

The coup d' état was administered to independent suppliers of heavy route equipment when the FCC declared that there was no compelling need to order AT&T to interconnect its broadband facilities with Western Union. With Western Union left with a segmented radio relay system and unable to use it to generate additional income for expansion, an independent market outlet for heavy route relay equipment was effectively forestalled. More important, compelling evidence suggests that the FCC's decision to limit the participants of intercity video channels to the common carriers, and then <u>prohibit</u> the carriers from interconnection

with one another enabled the Bell System to purchase time in order to shift from its nationwide coaxial cable system to its radio relay system.

Turning to private microwave systems, it is clear that the origin of the industry was tenuous--particularly when the raw material input, microwave frequencies were licensed on a developmental basis. However, as the end-user of communicative service, potential commercial users put the FCC on notice that they desired to exercise the option of owning private microwave as well as leasing private line services. The common carriers fought this request from 1955 to 1960. Following the first decision to liberalize the frequencies for private microwave in 1959, AT&T declared that space communication needs dictated that the Commission rescind its order and when the order stood, the implications for the nonintegrated equipment suppliers was clear. It looked as if the market potential for radio relay would be broadened; and it seemed reasonable to assume that the nonintegrated equipment firm would be less dependent upon Western Electric as an outlet for his products.

The FCC, in its Above 890 decision, announced its intention that the "Above 890" decision in liberalizing the use of private microwave would "spur competition" in the equipment industry.

The struggle between the private microwave supplier and the Bell System is in reality a struggle of innovation. The Bell System has a substantial investment in metallic circuits;

and although AT&T insists that microwave supplements metallic circuits, microwave also supplants it. Thus, when a customer elects to own his own radio relay system rather than lease his needs from the Bell System, in many cases he is electing radio circuits over metallic circuits.

This became evident with the second series of private line tariff cuts (Telpak)--introduced by Bell two months after the "Above 890" decision. Bell priced the tariff as if it were employing microwave system, but in actuality, metallic circuits were used in rendering the service. When the FCC ruled that Bell was violating its own tariff and required that the bulk users be transferred to broadband channels, AT&T avoided the implications of this decision by changing its tariff.

However, perhaps the most crucial decision as far as the nonintegrated equipment suppliers are concerned is the fact that the FCC has permitted Telpak to go into effect while the Commission determines whether the tariff is justified by the costs of the Bell System.

As a price reduction to potential microwave consumers, Telpak has swung the option from owning back to leasing. Applications for private microwave subsequent to Telpak have substantially diminished.[1] And again, as in the struggle

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[1]"Only one private microwave system operating in an area competitive with Telpak has been licensed to operate as a result of the Commission's Above-890 decision." Before the Federal Communications Commission, Telpak Docket, op. cit., Motorola Proposed Findings and Conclusions, p. 42.

for a nationwide video system, the FCC's decision to permit Telpak to go into effect has permitted the Bell System to purchase crucial time. As the lengthy process of hearings and adjudication take place, the Bell System is permitted to solicit most of the bulk communication customers and provide them service via its existing plant. Approximately 5 per cent of the bulk customers account for 55 per cent of the market. As AT&T introduces microwave circuits into its system, it can shunt its bulk customers from metallic to radio relay facilities.[1] Thus, the decision to permit AT&T to solicit customers at Telpak rates permits Bell to preempt the bulk market now and hedge on an adverse FCC decision later. If the FCC declares that on the basis of metallic circuit cost, Bell is engaging in pricing below cost, AT&T will have had time to shift its investment mix. Translating these effects into the equipment market, it is clear that the decision to lease under Telpak rates is in reality a decision to use Western Electric equipment; the decision to own resides in favor of the nonintegrated supplier. Telpak, win or lose, has shifted the comparative advantage from the nonintegrated suppliers to Western Electric, and the short run implications are such that the Commission's decision regarding Telpak is effectively nullifying the Commission's

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[1]The Bell System allocated $3 billion for the construction of new plant and facilities during 1962. No breakdown as to the investment mix of this expenditure is available. Wall Street Journal (February 20, 1963), CLXI:36, p. 4.

earlier decision liberalizing the use of private microwave. By default, Western Electric emerges as the beneficiary of FCC policy.

CHAPTER IV

INTERNATIONAL COMMUNICATION

In addressing ourselves to the potential restraints catalogued as legal-technical, structural, and past policy decisions, it must first be noted that the international communications market differs in two respects from its domestic counterpart.

In the first place, the innovation of microwave repeaters in the form of satellites remain in the stage of research and development. In fact, the pace of technological change is such that transitorized submarine cables may effectively compete with satellites.[1] On the other hand, there is increased probability that satellites will relay light waves as information signal carriers (Lasers) and

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[1]U. S. Congress, Senate, Satellite Communications Hearings before the Subcommittee on Communications of the Committee on Commerce, 88th Congress, 1st Session on Satellite Communication, 1963, p. 39. Mr. Dingman (Vice President, AT&T): "Last year, early last year, even before we put Telstar up, we started working on developing a transistorized version of an undersea cable. And that development is actively underway, and we have expectations that when it is completed, that cable will carry 720 voice circuits and television, but not concurrently. We hopefully expect that cable will give us lower cost per channel and that is the reason for the development. We would expect that a cable of this type would be available for usage by about 1966." See also: letter from D. Sarnoff (RCA) to Leo D. Welch, Chairman, Communication Satellite Corporation. "In my judgment, it is likely that all forms of traffic, including television,

hence supercede satellites as microwave repeaters.[1] Given this flux of the state of the art, estimates of the cost of a satellite system, its frequency needs, its capital requirements, pricing policy, etc. must remain highly tentative. In the second place, the channel capacity of a satellite system is such that it is estimated that one system alone is capable of meeting the international communication requirements for some time. The economies of scale inherent in a satellite system hold that rival systems will not be established as in the domestic market. This technical imposition necessarily limits the potential outlet of equipment suppliers.

If historically, patented knowledge ployed a central role in the size and structure of the internation communication industry, that knowledge was soon to be superseded by new technology. The conventional devices of HF radio and submarine cable largely associated with the existing common carriers was challenged by a new technology-satellite relay. As one of the byproducts of the missile age, the new techniques were sponsored by firms in the aerospace industry. As potential hardware suppliers, these firms sought market

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will be passing through transistorized cables on a regular commercial basis before the Satellite Corporation is ready to provide such services on a global scale," Congressional Record, 109:79 (May 28, 1963), p. 9208.

[1]Lawrence Lessing, "The Lasers Dazzling Future," Fortune, LXVII:6 (June, 1963), p. 162.

entry. Much of the conflict surrounding the formulation of a national communication satellite policy had as its base a struggle between two industries; the overseas communication industry and the aerospace industry. This inter-industry struggle was to find expression in the subsequent legislation passed by Congress.

Since much of the technology of a satellite system has been associated with boosters, launching facilities, tracking, etc., the aerospace firms derived most of their competence from participating in the space programs of either the Department of Defense (DOD) or the National Aeronautics and Space Administration (NASA). In the field of research and development, for example, some 85 per cent of the aerospace industry's research and development was financed from government contracts.[1] Furthermore, not only did the government substantially underwrite the research expenditures of the industry, it represented for all practical purposes the only consumer of the final product.

In the broad category of space satellites, the following projects reveal the breadth of functions under investigation via satellites and the name of the project.

1. Surveillance (Samos satellite)
2. Warning (Midas)
3. Navigational (Transit)
4. Weather (Tiros)
5. Communication (Advent, Echo, Relay, Symcom)

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[1]National Science Foundation, op. cit., p. 3.

Firms participating in these projects as prime or subcontractors acquired knowledge and competence in such operations as launching techniques, tracking and telemetry stations, guidance, transmitter and receiving stations, as well as acquiring expertise in such fields as metallurgy, the chemistry of propulsion, etc.

Although the aerospace industry encompasses sixty firms, those firms that expressed an interest in participating in the innovation of a commercial communication system included Lockheed, General Electric, Hughes, and Bendix. (The Samos and Midas projects were sponsored by Lockheed, and the Advent military communication satellite was contracted by Bendix and General Electric.)

Nevertheless, the manufacturing subsidiaries of the common carriers had participated in space research. Western Electric, for example, had participated as prime contractor for the Nike missile series; and had supplied the guidance system for the Titan missile as well as constructed the radar network of the Dew Line system. Working with NASA, Western Electric had participated in Project Echo--a passive satellite project, as well as in Project Mercury. As a matter of fact, Western Electric was classified as an aerospace firm.[1]

Other overseas carriers and their subsidiaries had engaged in space research. IT&T's manufacturing and research

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[1] The 1961 Aerospace Year Book, 42nd Annual Edition (Industries Association of America, Inc.), pp. 160-1.

firms had participated in the design and construction of ground-space communications network, the Ranger spacecraft series, and missile tracking and transmitting projects. RCAC's parent firm was preeminent in the weather satellite program of Tiros and Nimbus, as well as prime contractor for NASA's active satellite program, Project Relay.

The point to be emphasized is that in the era of space communications, the conventional overseas carriers did not stand alone in competence or expertise. As a matter of fact, they were challenged by some aggressive nonintegrated aerospace manufacturers. Thus, when the National Aeronautics and Space Administration entertained bids for the Agency's first active satellite project (Project Relay), not only did the participants include Bell Telephone Laboratories and Western Electric, International Telephone and Telegraph, Radio Corporation of America (International Common Carriers and their hardware affiliates), but the aerospace firms were represented by Collins Radio, General Electric, Hughes Aircraft, Bendix Corporation, Philco, etc.[1]

Thus, government sponsored contracts had acted as one factor in diffusing communication knowhow and competence beyond the traditional boundaries of the communication industry. In addition, the magnitude of government resources devoted to the total space effort had added a further factor affecting the integrity of patented knowledge; the viable life of the patent has been shortened. Thus, Simon Ramo has

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[1]John W. Finney, "RCA Will Build Satellite for TV," New York Times (May 19, 1961).

observed:

> The large government sponsorship in missiles and space has added a new factor of more rapid technical guide obsolescence.[1]

He added further:

> The missile and space requirements have pushed the art so rapidly and technological obsolescence has been so quick as almost to preclude the attainment of a base of stabilized products.[2]

In summary, government sponsored research holds two implications: it has tended to diffuse communication expertise beyond the traditional provinces of the communication industry and as an impetus to greater technological change has necessarily increased the rate of technological obsolescence.

Frequency

In Chapter II it was observed that conventional overseas communication was limited to the high frequency or short wave bands of the radio spectrum. However, as a natural resource, spectrum utilization has been expanded to the microwave range as the result of satellite repeaters. Nevertheless, the problems of frequency designation and allocation continue.

A first problem in frequency designation occurred between the aerospace industry and the overseas communication industry. In January, 1961 the FCC allocated to the carriers frequencies for experimental satellite use in the 6,000 band.

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[1]Simon Ramo, "The Impact of Missiles and Space on Electronics," Proceedings of the Institute of Radio Engineers, 50:4 (May, 1962), p. 1240.

[2]Ibid., p. 1237.

Subsequently, when NASA established frequency requirements on its first active satellite project a month later (Project Relay) in the 6,000 band, the aerospace firms alleged that the FCC's earlier assignment conferred a competitive advantage to the common carriers.[1] NASA explained that the 6,000 bands were requested by European countries participating in the satellite project.

More crucial to the operation of a satellite system may be the problem of frequency interference between terrestrial microwave and satellite microwave. As observed in the discussion on domestic frequency problems, the optimum frequency range for space communications appears to lie within the 1,000 MC-10,000 MC range. The Ad Hoc Report of the international carriers proposed that the FCC allocate for space communication a total of 2975 MC of spectrum space.[2] This space is currently used by private microwave systems in the domestic market. The problem of potential interference is seen in Figure 52.

Again, since no satellite system has reached the operational stage, the problem of frequency interference remains under study. For the present time, the FCC has observed that cochannel sharing of terrestrial and space microwave bands appears feasible.

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[1]"Clash over Radio Use of Space," Business Week (March 11, 1961), p. 117.

[2]Before the Federal Communications Commission in the matter of an inquiry into the administrative and regulatory problems relating to the authorization of commercially operable space communications systems, Docket No. 14024, reply of American Telephone and Telegraph Company, p. 5. (Cited as Docket No. 14024.)

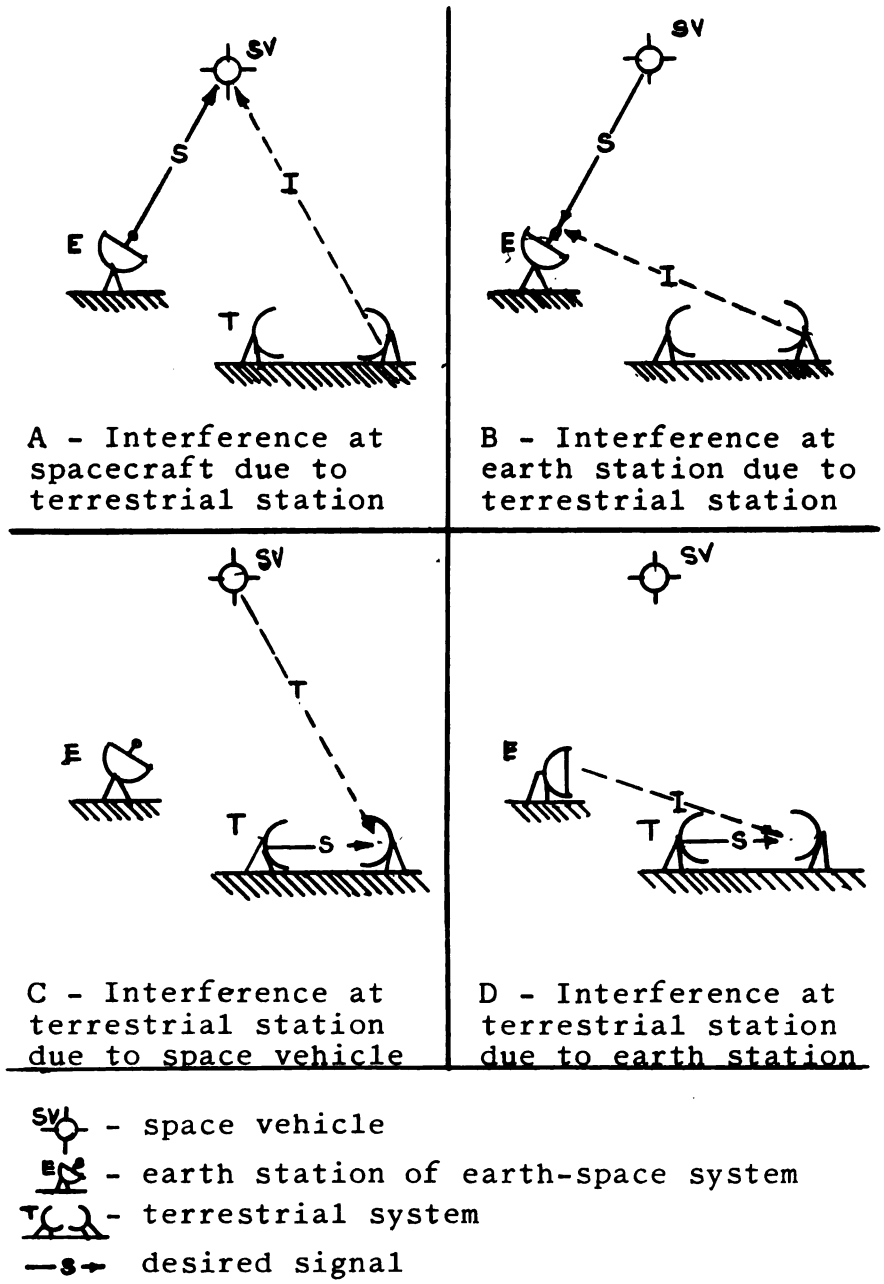

Figure 53. Space interference potential.
Source: Before the FCC in the matter of an inquiry into the administration and regulator problems relating to the authorization of commercially operable space communications systems, Docket 14024, reply of AT&T, p. 5 (cited as Docket 14024).

Capital Requirements

In tracing the transition in the domestic market from metallic circuits to radio circuits, it was observed that the capital requirements associated with the latter was tending to decline. It was further contended that the receding of the cost restraints tended to induce greater market access to the independent supplier. However, in the international market, capital requirements are tending in the opposite direction as seen in Table 34.

TABLE 37

COST/CHANNEL-MILE FOR CABLE VERSUS SATELLITES

	Estimated Total Cost	Channels	Estimated Channel-Miles	Estimated Cost per Channel-Mile
Cable 1963 (TAT-3)	$70,000,000	128	400,000	$175
Cable with TASI (TAT-3)	70,000,000*	233	933,333	75
Satellite 1975	420,000,000**	2,000	7,500,000	56
Satellite 1980	495,000,000**	5,000	18,500,000	27

*This figure is probably low (therefore conservative) since the addition of a TASI unit increases both the initial and annual maintenance costs. No cost data relating to TASI were obtained during this study.
**Including contingencies.

Source: "Telesat-Business Planning Study for a Commercial Telecommunication Satellite," Part 1, Lockheed Aircraft Corporation, Missile and Space Division, Sunnyvale, California, October, 1960, p. 68.

The cost projections are dependent upon such variables as the nature of the satellite system, the number of ground stations, the probability of successful launching, the average lifetime of each satellite, etc.

Thus, only AT&T offered to assume the investment burden of a private satellite system--a proposal originally amounting to $170 million.[1] The proposal assumed the establishment of a low orbit active satellite system employing fifty satellites and twenty-six ground stations. With the exception of the Bell plan, all other private proposals have embraced a joint venture concept in which several firms would pool their resources.

Some conception as to capital costs attending a space communication system is revealed by the FCC's Ad Hoc carrier report--a study undertaken by the U.S. overseas carriers.

In short, the capital requirements of an operational space communication system plus the fact that one system only will be established means that the independent equipment supplier must look to that system as the potential market outlet for his products.

One of the variables that influenced the degree of market entry was the ability of equipment firms to construct and launch experimental satellites. Telstar, as a tribute to AT&T, certainly held within its ownership implications

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[1]Before the Federal Communications Commission, The Above 890 Docket, op. cit., Testimony of Charles Mapes, 1960, p. 13.

TABLE 38

SATELLITE COST RANGES

Configuration	Cost ($ million)
(a) 20 medium-altitude satellites in random polar orbit	45 to 94
(b) Two pairs of satellites in synchronous orbit	50 to 100
(c) Configuration (a) plus 10 medium-altitude satellites in random equatorial orbit	67 to 141
(d) Three pairs of satellites in synchronous orbit	75 to 150

Ground Stations	U.S. inc. Hawaii ($ million)	Other Countries ($ million)
(a) For medium-altitude satellites including tracking station	26.5 to 34	45.5 to 63
(b) For high-altitude satellites	7.5 to 9	17.5 to 21

Source: Before the Federal Communications Commission, Report of the Ad Hoc Carrier Committee, Docket 14024, pp. 13-4.

that influenced the size of market participation. Again, the Telstar project emphasizes the advantages of vertical integration as it relates to the capital costs of the equipment firm. Western Electric and Bell Laboratories jointly engaged in the research and fabrication of the satellite. In addition, successful experiments included a complex of ground receiving, sending, and telemetry stations. The total expenditure of the Telstar project included the costs of land,

buildings, antennae, raedom as well as research and development outlays. The latter, incurred by Bell Laboratories was billed to AT&T (some $45 million) and as a public utility, this is doing business.[1] The telephone company is entitled to earn sufficient income to cover this expense.

It it evident that as a manufacturer vertically integrated with a public utility, Western Electric is conferred certain cost advantages not accorded an independent supplier. Specifically, Western and Bell Laboratories' expenses encountered by nonintegrated suppliers must be borne from their profits. This advantage became evident in a letter from the FCC to AT&T in what the Commission said:

> We have noted, for example, the substantial amounts that Bell Laboratories is billing your company . . .[2]

This billing prompted the FCC to request information regarding AT&T's overseas tariffs.

In sum, the capital requirements associated with either the establishment or the experiment of a commercial space system are substantial. For the nonintegrated firm unable to enjoy the virtues of public utility pricing, the capital requirements and risk of satellite experimentation became prohibitive. In this sense, market entry is further restricted.

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[1] Interview with Mr. Barnard Schwartz, staff member of Subcommittee on Antitrust and Monopoly, U.S. Senate.

[2] U. S. Congress, Senate, Small Business Committee Hearings, op. cit., p. 56. Letter from FCC to AT&T, July 6, 1961.

Structural

In the domestic market, the indirect implication of vertical integration upon market entry was traced by assessing the interconnection and the pricing policies of the Bell System. Since no system is in operation, one can only conjecture as to the influence of interconnection in the overseas market. While RCAC as a common carrier has expressed some apprehension as to AT&T's interconnection policy, the economies of scale dictate that rival systems sponsored by nonintegrated suppliers will not establish the interconnection problem associated on the domestic front.

The pricing of overseas communication services via satellite may indirectly affect the growth and potential size of the equipment market. In this connection it is noteworthy that the Bell System advocates the standard of average cost pricing, the contrast to the expousae of the incremental standard in the domestic bulk market. In a letter to Senator Russell Long of Louisiana, an AT&T official observed:

> However, by using the new facilities in combination with existing facilities, costs can be averaged and and this will help avoid the necessity for rate increases during the period of initial buildup.[1]

Policy

Although the parameters of cost, frequency, knowledge, and type of space system continue to evolve, the policy

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[1]U. S. Congress, Senate, Space Satellite Communications, Review of the Report of the Ad Hoc Carrier Committee. Hearings before the Subcommittee on Monopoly of the Select Committee on Small Business, United States Senate, 87th Congress, 1st Session, Part 2, November 8-9, 1961, p. 744.

alternatives relating to the ownership and operation of a satellite system have been crystallized by Congressional legislation.

The examination of a communication satellite policy will first survey how the communication carriers and the aerospace firms interpreted the definition of a space system; second, will trace the evolution of a national communication satellite policy; and finally, will assess the Satellite Act as it relates to the problem of market entry.

The common carriers and the aerospace firms, in attempting to justify their right to participate in satellite ownership, differed in their interpretation and emphasis as to the conceptual nature of a satellite system. Is it a space communication system essentially communication technology or is it essentially space technology?

As the most articulate spokesman for the carriers, AT&T emphasized the communications component of such a system.

Furthermore, Bell asserted that a space communication system was evolutionary in nature, not revolutionary.

> Since satellites will merely provide the means by which broadband microwave techniques employed for continental communications can be extended across the oceans to supplement existing common carrier facilities, it seems appropriate that the United States should look to its common carrier industry for the experience, competence, and financial ability to pioneer with satellite systems.[1]

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[1]U. S. Congress, House, Communications Satellite, Hearings before the Committee on Science and Astronautics, 87th Congress, 1st Session, 1961, Part 1, p. 310.

In emphasizing the communications component of a total system, AT&T reminded the Aerospace industry that it had contributed the transistor, the solar cell, the traveling wave moser for low-voice receivers, FM feedback receiving systems, and low-voice horn reflector antennas. AT&T remarked that:

> Government-paid research provides the transportation and industry-paid research provides the communication.[1]

AT&T offered the analogy between a terrestrial microwave repeater in emphasizing the communication aspect of a satellite system; and the telephone company asserted that functionally they were identical.

The telephone company conceded that space technology was necessary for the successful operation of the system, but AT&T reminded the aerospace firms that:

> . . . it should not be forgotten that many of the devices that guide the rockets and missiles, control their performance and make them useful have come from the research laboratories of the communications industry.[2]

Taking issue with the AT&T's definitional emphasis of a satellite communications, the aerospace industry's viewpoint was articulated by Lockheed, General Electric, and Hughes aircraft.

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[1] Telephone Engineer and Management, May 15, 1962, p. 90. AT&T Chairman F. R. Kappel at 1962 Annual Stockholders Meeting.

[2] Before the Federal Communications Commission, Docket 14024, op. cit., Response of American Telephone and Telegraph, p. 2.

In the first place, the aerospace firms emphasized the space technology inherent in such a system. Thus:

> . . . a satellite communications system represents a virtually different and unique adventure wholly unlike the traditional extension of existing facilities.[1]

Hence, rather than evolutionary in nature, it was revolutionary and unique. The aerospace firms observed that the space component--the launching, orbiting, tracking, guidance, attitude control, etc.--represented the largest segment of technology of the system. Furthermore, over 90 per cent of the total cost involved "space technology."[2] The observation that a satellite was essentially a repeater prompted General Electric to observe that the U.S. was not in a "microwave race" with the U.S.S.R., but rather engaged in a "space race."

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[1]Before the Federal Communications Commission, Docket 14024, op. cit., General Electric, Petition for Reconsideration, May 29, 1961, p. 17.

[2]The aerospace concept of space communication found support in an advisory report to the National Aeronautics and Space Administration. The report observed: "Satellite relays are more nearly analogous to a major new technology than merely an 'improved' cable or microwave system. Increased communications capacity (permitting new uses), new international implications use of governmental launch facilities, and operation in the space environment clearly make it more than another technical step in communications technology." The Commercial Application of Communications Satellites: A Study of Major National Policy Considerations, Prepared for the National Aeronautics and Space Administration, United Research Incorporated (February, 1961), p. 3. (Cited as United Research Study.)

The issue as to the ownership of a satellite system rested essentially upon what each adversary regarded as the essence of space communication. Naturally, AT&T in asserting that a satellite system represented the mere extension of existing facilities, argued hard that the ownership base of a commercial system embrace only the U.S. overseas carriers. (Originally in 1960, the telephone company had offered to go it alone.) AT&T offered as an organizational concept a joint venture consisting of the international carriers. In deciding upon a criteria of allocating the ownership within the common carriers, AT&T stated:

> The initial capital investment and continuing operating costs of satellites would be apportioned among the U.S. international carriers and foreign communication administrations and agencies participating in ownership on the basis of estimates of their prospective use of the satellites.[1]

Ownership determined by a use basis would yield to AT&T upwards of 80 per cent of the U.S. share of a joint venture, and some 40 per cent if foreign interest participated.

The carriers would be permitted, under the Bell plan, to own their own ground stations. The joint venture would decide on leasing policy, assignment of channels, etc.

Turning to the issue of supplying space hardware to the joint venture, AT&T stated:

> Manufacturers and suppliers of satellite equipment and launching will produce the satellite, build the ground stations and supply the rockets, etc. The

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[1]Before the Federal Communications Commission, Docket 14024, op. cit., Response of American Telephone and Telegraph, May 1, 1961, pp. 4-5.

> carriers, who are responsible to the public for its quality, adequacy and cost of the communications services they render should have control over the choice of the equipment to be used.

Thus, the aerospace companies would participate as suppliers rather than partners for:

> The launching of satellites will be an essential prologue, but nevertheless only ancillary to the operation of one portion of the communication system.[1]

In summary, the virtue of the Bell plan was epitomized by the following observation:

> The proposal we advance need not disturb the existing pattern of regulation or effect the competitive positions of the carriers.[2]

In commenting on the Bell System's ownership proposal of a space venture, both Lockheed and G.E. expressed apprehension that AT&T would emerge with a disproportionate share of the ownership base. As nonintegrated equipment suppliers, the aerospace firms expressed the intention of supplying a satellite system with its hardware components. But two factors became apparent to the aerospace firms. First, one space system only was to be established--and this alone would provide the market for satellite equipment; and second, the overseas common carriers were integrated as manufacturers (AT&T, IT&T, and RCAC). In addition, if the carriers were permitted to construct and own their own ground stations, it

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[1]U.S. Congress, Senate, Small Business Hearings, op. cit., Testimony of AT&T, p. 252.

[2]Ibid., p. 251.

was not inconceivable that carrier subsidiaries would preempt the equipment market. Lockheed, in particular, drew attention to the situation by commenting on the integration of carriers, manufacturers, and research laboratories.

Lockheed observed:

> . . . it is extremely difficult to envision a satellite communication system controlled by international carriers who are also hardware manufacturers in a joint venture which would preserve more than token competition in the hardware market.[1] [Emphasis mine.]

In pointing out the importance of the research and development stage in inhibiting market access of independent suppliers, Lockheed commented:

> If the international carriers through their related hardware companies conducted all of the research and development prior to the actual organization of the joint venture and then contributed such research and development to the joint venture, all outsiders would be effectively excluded from the research and development phase. If the international carrier should so preempt the research and development phase as preliminary to forming a joint venture, they will through the control of design and engineering specifications be able to discourage or preclude effective bidding by other hardware manufacturers for the ultimate equipment requirement.[2]

Confronted with a single satellite system and given the vertical nature of the carriers subsidiaries, the aerospace industry offered an alternative plan for a proposed space venture. Alluded to in Chapter II, the plan held that an entity called a common carriers' common carrier be created.

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[1]Before the Federal Communications Commission, Docket 14024, op. cit., Comments of Lockheed Aircraft Corporation on Petition of General Electric Company, p. 4.

[2]Ibid., pp. 5-6.

This organizational entity would reside between the carriers and their equipment subsidiaries. The carriers' carrier would own and operate a satellite system. It would lease to the carriers the channels necessary for the rendition of communication service. It would, in addition, purchase equipment and hardware associated with the establishment and operation of a space communication network.

The ownership of a carriers' carrier would include not only the U.S. overseas carriers but interested aerospace firms as well; and GE's plan suggested that the general public be allowed to participate in ownership. GE's entity was entitled Comsat; Lockheed's called Telecomsat. Nevertheless, each embodied a similar plan.

The aerospace firms were quite explicit in citing the virtues of a carriers' carrier:

> . . . by including all hardware suppliers who choose to enter--whether integrated with or independent of communications carriers--and by precluding any one carrier from exercising a dominant position, will minimize the possibility of anti-competitive conduct which has sometimes accompanied vertical integration.[1]

Both the GE and the Lockheed plan permitted the carriers' carrier or the common carrier to own their own ground stations. Nevertheless, Hughes Aircraft strongly urged that the ground stations and satellites of a space venture be owned and operated as one unified system.

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[1]Before the Federal Communications Commission, Docket 14024, op. cit., Comments of Lockheed Aircraft, pp. 26-7.

Of course, AT&T had reservations as to the organizational plan of the aerospace firms. Not only was such an entity unprecedented, but the telephone company insisted that the creation of a "stranger corporation" would disrupt existing communication relations and aggravate future administrative problems. The telephone company inverted the charge of dominance by stating:

> Indeed, in view of the small number of international common carriers, the General Electric formula appears designed to vest control in the aerospace group.[1]

While the Defense Department concentrated on active satellites (Projects Score, Courier, and Advent), NASA concentrated on the passive satellite research. (Recalling Chapter II, a passive satellite merely reflects, but does not amplify the microwave signal.)

Perhaps the most dramatic of NASA's efforts occurred with Project Echo--an orbiting balloon that permitted the ricochetting of a microwave signal. AT&T cooperated with NASA on the project and, in fact, invested from $600 million of their own funds in constructing receiving equipment and other ground facilities.

In July of 1960, NASA initiated discussions with DOD which permitted a realignment of their respective research

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[1]Before the Federal Communications Commission, Docket 14024, op. cit., Reply of American Telephone and Telegraph Company, May 15, 1961, p. 11.

in satellite communication. NASA, as a result of the DOD agreement, was permitted to engage in active satellite research if such research did not overlap the military effort.[1] Completing this arrangement, NASA embarked on its own active satellite program soon to be known as Project Relay.

The following month, AT&T approached the civilian space agency and inquired as to the feasibility of leasing launching vehicles and facilities for the hoisting of private satellites. In October of 1960, NASA's Administrator, Dr. T. Keith Glennan, in a speech in Oregon, outlined plans of accelerating a communication satellite system.[2]

Dr. Glennan offered to lease government boosters to private industry on a cost reimbursable basis and in testimony before the FCC, AT&T announced their intention of establishing a world-wide active satellite system.

The last month of the Eisenhower administration saw several developments. In the first place NASA began preparing specifications for bids on the Project Relay. On December 12, AT&T President, F. R. Kappel, in a letter to Dr. Glennan expressed interest in the government's leasing offer and suggested that since NASA's active satellite project

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[1]U.S. Congress, Senate, Communications Satellites: Technical Economic and International Developments, Staff Report, Committee on Aeronautical and Space Sciences, 1962, p. 193. Also: Philip J. Klass, "Indecision Bogs Communications Satellites," Aviation Week and Technology (April 17, 1961), pp. 104-5.

[2]U.S. Congress, Senate, op. cit., Committee on Aeronautical and Space Sciences, p. 193.

(Relay) and AT&T's active satellite project (Telstar) were similar in purpose:

> the material interest could be best served if our efforts were combined in this field so as to avoid wasteful duplication and delay in the development of a final system.[1]

AT&T offered to build the satellite and to bear the cost of the satellite and its launching. Furthermore, Bell observed that it would make available to the experiment its receiving station at Holmdel, New Jersey, a station constructed for the Echo Project. AT&T suggested:

> . . . that full information on satellite performance be made available to NASA.[2]

And concluded:

> If, as we are confident, this experiment is successful, it is our plan to move as promptly as possible toward the establishment of a commercial satellite communications system which will be integrated with existing carrier common carrier communications facilities, both here and abroad.[3]

NASA did not accept the telephone company's offer. Had such an agreement been consummated, it would have eliminated the planned competition for NASA's Project Relay. Subsequently, when the space agency announced competition for Project Relay, Bell Laboratories and Western Electric joined with six firms in offering bids.

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[1]U.S. Congress, House, Communications Satellites, Hearings before the Committee on Science and Astronautics, Part 1, 87th Congress, 1st Session, 1961, pp. 402-3.

[2]Ibid., p. 403.

[3]Ibid., p. 403.

If any doubt existed as to a national policy regarding the residence of a communications satellite policy, President Eisenhower removed that doubt in his last day in office. He declared that the government should aggressively encourage private enterprise in the establishment of a commercial communications satellite policy.[1] In addition, he directed NASA and the FCC to cooperate closely in establishing an early private system.

The change of administration brought a new head to the National Aeronautics and Space Administration, Mr. James Webb. Mr. Webb exhibited some hesitancy in following through on Dr. Glennan's offer of government launching boosters for private satellite research. One of the alleged virtues of such an offer was that it would permit the space agency to be reimbursed for the launching of private satellites and hence cut down on NASA's budget for space communication. One of the first acts of Mr. Webb was to return to Congress and request a reinstatement of the $10 million dollar cut. Mr. Webb explained to the House Space Committee that:

> This increase will provide full governmental as against partial industry financing pending necessary policy decisions as to the best means for wider industry participation. . . . This will postpone the necessity for negotiating arrangements for financial participation by industry until a proper basic policy can be laid.[2]

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[1]U.S. Congress, Senate, op. cit., Staff Report, p. 193.

[2]U.S. Congress, House, 1962 NASA Authorization, Hearings before the Committee on Science and Astronautics and subcommittees Nos. 1, 3, and 4, 87th Congress, 1st Session on HR 3238 and HR 6029, 1961, Part I, p. 192.

Furthermore, Mr. Webb prophetically testified:

> In other words, once you have committed yourself to one company or a group of companies, or committed yourself to completely competitive development, you then have to travel up that road.[1]

Subsequently, Mr. Webb returned to Congress and in a plea for a supplemental appropriation of $50 million on satellite research "to expedite what industry might take longer to do."[2]

Meanwhile, NASA and the FCC completed a memorandum of understanding. There were indications that the agreement represented one more step in determining the size of the ownership base of a commercial system. The memorandum stated:

> Both NASA and the FCC recognize as conditions of fact (3) that in accordance with traditional communications policy in this country, overseas communications are provided by private enterprise, subject to government regulation and that at the present time overseas voice communications are provided primarily by a single company and overseas record communications are provided by several companies.[3]

Thus, in accordance with "traditional policy," NASA and FCC agreed that:

> . . . private enterprise should be encouraged to undertake development and utilization of satellite systems for public communication services.[4]

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[1] Ibid., p. 221.

[2] U.S. Congress, Senate, op. cit., Senate Small Business Hearings, p. 304.

[3] Federal Communications Commission, memorandum of understanding between FCC and NASA on respective civil communications activities, Public Notice G, 1271, February 28, 1961.

[4] Ibid., p. 1.

Throughout the Spring of 1961, NASA weighed the seven competitive proposals on its Project Relay Satellite; and on May 18 RCA was judged the winner.[1] Both the communications and aerospace industry speculated that the NASA award conveyed to RCA commercial advantages in the establishment of a satellite system. However, the day of the RCA award one of the rejected bidders for the Relay Project, AT&T, received a call from Mr. Webb.[2] Mr. Webb reinstated and offered the Glennan booster lease to the telephone company. And when the offer and commitment became public, Mr. Webb suggested:

> . . . it will advance by some period of time the bringing into being of a commercially viable system.[2]

Thus, the new administrator was to have it both ways; public expenditures would speed what industry could not do, but private expenditures would more quickly establish a viable system. In seeking to advance the state of the space art, NASA's Telstar agreement had within its ownership implications that reached beyond the boundaries of pure research and development.

In an advisory report to NASA in February, 1961, the space agency had been forewarned of these implications. The report stated:

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[1]John Finney, "RCA Will Build Satellite for TV," New York Times, May 19, 1961, p. 2. Subsequently, a second government project, Syncom, was awarded to Hughes Aircraft.

[2]Conference memorandum, July 10, 1961, between Mr. James Nunn, Assistant Chief Counsel of NASA, Mr. N. Peterson, Senate Small Business Committee, and author.

> In the absence of a deliberate decision (as to ownership), the processes of the research and development phase may inadvertently decide the operational issue.[1] [Emphasis mine.]

If the space agency exhibited an ambivalence affecting the ownership base of a satellite system, the FCC did not. Following the NASA-FCC agreement reaffirming the "traditional" policy of communications in the U.S., the Commission initiated Docket No. 14024 as an inquiry into the problems of owning and administering a commercial satellite system. All interested parties were invited to solicit their opinions. Both the aerospace group and the common carriers were represented; the former advocating a broad base of ownership, the latter, a narrow base.

In May of 1961 the FCC, in declaring its first report, accepted the common carriers concept of a satellite system rather than the aerospace industry's. The FCC stated that:

> Communication via satellite will be a supplement to rather than a substitute for existing communication systems operated by the international common carriers, thereby becoming an integral part of the total communication system of each such carrier.[2] [Emphasis mine.]

Hence, the Commission observed:

> We fail to see why ownership participation by the aerospace and communications equipment industries will be beneficial or necessary to the establishment of a satellite communication system to be used by the common carrier industry.[3]

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[1]United Research Study, op. cit., p. 4.

[2]Before the Federal Communications Commission, Docket 14024, op. cit., First Report, p. 2.

[3]Ibid., p. 4.

The Commission summed its decision on the ownership base by asserting:

> We have concluded that the recommendations made herein with respect to the formation or arrangement of a joint venture (or joint undertaking) composed only of existing common carriers engaged in international telephone and telegraph communication is deserving of consideration and exploration as an effective means of promoting the orderly development and effectuation of such a system.[1] [Emphasis mine.]

In the meantime, Lockheed had pulled out, but General Electric and General Telephone pressed for entry by filing a petition for reconsideration of the Commission's report.

July, 1961 was a crucial month in the evolution of a national communications satellite policy. Reacting somewhat after the fact, on July 24, the President issued a policy pronouncement that, given certain conditions, private enterprise would own and operate a space communications system. Coinciding with this statement, NASA announced its agreement with AT&T to launch Telstar, and the FCC in rejecting the petitions of General Electric and General Telephone and Electronics formed an Ad Hoc Carrier Committee composed only of the international common carriers. Subsequently, General Electric withdrew all efforts to seek ownership.[2]

Meeting in the late Summer of 1961, the Ad Hoc Committee issued its report in October. The report reiterated the observation that satellites would add to but not replace

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[1] Ibid., p. 4.

[2] General Electric disbanded its Comsat Corporation.

existing overseas facilities.[1] Hence, the ownership of a space system would include the international carriers only. The vehicle for this joint venture would be embodied in a nonprofit satellite corporation, the purpose of which would be to:

> . . . develop, construct, operate, manage, and promote the use of the satellite system, other than ground stations . . .[2]

The ground stations were to be owned by each common carrier.

Furthermore, the equipment subsidiaries of the carriers (AT&T, IT&T, and RCAC) elicited an interest in supplying the joint venture with its communication and space apparatus and equipment. In short, only integrated equipment firms would be allowed to participate in the ownership of a satellite system. Nonintegrated aerospace firms would participate as suppliers, not as owners.

It became apparent that the non-profit was a slight misnomer since the carriers could include contributions to the joint venture in their rate base upon which they are entitled a reasonable rate of return. Since the source of revenue existed at the ground stations, it was important for the carriers to return private ownership of the stations. And finally, the existence of manufacturing subsidiaries within the joint venture left the problem of market access

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[1]Before the Federal Communications Commission, Docket 14024, op. cit., Report of the Ad Hoc Carrier Committee, p. 9.

[2]Ibid., p. 18.

by the nonintegrated aerospace firm less than clear.

The Ad Hoc Committee, with slight modifications, became embodied as the Kerr Satellite Bill.

Broad Base

Within the confines of the President's pronouncement that a satellite system was to be subject to private ownership, the broad base plan was essentially the organizational structure promulgated by the aerospace industry. Lockheed's carriers' carrier corporation included the participation of the carriers, the hardware firms, and the general public. General Electric's plan permitted 50 per cent of the corporation to be owned by those participants in the FCC 14024 docket with a 10 per cent limit imposed on any individual company. The general public would be permitted to own the other 50 per cent. Thus, both plans permitted the nonintegrated as well as the integrated hardware companies to participate in the ownership base.

Both plans embodied the criteria laid down by the Justice Department in responding to the FCC Docket 14024 on May 3. The Justice Department suggested that any joint venture must meet the following conditions:

> (1) All interested communication common carriers be given an opportunity to participate in the ownership of the system;
> (2) All interested communication common carriers be given unrestricted use of nondiscriminatory terms of the facilities of the system whether or not they elect to participate in ownership;
> (3) All interested parties engaged in the production and sale of communication and related equipment be given an opportunity to participate in ownership of the system; and

> (4) All interested parties engaged in the production and sale of communication and related equipment be given unrestricted opportunity to furnish such equipment to the system whether or not they elect to participate in ownership.[1] [Emphasis mine.]

However, when the FCC issued its first report on May 24, 1961, it modified the third criteria by excluding the aerospace firms from ownership. The Commission declared that the aerospace industry would be permitted to participate as suppliers rather than owners to a commercial venture.

However, subsequent to the FCC report, the Justice Department continued to press for broadened membership. In a meeting called by the FCC on June 5 between the interested participants of Docket 14024, the Justice Department restated its criteria of a broad ownership base;[2] and on June 14, Judge Loevinger testified before the Celler Antitrust Committee:

> We still feel that all four points were valid and should be considered, and have by no means abandoned urging them upon the FCC.[3]

Subsequently, on July 26 before the House Interstate and Foreign Commerce Committee, Mr. Loevinger modified the third criteria on ownership to read:

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[1]U.S. Congress, Senate, op. cit., Small Business Hearings, p. 465.

[2]U.S. Congress, House, op. cit., Committee on Interstate and Foreign Commerce, p. 134. "The Department of Justice then urged the Commission to consider the desirability of widening the base of ownership as the plan is being developed so as to lessen the likelihood that the system will be controlled by a single company.

[3]U.S. Congress, House, Antitrust Consent Decrees and the Television Broadcasting Industry, hearings before the Antitrust Subcommittee (Subcommittee No. 5), Committee on the Judiciary, House of Representatives, 87th Congress, 1st Session, June 14, 1961.

> All interested manufacturers should have an unrestricted opportunity to participate in the furnishing of equipment.[1] [Emphasis mine.]

Mr. Loevinger testified that the ownership criteria was perhaps "too doctrinaire."[2]

With the Justice Department's position essentially consonant with the FCC, only the administration was in a position to broaden the ownership base of a space satellite system. Such a bill was introduced and it incorporated the general concepts exposed by GE and Lockheed.

The final satellite Bill, as a compromise, is an amalgam of the Kerr Bill and the Administration Bill (Figure 54).

The Compromise Bill can be summarized under the topics covering ownership, ground stations, and the hardware market.

As to ownership, it will be recalled that the Kerr Bill advocated a "private" joint venture with ownership participation restricted to the international common carriers.[3]

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[1]U.S. Congress, House, op. cit., Interstate and Foreign Commerce Committee, p. 131.

[2]Ibid., p. 154.

[3]The integrity of a "private corporation" continues to be challenged. Prior to the satellite legislation, critics of the concept of a private system alleged that the government investment in space vehicles and communication satellites represented a "give-away." However, even supporters of a private corporation are finding entity in view of continued public expenditure ($55 million) in space communication by NASA. See: U.S. Congress, Senate, Nomination of Incorporators, Hearings before the Committee on Aeronautical and Space Sciences, 88th Congress, 1963, pp. 80-2.

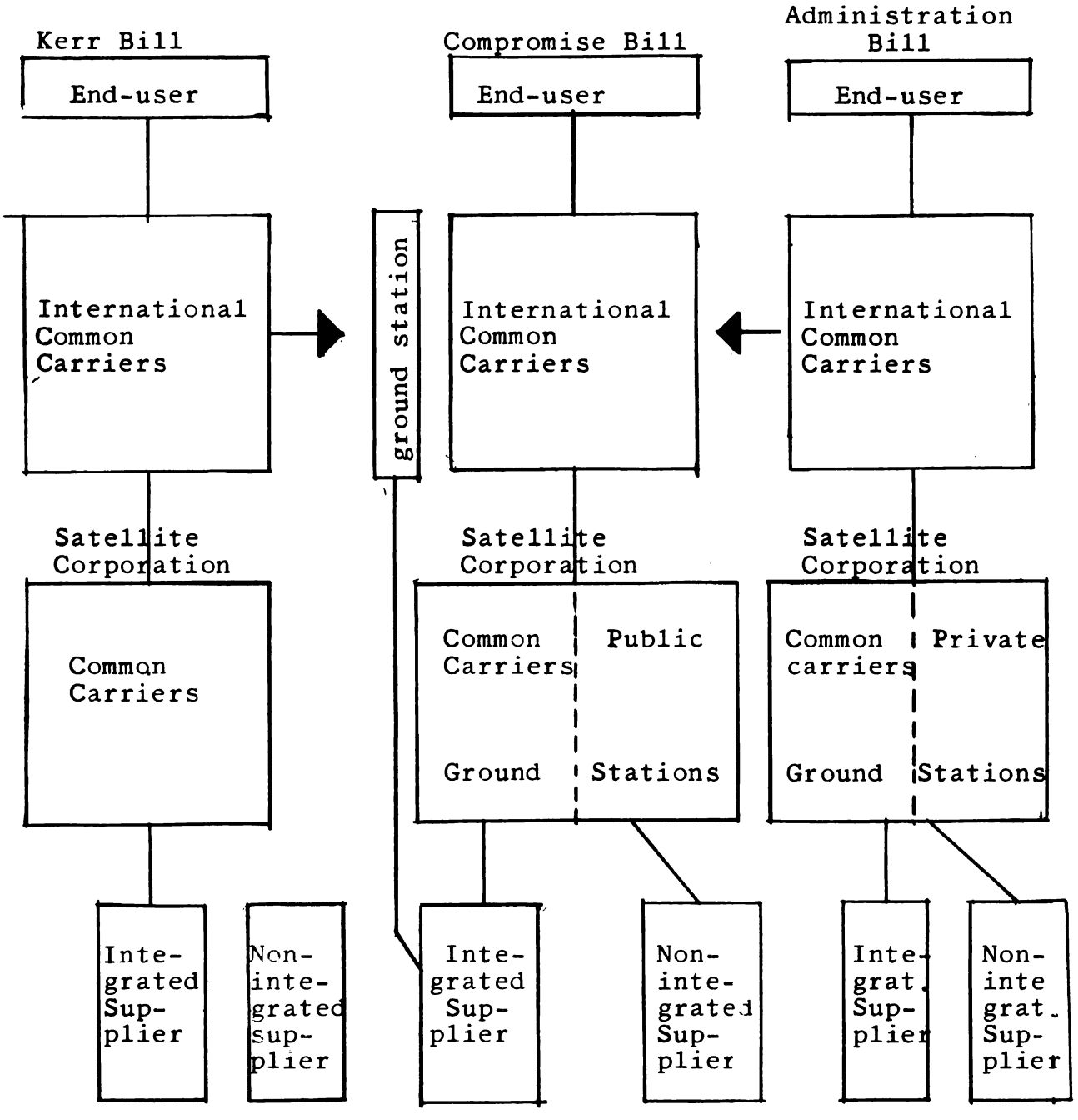

Figure 54. Compromise satellite bill.

The Administration Bill broadened the ownership base to include both. Thus, the carriers' carrier concept was embodied in the Compromise Satellite Bill. The Compromise Bill provided for the formation of a U.S. Satellite Corporation composed of two classes of stock; 50 per cent of the corporation's stock would be sold to the general public as Class A stock. The general public would be entitled to elect six members of the Board of Directors to the company.

The remaining 50 per cent of the stock, Class B, would be sold to the carriers. Although the carriers could elect six board members, they could not receive dividends from their investment. However, the carriers could include stock contributions into their rate base upon which they could earn a return.

Finally, whereas the Kerr Bill excluded the nonintegrated supplier from ownership participation, the Compromise Bill, like the Administration Bill, permits ownership in the public half of the corporation. The Compromise Bill, in this sense represents a strange amalgam.

The vertical integration of the international carriers is left intact. Furthermore, since the carriers are permitted to own ground stations, their hardware subsidiaries will undoubtedly supply the receiving equipment. On the other hand, since the nonintegrated suppliers are now granted permission to integrate forward (<u>partially</u>, since they are not common carriers) and since the corporation may construct and own ground stations, the final Bill conveys to the

independent supplier a form of market access.

It is essential to note, however, that we have like firms operating on both sides of the market. That is, equipment firms sell apparatus to an organization in which they themselves are partial owners. To deliver us from this potential conflict of interest, the FCC is charged with the mandate of insuring:

> . . . effective completion in the procurement by the Corporation of apparatus, equipment, and services . . .[1]

In reviewing the triad of restraints applicable to the domestic equipment market in both domestic and international segments, this study offers the following observations. First, in the domestic market the legal and technical barriers to entry no longer assume the proportions that they exerted historically. Patented knowledge as a barrier appears to be less important than formerly; the magnitude of the frequency spectrum has permitted expanded eligibility, and the capital requirements for both heavy and light route systems have tended to recede.

However, as the predominant form of market structure, vertical integration continues as the chief bar to entry in the equipment market. Not only has the Bell-Western Electric precluded entry in the procurement of equipment by the Bell operating companies, but entry is further inhibited by AT&T's interconnection policy and by her recent pricing.

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[1]U.S. Congress, Senate, op. cit., Subcommittee on Antitrust and Monopoly, p. 244.

Finally, it has been observed that policy determinations within the public sector have tended to re-enforce rather than dissipate the existence of vertical integration. The FCC in particular appears oversolicitous in regarding the interests of the Bell System as seen in limiting entry into the intercity video channel field and permitting the Telpak tariff to take effect while its cost legitimacy continues under investigation.

Of more crucial import is the failure of the Justice Department to address itself to the problem of market power associated with vertical integration.

Since a communication satellite continues to remain in the research and development stage, less certainties attend the problems in international communications. It may well be that the future technical advances in transitorized cables and the probability of the laser may consign the debate of metallic vs. radio circuits to academic interest. Nevertheless, patented knowledge does not appear to be an overriding bar to satellite communications; and the microwave bands are available for transoceanic use. Although cost parameters fall within a wide range, precise capital requirements attending a viable system continue as an unknown; and these costs, coupled with the economies of scale, suggest that one system only will be available in the near future.

Attention was drawn to the vertical nature of the overseas common carriers, and it was this structure that prompted

the aerospace industry as nonintegrated firms to seek market entry. Again, the policies of the FCC continued to favor the existing international carriers in their bid to limit ownership participation of a satellite venture. This bias of the FCC was epitomized by Commissioner Minow, who after participating in the drafting of the expanded ownership base of the Administration Bill, proceeded to testify against it. And again, the Justice Department's ambivalence as to size of the ownership base came previously close to deferring to the FCC. More dramatic and perhaps more crucial as a variable in determining public policy was a research and development launching contract negotiated by NASA in its ostensible mandate to advance the state of the communication art. These decisions, derived from the public sector, were premised upon the existence of the overseas communication market structure and as such tended to reinforce the entry restrains confronting the nonintegrated firm.

In postulating the virtues of vertical combination, the Spengler thesis holds that market power is associated primarily with horizontal integration and it is to this power that public policy should address itself. This study does not confirm the Spengler thesis. Rather, we have suggested that the problem of entry turns on the existence of vertical power. In the domestic market, an attempt has been made to document not only the entry deterrants associated with disproportionate vertical integration, but to record the exercise of that power in isolating the nonintegrated supplier.

In the international market, this study has postulated that the formulation of a national satellite policy originated as an attempt by the nonintegrated equipment supplier to gain a market outlet for his goods and services. This entry problem got "out of hand" when the issue evolved into a charge of "give away," filibuster and cloture--a long road from the original problem of market access. Given the problem of market entry, what policy options confront both the domestic and international equipment markets?

CHAPTER V

POLICY ALTERNATIVES

Domestic Market

The domestic communication equipment market is amenable to several policy formulations. One choice is to maintain the status quo and treat vertical integration as the norm for the equipment industry. The Consent Decree is premised essentially on this policy.

However, maintaining the status quo suffers from two difficulties. In the first place, the problem of competition and competitive entry is relegated to a position of secondary importance; and the nonintegrated firms' market outlet is left to the discretion of the integrated firms' decision to make or buy. In short, the nonintegrated supplier continues as a subcontractor in the factor market, while his position remains less than certain in the product market (due to Telpak).

A second problem attending a status quo policy is that it continues to convey to the integrated supplier a quasi utility status. As such, vertical integration rationalizes the FCC's regulatory extension into the equipment market. Whether the FCC's regulation of Western Electric is real or token in nature, it is not without its inadequacies.

In fact, the 1939 Telephone Investigation revealed that:

> Western computed costs for individual products do not provide an authentic basis for testing the reasonableness of the prices of these products nor do its overall profits from sales provide any better basis for testing the reasonableness of its prices for its products.[1]

The Commission requested authority to prescribe to Western Electric a system of standardized cost accounting. Subsequently, in 1941, a cooperative study between the FCC and the National Association of Railroad and Utilities Commissioners (NARUC) cooperated in a joint study of Western's operating results. These reports have been issued annually since 1948. Nevertheless, a Hoover Commission Report concluded:

> The prices and profits of Western have never been the subject of a definite investigation by the Commission.[2]

Again, the Justice Department's Consent Decree admonished Western Electric as to its cost accounting procedures. Thus:

> Western is ordered and directed to maintain cost accounting methods that conform with such accounting principles as may be generally accepted and that afford a valid basis, taking into account the magnitude and complexity of the manufacturing operations involved for determining the cost to Western of equipment sold to AT&T and Bell operating companies for use by them in furnishing common carrier communications services.[3]

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[1]1939 Telephone Investigation, op. cit., p. 322.

[2]U.S. Congress, Senate, op. cit., Subcommittee on Antitrust and Monopoly of the Committee of the Judiciary, p. 213.

[3]U.S. Congress, House, op. cit., Celler Hearings, p. 2595.

And again, a recent study sponsored by the Bureau of the Budget concludes:

> Since January 1, 1956, accounting compliance reviews have been accomplished for only 14 of 24 Bell System companies and 9 of 40 independent telephone companies. . . . In 1960 Bell System purchases from the Western Electric Company, a Bell Subsidiary, amounted to $1.8 billion, which amount becomes part of the rate base on which the Bell companies expect a return. Apart from occasional review of periodic reports, no examination of the books of Western Electric or other leading telephone equipment manufacturers has been undertaken to determine the reasonableness of charges to the Bell System.[1]

The evidence suggests that meaningful regulation of Western's prices and profits has been cursory at best. As one observer points out, Western "is limited in business conduct chiefly by executive discretion, not by external market forces or authority"[2]; and amplifying the observation that Western Electric is subject primarily to the discretion of its management, an AT&T vice president is quoted as observing:

> The Western has deliberately limited its profits. That is one of the important restraints of self-regulation practiced by the Bell System.[3]

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[1]Organization and Management Survey of the Federal Communications Commission for the Bureau of the Budget, Vol. 1, Chapter I-XIV (March, 1962), Booz Allen and Hamilton, p. 286.

[2]John Sheahan, "Integration and Exclusion in the Telephone Equipment Industry," Quarterly Journal of Economics, Vol. 70 (May, 1956), p. 249. Also: Bell System Comments on the Booz Allen and Hamilton Report on the FCC, July, 1962, p. 1. Bell's rebuttal: "The fact that accounting compliance reviews have not been made more frequently for more companies is much less significant that it appears. Any direct or implied criticism on these grounds overlooks the fact that all the companies in the Bell System follow the same accounting practices."

[3]Arthur W. Page, The Bell Telephone System (New York: Harper and Brothers, 1941), p. 147.

In sum, pursuing a policy of status quo neglects the issue of market access for the nonintegrated firm, and further lends a static bias to the structure of the communication equipment industry.

A second policy recommendation contends that only the common carriers be permitted to render service to the bulk communication market. The position is outlined as follows.

Private microwave permits the rendition of both voice and record signals and hence challenge the traditional market dichotomy of the telephone and telegraph companies.

> In fact, this new competition in a properly construed regulatory sense, must be viewed as a significant reduction in monopoly power for major segments of the telephone and telegraph markets.[1]

In responding to this "new competition," the common carriers have introduced several new services. The Bell System, in particular, has introduced a series of new tariffs, the most notable of which is Telpak. As a direct challenge to private microwave, Telpak offers the consumers of volume bulk communication a viable alternative to owning a radio relay system. Western Union, for competitive reasons, likewise offers a form of Telpak service, although, as we have seen, they are doing so under protest. In addition, the Bell System is offering WATS, WADS, and Dataphone. WATS stands for wide area telephone service and permits consumers

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[1]Bernard P. Herber, "The Impact of Microwave on the Telephone Business," Public Utilities Fortnightly, 70:62 (August 16, 1962), p. 219. Dr. Herber held a fellowship with the Mountain States Telephone and Telegraph Company--an AT&T operating subsidiary.

with heavy long distance telephone needs to obtain such service at flat monthly rates. The independent telephone companies protested this tariff, although it has gone into effect. A second service, WADS, stands for wide area data service. Similar in concept to WATS, WADS applies to users of teletypewriter service (FCC has ruled that this tariff is discriminatory). A third service, introduced by Bell, is Dataphone. This tariff permits phones to interconnect computers permitting "machine-talk."

In short, the above 890 decision has generated not only competition among the carriers but a new competition between carriers and private microwave systems.

Given this new competition, the expansion of private eligibility of microwave system has resulted in three problems: first, a problem of regulatory inequality; second, potential waste of microwave frequency bands; and third, neglect of the inherent economies of scale possessed by the carriers.

The first problem, the problem of regulatory imbalance is summarized by comparing the carriers to the private microwave suppliers. Thus:

> . . . one side of the competitive market--the private systems and their suppliers--face little or no regulation. However, the other side of the competitive market, the established common carriers such as Bell and Western Union are closely regulated as public utilities.[1]

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[1]Bernard P. Herber, "Telephone Industry Reaction to Microwave Competition," Public Utilities Fortnightly, 70:9 (October 25, 1962), p..634.

This condition, described as "regulatory inequity" is further intensified by the burden of Federal excise taxes accompanying common carrier services.

The existence of regulatory inequity, so the argument holds, means that:

> In some manner, the relative underregulation of the private microwave systems and their suppliers should be equated (or at least brought closer together) with the relative overrregulation of the common carriers.[1] [Emphasis mine.]

In short, the implication is that the FCC should redress the underregulation of the private systems and their suppliers by encompassing them within the regulatory authority of the Commission.

The second point relating to the problem frequency waste centers on the limited size of the frequency bands in the microwave region. Since the bands are scarce, expanded eligibility, as embodied in the FCC's Above 890 decision, only tends to increase the problem of scarcity--particularly when common carriers' facilities are in existence.

> Why create a precondition to inefficiency in the use of scarce economic resources in general (land, labor, and capital) and the scarce frequency spectrum in particular?[2]

It follows then, that:

> There is good reason to challenge the "economic propriety" of the Above 890 decision in terms of use of the scarce frequency spectrum . . .[3]

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[1] Ibid., p. 636.

[2] Ibid., p. 636

[3] Ibid., p. 640.

Again the implication exists that the Above 890 decision should be rescinded in favor of the carriers.

The final argument supporting the view that only the carriers be permitted to render volume communication service rests upon the thesis of economies of scale. Since the carriers possess inherent economies of scale, why should the FCC expand private microwave with:

> . . . the full knowledge that diseconomies of small scale will likely make them less efficient than the common carriers.[1]

In granting this position, it follows that:

> . . . there appears to be good reason from the standpoint of efficiency in resource use to permit natural monopoly power condition in the form of a regulated oligopoly market structure to continue to provide the nation's rapid communication needs.[2]

Perhaps the dissimilarity between the preceding position as outlined and the observations in this study stem from different concepts as to the relevant market. The preceding discussion has included the common carriers, the private microwave systems, and their suppliers. We, in turn, have focused upon the equipment market with specific emphasis upon the vertical structure of that market. It is our contention that the nonintegrated firm is confronted with several forces whose residence is traced to vertical integration. Thus, in the product market the nonaffiliated supplier is faced with Bell's Telpak tariff as well as AT&T's policy of purchasing of existing private microwave

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[1] Ibid., p. 638. [2] Ibid., p. 641.

systems. In the factor market, we have noted the dependence of the nonintegrated supplier upon the captive subsidiaries of the common carriers and specifically have noted the leverage power accorded the procurement policy of Western Electric. In short, the longevity of the supposed "new competition" in the bulk market is tenuous at best and hardly seems to support the statement that a "significant reduction" of monopoly power is occurring in the communication industry. More important is the view that, in the name of "regulatory inequity," FCC's jurisdiction should be extended to include the manufacturers of private microwave systems.

Since the integrated manufacturers are regulated, it follows that like supervision be extended to the independent suppliers as well. A policy advocating an administrative drift so as to include the industry's competitors is reminiscent of the railroads' pressure to bring the trucking carriers under the roof of the ICC;[1] and no known empirical study exists that documents the position that the equipment industry would prosper more effectively under government regulation than under the forces of the market place.

Turning to the issue of spectrum waste, the thesis that the FCC should revoke the Above 890 decision holds within it several implications. In the first place, a decision to withdraw the raw material essential to private microwave systems would be a decision to deny the product

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[1]James C. Nelson, "The Motor Carrier Act of 1935," Journal of Political Economy, Vol. 44 (1946), p. 465.

market to the independent suppliers. Furthermore, rescinding the Above 890 would resolve the alleged dilemma of regulatory inequity in that private microwave systems subsequent to the Above 890 decision would be nonexistent.

A second implication in advocating a policy to restrict private microwave use is the assumption that the new services introduced by AT&T (WATS, WADS, Telpak, etc.) derives from the benevolence of the Bell System rather than from the pressures of the market. While some may assert that the former is the case, AT&T's briefs before the FCC, suggest that private microwave triggered this host of new services and tariffs.

While the magnituide of the microwave bands remain finite per given point of time, the pace of technological change may hold surprises as to the available use of the frequency spectrum. One supporter of restricting the microwave bands to the common carriers has observed:

> The future may witness the use of light waves (Lasers) to provide a mass communications medium which will cause microwaves to appear as outdated in communications as a Conestoga wagon is today in transportation.[1]

Finally, does it follow that the common carriers alone should provide volume communication services since they exhibit economies of scale?

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[1]Bernard P. Herber, "Technological and Market Structure Changes in Communications," Business Topics (East Lansing: Michigan State University, Graduate School of Business Administration), 11:2 (Spring 1963), p. 60.

One difficulty in answering this question is whether a firm can segregate its joint costs in order to establish the existence of scale economies for a specific service. Presumably this hurdle is not insurmountable, although AT&T was reluctant to do so in the private line case and did not conduct a cost study of the actual plant inventory in the Telpak case. Yet, in granting this knowledge of economies of scale, presumably these economies were in existence before the FCC's decision to stimulate private microwave. If so, why were not these economies passed on to the consumer prior to the 890 decision? And if Telpak now conveys to AT&T a reasonable rate of return, does it not suggest that the bulk tariffs prior to Telpak earned unreasonable profits?

But more important, if we grant that economies of scale exist and are known to the carriers, it does not follow that these economies are derived from the economies of manufacturing or vertical integration. In fact, the vitality of such nonintegrated suppliers as Collins Radio (sales $207.7 million, 1962) and Motorola (sales $346.8 million, 1962) argues hard that the optimum manufacturing scale may be considerably less than the dimensions of Western Electric (sales $2.5 billion, 1961).[1]

A final policy choice holds that the communication equipment market is amenable to competition and that vertical

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[1]Standard Corporation Descriptions, Standard and Poor's Corporation, 1963.

integration inhibits the attainment of that goal.[1] This study supports such a conclusion and suggests the following steps in promulgating competitive entry into the equipment market.

First, the Justice Department in returning to its position of 1949 should demand the divestment of Western Electric from AT&T. Furthermore, the General Telephone's integrated system should likewise receive careful scrutiny. Again, the Department may find it necessary to split Western into several competing firms. The point is that divestiture would permit the Bell associated companies to expand the number of alternative equipment sources as well as broaden the factor market potential to the nonintegrated supplier. It is conceivable that Western Electric, acting as other equipment manufacturers, may be tempted to tap the product market by selling private microwave systems to end-users. In this sense, both product and factor markets will be subject to competitive aeration.

Second, vertical disintegration would remove the quasi-utility status surrounding Western Electric. Western's divestment would remove the FCC's rationale for overseeing the company's profits and prices. Rather than extending government regulation into larger areas of the equipment industry, divestment would tend to confine the Commission's activities to the tariffs of the carriers. In short, the

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[1]Before the Federal Communications Commission, Celler Hearings, op. cit, Hearings for Bell System's defenses of vertical integration, Part II, Vol. I, pp. 1973-2000.

equipment industry would be deregulated and exposed to market forces. In addition, the FCC should reexamine the interconnection policy of the common carriers. Interconnection of carrier and private microwave facilities could be permitted at reasonable rates to the carriers and if the feared "cream skimming" reached demonstrable portions, the Commission could adjust the interconnection rates accordingly.

Third, the Government Services Administration (GSA) as the purchasing agent for the U.S. government should reevaluate its procurement policy with respect to volume communication channels. Certainly the agency, in taking its communication needs automatically from the carriers, did little to stimulate and encourage competition in the equipment market.

Common carrier subscription in the light of the available economies of private microwave suggest that government procurement practices amounted to an outright subsidy to the carriers. Assuming that these economies exist, Government procurement policy could effectively stimulate competition in the private sector.

Finally, one of the dramatic transitions occurring within the past twenty years is the displacement of research funding from the private to the public sector. Not only is the U.S. Government underwriting a larger share of the nation's total research and development, but in specific industries, notably the communication industry, that burden is approaching 80 per cent.

One of the assertions of this study is that the firms sponsoring a technical alternative in the communication industry owed much of their origin to government research and procurement activities. While the competitive effects of research and development contracts were perhaps not pursued as a matter of explicit policy, the research and development contract holds within it a powerful tool in broadening the base of new technology and hopefully generating the birth of new firms. The Government research and development contract can be employed as a deliberate policy directed to increasing rather than diminishing a competitive environment within the private sector. This study concurs with Dr. Charles Hitch who observes:

> The problem in managing governmental research and development is not how to suppress competition, but how to divert it into more productive channels.[1]

It is appropriate to note that a Federal patent policy permitting the prime contractor to retain patent title on inventions arising from publically funded research tends to negate whatever competitive implications the research and development contract holds for the private sector.

The international market, like its domestic counterpart, is confronted with several policy alternatives. One such alternative is to continue the status quo as now

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[1]Charles J. Hitch, "Research and Development in the Competitive Economy," Proceedings of a Conference on Research and Development and its Impact on the Economy (National Science Foundation, 1958), p. 139.

embodied in the recent communication satellite legislation. This legislation, it will be recalled, permits 50 per cent of a U.S. satellite corporation to be owned by the international carriers and the other 50 per cent to be owned by the general public. We have suggested that the carrier half of the corporation retains the existing vertical structure of the three largest carriers. Furthermore, the ability of the nonintegrated suppliers to purchase up to 10 per cent of the public half of the joint venture represents a partial forward integration of those suppliers. A national space communications policy appears to contain some elements of compulsory integration suggested in Chapter I by Chamberlin.

This type of market arrangement may lend itself to a potential cartelization of the equipment market. Several dominate suppliers could purchase their 10 per cent limit in the public half of the corporation and proceed to rotate equipment contracts to each other. In short, it is difficult to envision arm-length bargaining when common ownership spans the same market.

It has been asserted that competition will be maintained by the new mandate directing the FCC to insure competitive bidding, where feasible, in the purchases of the satellite corporation. Although the Commission may be capable of the task, the fact that it has not determined the reasonableness of the prices in the overseas product market hardly assures the FCC extension into the equipment market. For example, an FCC letter to AT&T in July, 1961 stated:

> As you are aware, the Commission has never had before it data on which to properly evaluate your overseas communication service. Such an evaluation can no longer be delayed.[1]

Subsequently, the Commission commented that the figures submitted by Bell were so rough that they were "almost meaningless."

Thus, the extension of the FCC's authority into the overseas equipment industry casts some skepticism as to whether such regulation is possible and more important, whether it is desirable.

A second policy alternative is to place the joint venture under government ownership. Two Congressional bills incorporated this approach. The Government corporation would purchase and own both ground stations and satellites; and then lease these facilities to the common carriers. From the standpoint of maintaining competition and precluding the extension of vertical integration in the factor market, public ownership offers advantages not contained in the present satellite corporation. However, politically, public ownership met with little enthusiasm. Furthermore, public ownership does not address itself to the problem of existing vertical integration in the overseas market since the lessors could still purchase from their equipment subsidiaries.

A third policy choice, recommended by this study, is to retain the idea of a "private" joint venture, but prohibit

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[1]U.S. Congress, Small Business Hearings, op. cit., p. 56.

vertical integration. That is, all existing common carriers --AT&T, IT&T, and RCAC--could participate in the ownership of the corporation on the condition that they disaffiliate from their equipment subsidiaries. Furthermore, if each carrier desired to construct and own satellite ground terminals, they would be permitted to do so. In addition, no non-integrated aerospace firm would be permitted to purchase stock ownership to the full corporation. In short, full vertical integration as a matter of public policy would cease and partial forward integration would be disbanded. The virtue of this approach is that it removes the FCC's rationale for the extension of government supervision into the equipment industry. A policy of divestiture is premised on the observation that the equipment market should be left to market forces rather than assume a quasi public utility status. In this regard, recent research contracts by NASA hardly augments a policy of technological diffusion. Specifically, Mr. James Webb, Administrator of NASA, initiated and consummated a contract between the Space Agency and Bellcom. Bellcom, a subsidiary of AT&T and Western Electric,[1] will perform the role of systems advisor for the Apollo manned lunar program. That the range of new technology generated by the government's space program will be available to Bellcom was alluded to by Mr. Webb who stated:

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[1]U.S. Congress, House, 1963 NASA Authorization, Hearings before the Committee on Space and Astronautics, 87th Congress, 2nd Session on HR 10100, 1962, p. 159.

> . . . a necessary result of the close relationship between Bellcom and NASA is that a new company will become privy to the kind of information regarding current and future plans and programs of NASA that could give the Bell System a competitive advantage in connection with other works.[1]

Perhaps this contract epitomizes the narrowing rather than the broadening market bias of recent government decisions.

First, Bellcom will have access to the most crucial U.S. research investment for the next ten years.

Second, Western Electric, Bellcom's part-owner, will be permitted to solicit equipment contracts to NASA subject to the discretion of NASA's administrator.[2]

Third, the recent proposal to permit NASA's prime contractors to retain patent titles from government financed research could erect the potential barrier of patented knowledge.

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[1]U.S. Congress, House, Systems Development and Management (Part 5), Hearings before a Subcommittee of the Committee on Government Operations, Military Operations Subcommittee, 87th Congress, 2nd Session, 1962, p. 1702.

[2]Ibid., p. 1763. Mr. Roback (Committee Counsel) ". . . If and when on some new project the fact that Bellcom may be privy to a considerable amount of special information which confers a competitive advantage, then the Administrator (of NASA) will on a case-by-case basis decide whether or not it is appropriate to permit bidding by Bell companies. . . ." Also Space Technology Laboratory was dropped as Air Force systems advisor because of a conflict of interest in being integrated with a space hardware manufacturer, Thompson-Ramo Wooldredge.

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