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THE BYPASS ISSUE: AN EMERGING FORM OF COMPETITION IN THE TELEPHONE INDUSTRY

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EXECUTIVE SUMMARY

The market for telephone network services has been opened to competition through a series of key decisions by the FCC. Chief among those are the Above 890 decision, the MCI decision, and the Specialized Common Carrier decision. Each of these decisions was reached amidst controversy and concern over the impact of competition on the viability of established telephone carriers and their ability to provide universal service at affordable rates. Today, there is a new focus for that concern, the "bypass threat." Bypass refers to the provision of telecommunications services without the use of telephone company facilities, that is, a customer "bypasses" the network.

Innovations in the applications of various technologies have given rise to increasing amounts of bypass activity. Not surprisingly, bypass has been defined by various authors in various ways. One of the more frequently used definitions is "the origination and/or termination of telecommunications traffic without the use of telephone company facilities." Other definitions have spoken of bypass of the public switched network and have included the use of telephone company private lines as a form of bypass; some definitions exclude intralocation traffic, and others consider bypass to occur only if similar facilities are available from the telephone company. This report contends that bypass is simply another source of competition. The study results confirm that there is emerging competition for nearly all telephone company services. This is the expected outcome of the technological advances and procompetitive regulatory policies that have characterized the telecommunications field in recent years.

Many parties have spoken of economic versus uneconomic bypass, the latter being bypass that occurs because telephone company services are overpriced in relation to actual costs. Economic bypass is that which occurs even when telephone company services are correctly priced. This report suggests that a distinction between "avoidable" and "unavoidable" bypass might be more appropriate. Avoidable bypass includes uneconomic bypass, and also includes bypass that occurs because of other factors such as excessive overall costs of the telephone company, unaggressive or inept marketing procedures, inadequate responsiveness to customer needs, and unnecessary regulatory restraints. Avoidable bypass is a preferred term because it encompasses a broader spectrum of reasons for bypass and because it places the responsibility for this sort of bypass on both the regulators and the telephone companies. Unavoidable bypass is that bypass that occurs when market forces are functioning well, and telephone company services are correctly priced.

The bypass issue is especially important because of its potential effect on universal service. If large numbers of customers install alternative telecommunications systems and thereby reduce their use of telephone company facilities, there could be significant amounts of idle telephone company plant. If the costs of this idle plant were then spread among remaining customers, rates would rise, leading to more bypass and also to drop-offs of residential customers. Bypass by many large customers can lead to significant amounts of stranded plant causing financial problems for the carriers as well as rising rates for remaining customers. Because of these potential problems it is important to understand why bypass is occurring today and how it affects the use of telephone company services.

Eight basic bypass technologies have been identified that make it possible for customers to provide their own communications facilities. The major bypass technologies are satellite, microwave, digital termination systems, coaxial cable TV, fiber optics, local area networks, teleports, and cellular mobile telephone. Each of these technologies has introduced new alternatives in supplying business and residential telecommunications services. Satellite communications are offering new small earth stations with disks measuring 2 feet in diameter and weighing 15 pounds. These earth stations receive transmissions from broadcast satellites to distribute video and data information to homes and offices. High frequency microwave systems are emerging as an important supplier of short haul communications in crowded urban areas. These microwave systems operate at 18 GHz and 24 GHz with a range up to 8 miles.

Digital termination systems (DTS) are a new type of system providing digital metropolitan private line service by employing efficient microwave systems and a central distributing switching center. There are over ninety-four DTS applications for extended and limited carriers in over fifty cities. Cable TV is playing an important role in metropolitan communication networks for private business networks and enhanced residential services. Coaxial cable provides higher capacity than local loops to distribute voice, data, and video transmissions. These networks are being used to connect businesses directly with interexchange carriers while providing high speed data transmission and video services. Fiber optics has the greatest potential for replacing coaxial cable and copper wire as a network medium. Its attributes include high capacity, low noise, light weight, and high security. Fiber optic cable is being installed by most major telecommunication companies to increase capacity along their high density traffic routes.

With new applications in data communications, local area networks (LANs) are being used to interconnect communication and data processing equipment to form a single homogeneous network. These networks would allow users of dissimilar equipment to exchange information without the requirement of a central processing center. LANs are usually applied to intraoffice communications. Many of the technologies above are being integrated into teleport facilities to enhance real estate value. Teleports provide common telecommunication services to a multitenant facility that includes long haul satellite communications, video teleconferencing, central PBXs, and a local area network to interconnect data processing and switching centers.

A telephone survey was taken of a nationwide random sample of large manufacturers and financial institutions. The sample consisted of 700 locations of manufacturers 300 locations of financial institutions, each with 500 or more employees. Completed responses were received from 561 locations. The actual response rate was 63 percent, since 109 locations in the original sample were deemed ineligible, for such reasons as duplicate names, small size, or having gone out of business.

One goal of this study was to find out the extent to which all telephone company services are being replaced by privately supplied systems. A second goal was to uncover the reasons for bypass. A third was to identify characteristics of bypassers.

Sixteen percent (89) of the 561 respondents are bypassers. That is, they either have a bypass system in place or they have made a firm commitment to install one. A firm commitment was defined as having at least secured a bid for the installation of bypass facilities. The bypassers typically have multifaceted systems, using a combination of technologies. Forty percent have private microwave systems; 49 percent have local area networks (LANs); 27 percent use satellite/customer earth station facilities; 39 percent use digital termination systems; 33 percent use fiber optics; 17 percent use teleports; and 58 percent use coaxial cable. Only 1 of the bypassers uses only a LAN.

The survey was not designed for the purpose of forecasting the future use of bypass. Nevertheless, four facets of the responses indicate that the use of bypass facilities is increasing. The first one is that most (fifty-eight of eighty-nine bypassers) of the systems in place today have been installed since 1980, while only sixteen were installed prior to 1980. Secondly, twenty-two of those bypassers with a system in place today have made firm commitments to expand their bypass facilities. Thirdly, ninety respondents who are not defined as bypassers are currently considering the use of bypass systems. Finally, of these ninety now considering the use of bypass systems, twenty-nine had previously considered and rejected the use of bypass.

The eighty-nine bypassers were located in 35 states. Twenty-one of the states are represented by single bypass locations while 2 of the 35 states have 23 of the bypass locations in the completed sample. The bypass locations were typically part of multilocation firms, with only 5 being single location firms. The total number of locations ranged up to 700. Forty-seven of the bypass locations were headquarter locations. Employment at the respondent locations varied from 522 to

11,000 with a mean of 2,072. Thus, there was substantial variation among the bypassers regarding their location and size. The fact that the bypassers were not evenly distributed across the nation is to be expected since industrial locations are not evenly distributed. This lack of geographic uniformity has important policy implications. If additional regional or statewide surveys confirm this uneven impact of bypass, regional or state-by-state policies will be more effective than uniform, nationwide policies.

This lack of uniformity among bypassers was also observed with respect to telecommunications traffic patterns. There was no dominant pattern among the bypassers with respect to the percent of employees who use the telephone or the percent of calls that are incoming. Bypassers did tend to have more outgoing than incoming data transmissions (only eighteen [20 percent] reported that incoming data transmissions were more than 50 percent of total data transmissions), but there was still variability in the percentages reported. Finally, there was no prevailing pattern regarding the percent of the company's total bill generated at the bypass location. At most, the bypassers can be characterized as typically being part of a multilocation firm and tending to have more outgoing than incoming data transmissions.

The bypassers had average monthly bills from the telephone company in 1983 (excluding customer premises equipment) ranging from $500 to $12 million, with a median of $40,000. With few exceptions, these bypassers are clearly significant customers of the telephone company.

The bypass systems are used most frequently for voice communication, followed by voice grade data traffic. Only fourteen (15 percent) of the respondents who are bypassers use their systems for video traffic, and four use their bypass facilities only for video. Seventeen (19 percent) reported that 100 percent of their bypass traffic is long distance while eighteen (20 percent) said none of their bypass traffic is long distance. Eleven (12 percent) reported that 100 percent of their bypass traffic is intracompany, interlocation, while twenty-two (24 percent) said none of their bypass traffic is of this type. Thirteen (14 percent) reported that 100 percent of their bypass traffic is intralocation and twenty-nine (33 percent) reported that none is intralocation traffic. While it would be tempting to dismiss intralocation traffic as unimportant relative to long distance traffic in terms of its impact on telephone company revenues and plant utilizations, this would be a mistake. The impact of this type of traffic is a function of the number of buildings involved and the type of telephone company service being replaced. The loss of intralocation traffic of large customers could mean a significant reduction in the use of telephone company services. The detailed responses regarding the types and jurisdictions of traffic carried or bypass facilities suggest that the typical bypasser is using bypass for several kinds of traffic.

One of the major controversies surrounding bypass has centered around the reasons for bypass. Many contend that price is the reason, while others contend that bypass occurs primarily for nonprice reasons. There are two major questions to study relative to the role of price in the bypass decision. One is the question of which prices are influencing the bypass decision. The second is the question of what set of attributes is being purchased at a given price.

Economic theory tells us that price is not the sole determinant in a decision between two products except for the case of homogeneous or identical products. The choice between bypass systems and telephone company services is not a decision about identical products. These are products with varying degrees of product differentiation, and therefore it becomes important to discover what the consumer is choosing to buy at the price he is willing to pay. That is, what attributes of a communication system are important to the customer? The fact that price influences the decision is simply a statement that there is an upper limit to the amount that the customer is willing to pay for an attribute or, conversely, that there is also a price sufficiently low that the customer will forgo a set of attributes.

The NRRI survey reported here was designed to uncover the set of attributes that customers seek when the bypass decision is made. Therefore, several questions were asked of the bypassers regarding the factors that influenced their decision to bypass. The companies were read a list of six factors that have frequently been mentioned as important in the decision to bypass. They were asked to indicate whether each of these was "very important," "important," or "not important" in their decision. The six factors were:

1. Inability of telephone company to provide desired services (availability)

2. Greater reliability of bypass facilities (reliability)

3. Greater flexibility of bypass facilities (flexibility)

4. Concern over control, security, and/or privacy (security)

5. Price of telephone company services (price)

6. Stability of prices over time (stability)

Each of the factors named was considered very important by some respondent, and each was considered not important by some respondent. Price, as would be expected, was most frequently cited as very important (55 percent of bypassers); flexibility had the next highest frequency as a very important factor (46 percent), followed very closely by price stability (45 percent). Availability was cited as not important by more bypassers (42 percent) than any other factor, and 36 percent said security was not important. Seventeen percent said price was not important.

Given the assumption that the bypass decision was influenced by more than one factor, and in order to get additional insight into the relative importance that each factor plays in the decision to bypass, the bypassers were then asked to rank those factors that they considered either somewhat important or very important.

Sixty-four percent of the bypassers ranked price as one of the top three factors in their bypass decision. Flexibility was ranked as one of the top three factors by 42 percent of the bypassers; stability by 40 percent; reliability by 36 percent; availability by 29 percent; and security by 19 percent. While price, flexibility, and stability have been mentioned most frequently as being significant in the bypass decision, each of the other factors was considered important by substantial numbers of bypassers.

The respondents were read a list of telephone company prices and asked to indicate which were significant in their decisions to bypass. MTS rates, both state and interstate, were cited as influencing the bypass decision by fewer bypassers (15 percent and 26 percent respectively) than were nearly any other prices. State private line rates were cited by 40 percent; interstate private line rates by 36 percent; interstate WATS rates by 31 percent and intrastate WATS by 26 percent. Interestingly, 38 percent cited a proposed intrastate end-user charge as significant and 33 percent cited the interstate end-user charge. Various local service rates (including those for (1) Centrex, (2) PBX trunks, (3) local measured service, and (4) intracompany trunks, tie lines, and off-premises extensions were cited a total of 113 times, with each being cited by a significant percentage of bypassers.

The data show that several prices, including local service prices, are considered to be significant by bypassers, and there is no one pattern of prices that most frequently influences the bypass decision. A similar pattern exists for those nonbypassers who are currently considering bypass. Sixty-five percent cited intracompany trunks, tie lines, and off-premises extensions; 59 percent cited proposed intrastate end-user charges; 56 percent cited PBX trunks; 48 percent cited the interstate end-user charge; 44 percent cited intrastate WATS rates; 42 percent cited interstate private line rates; 38 percent cited local measured service; 34 percent cited interstate MTS; 32 percent cited intrastate MTS; and 23 percent cited Centrex rates.

These results point toward at least three considerations relative to policy options. One, that to view any one price as being responsible for bypass is faulty. Two, any attempt to adjust a given price (and consequently alter revenue requirements for other services) will risk retention of customers for one service at the expense of other services. Three, the number of times that local service prices were cited as significant suggests that local bypass is important and, therefore, deserves more attention than it has received in the past. Given the variety of prices that influence the bypass decision, it is not possible to manipulate any single price in order to forstall all bypass.

The conventional wisdom is that a company that bypasses reduces its use of all but the most basic local service. However, there is substantial question about the extent to which bypassers do, in fact, reduce their use of telephone company services. Therefore the survey contained questions designed to supply information on this issue.

While every telephone company service has been reduced by some bypassers, in no case have all bypassers with the equivalent service capability in their bypass system reduced their use of telephone company services. This might imply that some bypass systems have been built to accommodate either growth in existing customer needs or new services needed by the customer. It could also imply that existing bypass systems have excess capacity and therefore pose a future problem to telephone companies. Clearly more research is needed on the capacity and usage of bypass systems.

The use of intracompany trunks, tie lines, and off-premises extensions has been reduced by more bypassers than has any other type of service. This is understandable in light of the number of bypassers with local area networks. The revenue loss to the telephone company from these services is typically assumed to be less significant than the revenue loss from many other services. However, the full impact of these decreases cannot be measured without knowing the ways in which the bypass facilities are being used. To the extent that any of these bypass replacements for intracompany trunks, tie lines, and off-premises extensions result in reductions of local switched minutes of use, the effect could be significant. For example, a large factory with several buildings scattered over many acres, which had its own switch and intralocation trunks or lines, could carry all intracompany communications and significantly reduce the use of Centrex lines, PBX trunks, or other local lines. Similarly, banks with several branches or business locations with several buildings could achieve the same effect. The percentage of bypassers with local service capability in the system who have decreased their use of telephone company facilities suggests this may be happening.

The use of bypass facilities for toll services is particularly interesting since this is currently the focus of much of the public policy debate. The survey data show that in no case did all bypassers who had used a particular telephone company long distance service acquire bypass facilities capable of providing that service. With the sole exception of intrastate 56-Kpbs private lines, the percentage of users of telephone company private line services who have the equivalent capability in their bypass system is significantly higher than the percentage of users of MTS/WATS who have the equivalent capability in their bypass system. This would seem to imply that more bypass systems are being acquired to replace private line service than are being acquired to replace MTS/WATS services.

Typically, less than half of those who used a particular telephone company service acquired an equivalent capability in their bypass systems. Also, typically, 60 percent or more of the bypassers who did acquire an equivalent service capability reduced their use of telephone company facilities.

The reduction in usage of telephone company services was significant in many instances, although the overall nationwide impact is less significant. For example, two of the five bypassers who reported the percentage decreases in their use of state MTS services reduced their usage by 100 percent. These two bypassers represent 8 percent of bypassers who used state MTS services prior to acquiring their bypass facilities, and only 2 percent of all bypassers. Four of the twelve bypassers reporting the amount of decrease in usage of interstate OUTWATS reported a 100 percent reduction in use. These four bypassers represent 25 percent of those who reported their percentage decrease, 17 percent of those bypassers with the equivalent service capability, and only 4 percent of all bypassers.

The number of bypassers reporting various percentage decreases is too small to draw definitive conclusions. The data do suggest that there is considerable diversity in the degree to which bypass systems displace the use of telephone company services. Some bypassers substantially decrease their use of telephone company services, while others reduce their usage by limited amounts or not at all.

The fact that there appears to be no immediate overall effect from bypass should not be interpreted to mean that no policy responses are needed. What it does mean is that in many cases there is time to make reasoned adjustments in policy to adjust to the increased use by customers of competitive alternatives to telephone company services. How much time there is will vary among locales. In areas or services with large amounts of bypass activity the reaction may need to be prompt. The needed responses are easy to identify, but less easy to apply. A state commission would first identify the types and extent of bypass activity in its state and the reasons why it is occurring. This would determine the speed at which other responses should be taken. Then rate structures that ultimately reflect the costs of various services could be designed. These steps by both the telephone company and regulatory commissions would remove some of the causes of avoidable bypass.

Since there appears to be no single prevailing pattern to bypass activity and it appears to be developing at uneven rates across the country, the most logical policy approach would seem to be one that reflects the degree of development of competitive telecommunications markets in particular states and regions. A uniform national policy risks distorting market development. An alternative to the interstate end-user charge is to decrease interstate subscriber loop cost allocations. Such a change in cost allocations could reduce incentives for MTS/WATS bypass including direct connections between a customer's premises and an interexchange carrier, while at the same time allowing the state regulatory commissions the flexibility needed to tailor rate designs to reflect the actual status of market development in their states.

Most of the recent discussion regarding interexchange bypass has been based on its potential. As mentioned, the potential for local bypass is also great. Currently, most of the local activity is in intracompany trunks and lines, and in LANs. Yet there has been little analysis of the extent to which local loops and local switched traffic is being reduced by the use of local bypass systems, or even if there has been any reduction at all. It may be that currently most of the local bypass is in incremental traffic and is not in existing telephone company usage. However, recent trends in technological innovations create the potential for extensive local bypass, as switched voice communications are routed through private systems and private systems are developed that reduce the number of local loops needed. While some monitoring and study of residential drop-offs has been done (and should be continued), it is also important to begin to monitor and study changes in the way large business customers are using local telephone company facilities.

One long term result of this competitive activity may be a reduction in the necessary capacity of the telephone company's local service plant, in which case the regulators will be faced with difficult decisions regarding the "stranded" investments. Another possibility is that the total market for telecommunications services will grow, but the telephone company may, in the long run, be offering a different product mix.

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FOREWORD

The likely impact of competition on the viability of established telephone carriers has as one of its aspects the threat of bypass. This refers to the provision of telecommunications services without the use of telephone company facilities and has its counterparts in the natural gas and electric networks.

In this report we have attempted to identify the characteristics of companies that bypass and their reasons for doing so. We believe a strength of this report is its substantial empirical base--a nationwide random sample of large manufacturers (in seven hundred locations) and of large financial institutions (in three hundred locations). The authors draw certain conclusions from these data that will be of particular interest to all parties to the bypass debate--the data are rich enough for others to perhaps make additional findings.

As with most of our studies and reports, the main object is to help elevate the discussion and shed light on current policy issues in the fixed utilities field.

Douglas N. Jones
Director
December 31, 1984

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CHAPTER 1

THE BYPASS CONTROVERSY

Introduction

Bypass is a phenomenon whereby customers meet their communications needs through private facilities and therefore do not utilize established telephone company facilities. While bypass is not a new phenomenon, in the past two years there has been intense public debate over the extent of bypass and the appropriate policy responses to bypass.

This project was undertaken to supply answers to the following questions:

1. Why is bypass occurring?
2. To the extent that telephone company prices are a factor in the bypass decision, which service prices are significant?
3. What telephone company services are being displaced by bypass facilities?
4. To what extent is the use of these telephone company services being reduced?
5. Who is bypassing? That is, what are the corporate and communications traffic characteristics of bypassers?

The answers to these questions are viewed as necessary information for determining optimal policy responses to bypass.

In addition to answering these primary research questions, the project had the following objectives:

1. To provide information on bypass technologies which would serve as educational and reference materials for regulatory commissions

2. To provide background material on the policy issues that result from bypass, including those issues that have already been identified and issues that may be delineated by the answers to the research questions

3. To identify additional areas of study that may be needed to fully understand and respond to bypass

Historical Developments

Since the early part of this century the telephone industry has been characterized by a monopoly market structure in the provision of customer premises equipment, local network services, and long distance services. There was an underlying belief that the cost structure was one of decreasing costs and that social welfare would be maximized with a regulated monopoly structure. Technological advances in recent decades combined with increasingly diverse customer needs led to a reconsideration of the merit of a monopoly structure for all segments of the telephone industry.

Federal Communications Commission (FCC) decisions in three well-known major dockets opened the door to competition in network services. These were the *Above 890* decision,[1] the *MCI* decision,[2] and the *Specialized Common Carrier* decision.[3] The *Above 890* decision allocated frequencies in the bands above 890 MHz to various user groups. In particular, it liberalized the rules regarding the licensing of privately constructed (non-carrier) point-to-point microwave systems. Thus, non-telephone companies could construct microwave systems to carry their own communications traffic.

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[1] *In the Matter of Allocation of Frequencies in the Bands Above 890 Mc*, *Report and Order*, 27 FCC 359 (1959).

[2] *In Re Applications of Microwave Communications, Inc., Decision*, 18 FCC 2d 953 (1969).

[3] *Specialized Common Carrier Services*, *First Report and Order*, 29 FCC 2d 870 (1971).

The MCI decision granted MCI the right to construct facilities to provide point-to-point microwave communications between Chicago and St. Louis and to sell the use of these facilities to private businesses. Thus, the first carrier competition in the provision of long distance telephone services was authorized.

The Specialized Common Carrier decision allowed new carriers to offer "specialized" services in competition with the telephone companies, though the order did not define specialized services. Competing carriers were established and, in time, began offering services that were functionally equivalent to MTS/WATS services.[4] These events culminated in the Report and Third Supplemental Notice of Inquiry and Proposed Rulemaking in the FCC's Inquiry into the MTS-WATS Market Structure.[5] In this report the FCC determined that a policy of open entry for all states but Alaska should be followed in the market for interstate MTS-WATS services and their functional equivalents. A decision on the Alaskan market was delayed to allow for further comments.[6]

Each of these three decisions created a break with the traditional regulated monopoly market structure, and each was accompanied by considerable controversy and concern on the part of both the regulated telephone companies and various state regulatory bodies. One consistent focus of concern was the impact on telephone company revenues due to any reduction in services sold, a consequent increase in telephone rates, and a subsequent threat to universal service at affordable prices.

The Report and Order in the Above 890 decision summarizes comments by interested parties to numerous issues relevant to the allocation of frequencies. For example, as issue no. 7, the FCC asked the question,

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[4]MTS/WATS is message toll service and wide area telephone service.

[5]MTS/WATS Market Structure, 81 FCC 2d 177 (1980).

[6]Ibid., at para. 146, 149.

> What effect would the authorization of private point-to-point systems where common carrier facilities are available have on the ability of the common carriers to serve the general public and, if such effect is detrimental, the specific nature, extent and magnitude of such detriment?[7]

The FCC said the following in its summary of the comments:

> The Bell System witnesses contended that to permit the licensing of private 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 indispensable in times of national emergency. Also, they claimed that widespread licensing of private systems would not only increase the cost of communications to the Nation's economy as a whole, but would cast an added burden upon the individual and the small businessman who would continue to rely on common carriers. This would cause either (1) a drastic revision of rate schedules, or (2) great financial harm to the carriers, or (3) a combination of both.[8]

Similar comments were filed in the proceedings leading to the MCI decision. That is, the regulated carriers contended that the entry of Other Common Carriers (OCCs) such as MCI would result in "cream skimming." The OCCs would have no obligation to provide nationwide service and, thus, would choose to offer services for high density, low cost routes. This, in turn, would result in higher costs to customers remaining with the regulated carriers. The decision includes the following (paragraph number 21) in summarizing the positions of the various parties to the docket.

> The carriers argue that even if lower rates for MCI communications services have been shown, that factor may not properly be considered in resolving the issue of need. They assert that they are required by the Commission to serve both high-density high-profit and low-density low-profit areas and in order to maintain rates which are relatively uniform, all rates are based on a cost averaging principle.

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[7]Above 890, 27 FCC 359 at 387.

[8]Ibid., at 388.

Claiming that MCI is "cream skimming," i.e., proposing to operate solely on high density routes where lower fixed costs per channel permit lower rates with higher profits, the carriers state that in order to compete with MCI they will be forced to abandon their cost averaging policies with a resultant increase in rates for subscribers on lightly used routes.[9]

The FCC response to these arguments in paragraph 22 was:

MCI is offering a service intended primarily for interplant and interoffice communications with unique and specialized characteristics. In these circumstances we cannot perceive how a grant of the authorizations requested would pose any serious threat to the established carriers' price averaging policies. Lower rates for the service offered is not the sole basis for our determination that MCI has demonstrated a need for the proposed facilities, but the flexibility available to subscribers, and the sharing and the part-time features of the proposal have been considered to be significant factors as well. The case of WADS. 35 F.C.C.149 (1963), cited by Bell is therefore inapposite. Here the potential demand for the new service is not generated solely by reason of lower rates for a like service but because there is a "need for service which, if not met, would result in a serious deficiency in the communication services available to the public" (35 F.C.C. at 155). It may be, as the telephone companies and Western Union argue, that some business will be diverted from the existing carriers upon the grant of MCI's applications, but that fact provides no sufficient basis for depriving a segment of the public of the benefits of a new and different service.[10]

The First Report and Order in the Specialized Common Carrier docket includes the following in its "Description of Representative Applications and Opposition Pleadings":

AT&T states that applications of the type filed by the MCI carriers and others cannot be regarded as an isolated experiment, but rather necessitate a Commission determination of "basic and important policy questions regarding future development of common carrier communications services throughout the United States." In connection with MCI-New York West's applications, AT&T summarizes its position as follows:

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[9]Microwave Communications, Inc., 18 FCC 2d 953 at 960.

[10]Ibid., at 960, 961.

> MCI-NY West's proposal and others like it confront the Commission with basic policy questions regarding the future development of common carrier communications services. They would offer to serve only limited segments of business users in certain selected cities, without concern for the deleterious impact this might have on the other business and residential users who are subscribers of the existing common carriers. Such proposals, if granted, would seriously undermine the policy of uniform interstate rates and dilute or delay the benefits that economies of scale would otherwise make available to the general telephone-using public. Moreover, the authorization of such proposals would result in harmful electrical interference to existing common carrier routes, inefficient and under-utilization of scarce common carrier facilities, to the detriment of the general public. As shown above, there is no demonstrated unfilled public need for MCI-NY West's incomplete and inadequate proposal or for the network of which it would be a part. Existing common carrier facilities are more than adequate to meet the public need and the existing carriers stand ready to serve any additional need which may be found to exist in the future.[11]

It is apparent from the documents cited above, that each step in the opening of the telecommunications market to competitive market forces has been accompanied by serious concern about the viability of the nationwide telephone system and of universal service at affordable rates. These concerns have been voiced, at one time or another, by both regulatory agencies and established carriers. Currently there is a new focus for that concern--the bypass issue. Bypass refers to the process of providing telecommunications services without the use of an established telephone company, i.e., the customer "bypasses" the telephone company.

Bypass gained most of its recent prominence as a result of the FCC access charge decision. In its Third Report and Order[12] the FCC established a new system for interexchange carriers to compensate local

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[11]Specialized Common Carrier Services, 29 FCC 2d 870 at 876.

[12]MTS/WATS Market Structure, 93 FCC 2d 241 (1983).

companies for interstate use of local exchange facilities. This new system consists of a series of access charges composed of three categories: the carrier common line element, the traffic-sensitive elements, and an end-user charge. The end-user charge was designed to allocate, over time, the interstate share of subscriber loop costs to the end user in a flat rate. The FCC stated its belief that collecting subscriber loop costs on a usage basis results in heavy users subsidizing light users, since these loop costs are typically considered to be nontraffic sensitive.[13] This result was believed to contribute to "uneconomic" bypass, or bypass occurring because the telephone company services are priced above their relevant costs and thus are not competitive with private systems. The FCC believed that by shifting these costs to the end user the potential for uneconomic bypass by large users of interstate toll services would be reduced.

State regulatory commissions, consumer representatives, many small and rural telephone companies, and others voiced concern over the end-user charges because of the potential impact on universal service. Their concern was that if all subscriber loop costs were allocated to end users, the total cost of telephone service would be raised significantly for subscribers who make limited or no use of the toll services, and consequently customers would "drop off" the network.[14]

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[13]These costs are typically considered to be nontraffic sensitive because of the contention that the costs do not vary with the number of calls. Recently there has been some debate, as yet unresolved, with respect to this. For example, it has been contended that the calling pattern of a neighborhood affects the investment in line concentrators and other equipment on the local loop. Additionally, remote switches can be used for certain traffic patterns, and thereby reduce the length of the local loop. Moreover, there is a contention that insufficient purchases of local loops by a customer will cause congestion throughout the network as calling parties get busy signals. These considerations raise questions about the degree to which switching and loop costs are interchangable, and therefore the extent to which loop costs are nontraffic sensitive.

[14]The assumption is that the shifting of these costs to end users will result in lower toll rates which would, for those customers who make a sufficient volume of toll calls, result in sufficient savings to offset the end-user charge.

The toll carriers and large local telephone companies argued that the loss of large business customers to bypass systems would have an even more serious impact on universal service. Consequently a shrinking customer base would be responsible for a larger share of telephone company costs. The underlying assumptions were that telephone company costs would not decrease in the same proportion as would revenues, and that bypass by large users of interstate MTS/WATS services is more significant than is bypass by users of other services. Largely because of the public debate which followed the issuance of the access charge order, imposition of the end-user charge on residential and single line business customers has been delayed. Multiline business customers are currently paying a maximum $6.00 per line end-user charge.

Much of the ensuing debate has focused on the bypass issue, the extent of current and future bypass and its impact on telephone companies.

The literature available on bypass at the time this study was begun was limited. It consisted primarily of an appendix in the Third Report and Order, FCC CC Docket 78-72; testimony filed in various state commissions; and trade reports and newsletters by suppliers and consultants in the bypass industry. Since that time the FCC has issued a Public Notice[15] calling for studies and data on bypass and comments regarding various bypass issues. As a result of this request several comments and some additional studies have been submitted to the FCC.

The many submissions included comments by customers and customer groups regarding their use of both telephone company and bypass facilities. Comments were also received from telephone companies that included discussions and data on the amount of bypass and the amount of revenue estimated to be vulnerable to bypass. Some commentors submitted economic models of the potential impact of bypass.

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[15]FCC, Public Notice 3206, released March 28, 1984.

Three models based on nationwide effects of bypass were submitted.[16] They included (1) a model constructed by the United States Telephone Association (USTA) that estimated nationwide and regional telephone company vulnerability to bypass under existing MTS cost recovery programs; (2) a model submitted by Bell Communications Research (Bellcore) that estimated the impact on ratepayers of both an end-user charge and no end-user charge, calculated as a function of potential bypass, tariff shopping and resale; and (3) a model devised by Gerald W. Brock of the FCC's Office of Plans and Policies that was designed to estimate whether an equilibrium level of access charges at which no further bypass would occur was attainable, and, if so, under what conditions.

The USTA study was based on data received from telephone companies representing 77 percent of all access lines in the country. The study estimated the theoretical maximum vulnerability to bypass on the assumption that all customers with existing toll costs greater than the study's estimated circuit cost for bypass would leave the public switched network. The study concluded that 40.5 percent of the nationwide business customer base was vulnerable to bypass and 21.2 percent of the nationwide residential customer base was vulnerable to bypass. The study also reported bypass vulnerability on a regional basis and the results indicated variability among the regions in the percentage of customers vulnerable to bypass. In addition, the study reported bypass vulnerability by company size and indicated that all companies have bypass vulnerability, either through loss of customers to bypass or reductions in the National Exchange Carriers Association carrier common line pool as a result of bypass in other telephone company areas.[17]

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[16] A computer simulation analysis of one serving area of a GTE operating company was submitted by GTE. This analysis reported on the potential for business customers using message toll services to move to dedicated facilities. See: Comments of GTE, FCC CC Docket 78-72, May 1984.

[17] United States Telephone Association, Bypass Study, FCC Docket No. CC 78-72 October 5, 1984.

The Bellcore paper utilizes a customer choice analysis to measure the vulnerability of access charge revenues to bypass and tariff shopping, and another model to quantify the amount of BOC revenue vulnerability to resale. The analysis concludes that without end-user charges, "total BOC access revenue vulnerability (both NTS and TS) for the nation as a whole averages approximately $16.50 per month per access line." With end-user charges averaging $3.81 per month per line, consumers will "derive a potential economic value of an average of $9.19 per subscriber line per month" consisting of a $5.65 reduction in NTS revenue vulnerability per line, $1.74 savings in toll rates, and $1.80 in economic welfare gains. Total consumer benefits are estimated to be $5.38. That is, $9.19 minus $3.81.[18]

The model assumes customers will choose the least-cost alternative while maintaining the existing grade of service, and that there is sufficient capacity on the part of the interexchange carriers to serve all customers who wish to connect directly to the interexchange carrier's point-of-presence.

The Brock paper presents a model which was designed to determine what, if any, was the equilibrium level of access prices at which the revenue requirements would be met and no further bypass would occur. Under assumptions that the nontraffic-sensitive (NTS) revenue requirement is fixed, and that the traffic-sensitive (TS) revenue requirement varies with changes in usage, a 70 percent increase in access charges is needed to meet the 1984 NTS revenue requirement, if the elasticity of demand is -0.75. With an elasticity of -0.5, only a 56 percent increase is needed, but with an elasticity of -1.0 a 93 percent increase is needed. These data are based on the assumption that both incoming and outgoing calls are subject to bypass. If only outgoing calls are subject to bypass, then a 34 percent increase in access charges would be needed, with an elasticity of demand equal to -0.75.

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[18]Bell Communications Research, Inc., The Impact of End User Charges on Bypass and Universal Telephone Service, FCC Docket No. CC 78-72 September 1984.

Under the assumption that both the NTS and TS revenue requirments are fixed and must be recovered from toll users, and with an elasticity of -0.75, a 121 percent increase in access charges is needed. With an elasticity of demand of -0.5, a 75 percent increase is needed. If the elasticity is -1.0, then there is no reasonable level of access charges which will achieve the equilibrium.[19]

This is an equilibrium model and does not incorporate the possibility of change in any of the factors currently influencing either bypass or the use of established telephone company services. It assumes that all customers with sufficient traffic volume to justify bypass will do so.

These models all assumed bypass was a function of price only and dealt with the theoretical maximum amounts of bypass under specified cost conditions for bypass circuits. They did not examine the effect of end-user charges on bypass of local service. They did not allow for offsets to the impact of bypass from growth in demand by nonbypass customers. These models deal only with the potential for bypass and consequently are not further discussed in this report.

Survey results submitted to the FCC by the International Communications Association are briefly summarized in a later section of this chapter.

Definitions of Bypass

One of the more difficult aspects of the bypass controversy is the question of how bypass should be defined. The difficulty is illustrated by the fact that the FCC Public Notice requesting information on bypass also asked for discussions relating to the "appropriate functional and jurisdictional definition(s) of bypass." There have

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[19]Gerald W. Brock, Bypass of the Local Exchange: A Quantitative Assessment, (Office of Plans and Policy, Federal Communications Commission, September 1984).

been many definitions of bypass used in public discussions. Some examples of the various definitions follow:

1. "The use of communications facilities or services (video, voice, or data) which go around the local telephone exchanges of the public switched network."[20]

2. "The origination and/or termination of a call without the use of a local telephone company's plant."[21]

3. The International Communications Association (ICA), in a survey of its members, defines bypass as the use of customer-provided communications systems (CPCS). CPCS is defined to mean "a system that is owned or leased by a company or shared with another firm that is not principally engaged in providing any telecommunications service or equipment for sale or lease to others...This term is meant to exclude customer-provided Local Area Networks (LANs) that exist wholly within one building or within contiguous buildings occupied by the same company."

   Using "customer-provided communications system" as the basic definition in the survey also effectively excluded any bypass system that might be offered by another common carrier in competition with the carrier providing the displaced transmission service.[22]

4. The United States Telephone Association (USTA) contends that bypass "occurs whenever there is avoidance of the public switched network whether by local exchange carriers, other carriers, or customers." This definition, therefore, includes the use of telephone company private lines as a form of bypass.[23]

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[20]FCC, Third Report and Order, Docket No. CC 78-72, Appendix F, p. 5.

[21]Testimony submitted to the Wisconsin Public Service Commission, by Joseph Kraemer, Touche Ross & Company, Docket No. 6720-TR-36 (1983).

[22]International Communications Association, Report on Customer-Provided Communications Systems, FCC Docket No. CC 78-72 (May 1984) p. 8.

[23]Donald L. Hirt, Presentation on Bypass, United States Telephone Association, before the NARUC Subcommittees on Communications and Cost Allocations, (July 1984).

5. The Utilities Telecommunications Council (UTC) suggests that bypass could be defined as "the provision of telecommunications service without the use of PSTN [public switched telephone network] plant, in those situations where the PSTN is capable of providing the telecommunications service needed by the user."[24]

6. The functional definition of bypass is "any transmission path between a customer premise and a point of presence that does not use PSN facilities." This definition includes the use of the exchange carrier's own dedicated facilities and is consistent with underlying neoclassical economic principles.[25]

The definitional problem is further complicated by attempts to define subcategories of bypass. One such subcategory is bypass of the local exchange company as opposed to bypass of the interexchange network. This is, in practice, a difficult subcategory to sustain in that bypass of the interexchange carriers can also result in bypass of local company access facilities. To the extent that any party focuses attention only on bypass of toll services, the broader problems of local companies become miminized and risk being overlooked.

The most frequently discussed subcategory is that of economic versus noneconomic bypass. Economic bypass is generally defined as bypass that occurs even though telephone company services are priced at cost and noneconomic bypass is bypass that occurs because telephone company services are priced above relevant costs. This is, of course, an important distinction. To the extent that bypass occurs in those services that are overpriced, that is, occurs because of high telephone company prices, the appropriate policy response is clear. The telephone company prices should be reduced to the level of relevant costs.

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[24]<u>Comments of the Utilities Telecommunications Council</u>, FCC Docket No. CC 78-72, (May 18, 1984) p. 3.

[25]<u>Comments of GTE</u>, FCC Docket No. CC 78-72, (May 1984) p. 10.

However, important though it is for delineating this aspect of the bypass "problem," the distinction between economic and noneconomic bypass is troublesome in practice. A major difficulty lies with trying to apply the definition. There is no way of knowing whether the price of the competing service has been set at cost, or whether it has been underpriced in order to gain entry into a new market. Further, there is no way of knowing whether all associated costs of a private system have been identified by the bypasser. More important, it is difficult to determine definitively, what are, in fact, the relevant costs for any given telephone company service.

The telephone company services subject to bypass typically incur common costs, so the question of the allocation of common costs becomes a significant issue in determining cost-based rates. However, there is no definitive method for the "correct" allocation of common costs. In fact, there are many articles in the economics literature which discuss alternatives for the allocation of common costs. These alternatives include, among others, allocation based on price elasticities of demand, on relative usage, on opportunity cost, and on applications of game theory. Given the inability of economists to reach agreement on this issue, it is likely that practical applications of cost-based pricing can, at best, achieve only a range of reasonableness in the costs assigned to each service. Nevertheless, it is important that regulators examine rate structures to identify any obvious cross subsidies among services facing competitive forces.

Further, the "correct" cost of any given telephone service is likely to vary with many factors such as subscriber density, peak usage period, length of subscriber loops, technological characteristics of equipment, the specific communication needs of customers, and the regulatory constraints in place. These factors vary across the nation and often within a franchise service area. Therefore, a determination that uneconomic bypass has occurred requires thorough understanding of cost factors for each area. Uneconomic bypass may be capable of being recognized only in the presence of the most blatant cross subsidies.

Finally, when defining an instance of bypass as economic or uneconomic, it seems unrealistic to look only at the relative price levels of the alternative services. The major problem is that it is unlikely that a private system will be precisely equivalent to the service provided by the telephone company. Therefore, the relevant decision point is the relative merits of the total package of services available from the telephone company for one price versus that which is obtainable from a private system at another price. There will be considerations other than price that enter the decision when differentiated products are being compared. These include comparisons of the technologies involved and the service reliability of the suppliers. They also include consideration of the value attached to the full range of objectives of the customer. For example, in addition to meeting specific communication needs, the customer may be seeking broader objectives such as resale opportunities or the ability to foreclose a competitor's opportunities by acquiring available spectrum. Factors such as these all play a part in a business's decision regarding the profitability of bypass and affect the determination of whether to engage in bypass.

For all the foregoing reasons, this report makes no attempt to distinguish between economic and noneconomic bypass in its analyses. This should not be interpreted as a belief by the authors that the issue is irrelevant. In fact, it is particularly important in the new competitive environment that telephone rate structures as well as overall telephone company costs be thoroughly examined.

A more useful distinction might be "market-generated or unavoidable" bypass versus "nonmarket or avoidable" bypass. Unavoidable bypass would be viewed as the "natural outcome" of both the procompetitive policies of recent years and the continuing advances in technology. Avoidable bypass would include noneconomic bypass, as defined above, as well as the following types of bypass: (1) bypass that occurs because the overall level of company costs is too high, which may mean the market is not strong enough to elicit cost containment policies on the part of the telephone company; (2) bypass that occurs because the telephone company's reliability and quality of service are different from those offered by competitors, which may mean the market is not strong enough to force increased concern for customer needs;[26] (3) bypass that occurs because the service is not available or is perceived to be unavailable, where the unavailability is the result of either unaggressive marketing on the part of the telephone company, or regulatory restraints that prevent the telephone company from offering the service; and (4) bypass that occurs because the telephone company is unable to respond adequately or in a timely manner due to unnecessary regulatory constraints.[27] This more broadly defined dichotomy of bypass as avoidable or unavoidable bypass implies the need for broader policy responses geared to preventing avoidable bypass, and places responsibility for responding to avoidable bypass on both the regulator and the regulated company.

As to the broader question of an appropriate definition of bypass itself, it is the contention of the authors that any such specific definition is likely to mislead policy discussions by creating too narrow a focus. While any one of the definitions in use has value for measuring a specific type of bypass, the use of privately supplied telecommunications systems is simply another source of competitive

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[26]It should be noted that there can be instances of bypass due to differences in the telephone company's reliability or quality of service which are, in fact, instances of economic bypass. For example, when telephone company services are correctly priced and meet prescribed service quality standards, there may still be competitors who, by seeking out particular market niches, are able to deliver greater reliability or responsiveness to customer needs.

[27]This definition of avoidable or nonmarket-generated bypass includes the assumption that with product differentiation, there will not be perfectly competitive markets. It could be argued that types (2) and (3) could be merely examples of product differentiation and hence fall in the category of traditional market phenomena. Here, however, we are distinguishing as "avoidable" that bypass which does not result from considered judgments regarding services to offer and markets to pursue.

pressure in the telecommunications market and should be viewed as such. To attempt to apply a particular nomenclature, such as "bypass," creates the impression that a specialized problem has been found for which a specific solution is possible. In fact, as the results of the survey reported in this study show, the problem is much broader.[28] Competitive sources are emerging for virtually all types of telephone company services.

The results of the survey conducted as part of this study indicate that business customers are finding ways to replace nearly every type of service previously supplied by the telephone company. Just as the term "customer-provided" equipment was once used to designate customer-premises equipment that was privately supplied, a similar term is needed to describe the switching and transmission services that can now be privately supplied. Yet, in point of fact, today's technology begins to blur the distinction between CPE and transmission and network services, so any such definition could have only a short useful life. At any rate, failure to view this issue as one of emerging competitive forces risks policy decisions that retain one group of customers while inadvertently encouraging other groups to leave the network, and may distort the growth pattern of the emerging market forces.

Significance of the Bypass Issue

Bypass has existed to some extent for many years, particularly in long distance communications. Prior to the *Above 890* decision, private microwave systems were used typically by public safety organizations; utilities, such as pipelines and railroads that own rights of way; and by private businesses with communications needs that could not be met by the common carriers. The *Above 890* decision resulted in an expansion of

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[28] See chapter 4.

private microwave systems to other businesses including those with needs that could have been met by the common carriers. So bypass is not a new phenomenon. It has, however, taken on new significance recently. As previously mentioned, this is due primarily to rapid technological change, the new regulatory environment and industrial structure for the telecommunications industry, the FCC access charge decisions, and the impact on local rates of other FCC decisions.

The rapid technological advances of recent years have given increased impetus to the use of bypass facilities. The cost per channel of satellite and microwave systems is falling and other technologies are being developed. Bypass is becoming a viable alternative for growing numbers of customers. Changing technologies have made it possible for users of telecommunications services to use private facilities or those of new carriers--including cable television companies--to connect themselves directly to telephone company central offices, earth stations of interexchange toll carriers, and even other end users in the local area, without relying on telephone company facilities. In addition, today's regulatory environment and industrial structure promote the growth of competitive market forces. Thus the increasing use of bypass facilities is one reason that bypass is a focus of policy debates today.

The FCC end-user access charge would increase the price of basic telephone service in an effort to reduce toll rates and blunt the growth in toll bypass. However, state regulatory commissions generally have expressed great concern over this policy because of its potential impact on local users of the network. Many questions have been raised regarding the probable extent of bypass and the reasons for it. The state commissions' concerns over the end-user charge and bypass were heightened by earlier FCC decisions that had the effect of raising local rates. These included the expensing of inside wiring, deregulation of customer premises equipment, and changing depreciation rates. The AT&T divestiture also created pressures for increased rates due to the reduction in toll revenues for Bell Operating Companies, among other reasons.

In 1983, therefore, the state regulatory commissions were faced with several forces creating upward pressure on local rates and calling for restructuring of local rates. The local companies were facing emerging competition for many services, the federal access charge was altering traditional compensation methods for interstate toll, intrastate access charges needed to be developed, and the industry structure was being reorganized in the wake of divestiture.

The primary concern over bypass relates to the extent to which large users use, or are planning to use, privately supplied communications facilities. Where telephone company services are replaced by private systems, there is the threat of idle telephone company plant and a consequent need to recover the costs of the idle plant. (This is called "stranded plant" and is discussed in chapter 6.) The bypass potential creates both short run and long run problems for regulators. In the short run, as customers bypass the local or toll networks, the unavoidable cost of existing facilities may be spread over a shrinking customer base. This raises concerns about the ability to maintain universal service due to the resulting increases in rates. These rate increases, in turn, may lead to further bypass.

In the longer run the potential for bypass raises problems associated with competition in the local loop and managing the transition from a monopoly environment to a competitive market. It is particularly important that the transition to competitive markets be handled in such a way as to balance the need for universal access to basic telephone service, the need to avoid distorting market development, and the need to avoid deterring technological advances.

Summaries of Four Other Surveys of Bypass Activity

An important question in the bypass debate has been the extent to which bypass systems are used today. One of the early surveys of telecommunications users was done by the FCC and was released as an appendix to the Third Report and Order, Docket 78-72. Touche Ross &

Company has surveyed large users in many states since the Access Charge Order was released. Bethesda Research Institute conducted a study of local bypass in New York, on behalf of the Committee of Corporate Telecommunications Users. In response to the FCC's Public Notice requesting information on bypass, several parties submitted comments that included various data on bypass activity, and one of the more widely discussed submissions included the results of a survey of the membership of the International Communications Association.

Summaries of these four surveys are contained in the following subsections. They tend to differ from this report in two major ways. One, the primary objective of some of the other surveys was to estimate the extent of bypass, while the primary objective of the NRRI survey was to identify the reasons for bypass and the services in which bypass is occurring. Two, typically the other studies reported results for a specific geographic area or organizational membership rather than a random sample. This project surveyed a nationwide random sample of two major industrial classifications--manufacturers and financial institutions. The combined results of all the studies should help to answer some of the many questions involved in the bypass controversy.

Third Report and Order, FCC Docket No. CC 78-72

The material in appendix F of the Third Report and Order[29] was collected by the FCC Common Carrier Bureau from a literature search plus telephone interviews with users, suppliers, and others. There was no intent to do a statistical study based on a random sample. The report contains data and information on large users only.

The report states that large financial organizations, "distributors or manufacturers with national or international distribution networks,

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[29]FCC Third Report and Order, "Status Report on Near Term Local Bypass Developments," FCC Docket No. CC 78-72 (93 FCC 2d 241) Appendix F.

aerospace firms, government and educational institutions, and the transportation industry tend to lead in the use of bypass."[30] The firms that bypass tend to have high communication bills, information handling costs which are high relative to operating expenses, a concentration of traffic, heavy usage of high speed data facilities, and tend to use, or plan to use teleconferencing.

Increasing communication costs are cited as a major reason for bypass, and specific mention is made of the increases in rates for private lines. Other reasons cited for bypass are a need for flexibility, the quality and reliability of telephone company services, and the unavailability of some services such as wideband (T-carrier) services.

Touche Ross & Co. Reports

Touche Ross performed a series of studies of bypass for most of the Bell Operating Companies and some non-Bell companies. The results of these studies were presented by Dr. Joseph S. Kraemer in hearings at various state public utility commissions. The Touche Ross studies typically involved either on-site or telephone interviews with generally the one hundred largest customers of each telephone company.

While results varied from state to state, the results published by Touche Ross in Bypass of the Local Exchange: The Five Great Myths and the Realities of Competition are said to be "generally representative of what we have found nationally."[31] The report presents results from studies in Wisconsin, Ohio, and Michigan. Table 1-1 summarizes some of those results.

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[30]Ibid.

[31]Joseph S. Kraemer, Bypass of the Local Exchange: The Five Great Myths and the Realities of Competition, (Washington, D.C.: Touche Ross & Co., 1984).

TABLE 1-1

SELECTED RESULTS FROM TOUCHE ROSS STUDIES OF BYPASS

State	Number of Respondents	Percent of Respondents Currently Bypassing	Percent of Respondents Considering Bypass
Michigan	106	25	28
Ohio	105	30	33
Wisconsin	98	16	22

Source: Joseph Kraemer, (Washington, D.C.: Touche Ross & Co., 1984) Bypass of the Local Exchange: The Five Great Myths and the Realities of Competition

The Touche Ross study also reports that in these same three states between 74 and 83 percent of the customers cited equivalent service at lower cost as the primary reason for bypass.

International Communications Association, Report on Customer-Provided Communications Systems

The International Communications Association (ICA) membership consists of more than five hundred business, institutional and government organizations, each of which spends a minimum of one million dollars a year on telecommunications products and services. The ICA conducted a survey of its members regarding bypass-related issues.[32] The survey results were compiled and analyzed by Economics and Technology, Inc. As mentioned earlier the ICA definition of bypass excluded intrapremises or intrabuilding communications systems as well as any bypass system offered by another common carrier. Their report contains the results of the responses from 187 members that were received by May 7, 1984. Among the survey results are:

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[32] Comments of the International Communications Association, FCC Docket No. CC 78-72, (1984) pp. 15, 17, 21, 29.

1. Twenty-nine percent of the respondents use a bypass system as defined by ICA

2. Fifty-three percent of the respondents are considering using such a system

3. Those respondents currently using a bypass system reported that an average of less than 15 percent of their total usage of United States domestic tranmission services of all types was carried by bypass systems

4. Thirty percent of those using a bypass system reported that their point-to-point systems neither replaced primarily local services nor replaced primarily inter-LATA services

5. Eighty-nine percent of the bypassers reported that the company had realized improvements in service quality

6. The bypassers reported that an average of 42 percent of their systems were used for telecommunications applications believed not to be available from the telephone company at the time of installation of the system

7. Forty-two percent of the bypassers reported savings of more than 50 percent on intra-LATA systems, and 21 percent reported savings of less than 10 percent or none

8. Sixteen percent of the bypassers reported savings of more than 50 percent on inter-LATA systems, and 31 percent reported savings of less then 10 percent or none

Bethesda Research Institute, Study of Local Bypass--Final Survey Results

The Bethesda Research Institute undertook a study of local bypass in New York State on behalf of the Committee of Corporate Telecommunications Users (CCTU). The survey results were submitted to the New York Public Service Commission.[33] CCTU members surveyed included "companies

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[33] Bethesda Research institute, Study of Local Bypass--Final Survey Results, Submitted to the New York State Public Service Commission, Case No. 28710, June 1984.

and organizations in the telemarketing, hospital care, rental car, publishing, advanced education, and banking and other financial industries."[34] The results of this survey include (emphasis in the original):

1. "Responsiveness to customer "needs" (e.g., availability, flexibility, reliability) is the most important factor in making these types of decisions.[35]

2. Other significant criteria are maintenance, technical quality of service, and experience of the company.[36]

3. Least important are reputation of the company, user control, financial resources and "staying power" of the company, price, large start-up investment, statewide presence, and lastly, innovation performance (system features).[37]

4. If New York Tel and a bypass provider offer equivalent nonprice features, then the telephone company would probably receive the user's business if its "price" is 5 percent higher. However, when the telephone company's "price" is 10 percent higher, the bypass provider would capture the business.[38]

5. If all nonprice features were equivalent except that New York Tel's responsiveness to customer "needs" was perceived to be superior to that of the bypass provider, a telephone company "price" of 5 percent higher would still generally cause the user to subscribe to that company's service. A 10 percent "price" differential in this case would also give the business to the BOC.[39]

6. If the 5 and 10 percent "price" difference were accompanied by a superior New York Tel technical service quality, all other things equal, the typical corporate user would obtain his local service from the telephone company.[40]

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[34]Ibid., p. 3.

[35]Ibid., p. 6.

[36]Ibid.

[37]Ibid.

[38]Ibid., pp. 7, 8.

[39]Ibid., p. 8.

[40]Ibid.

7. Respondents indicated that a 5 percent "price" disavantage for the telephone company would be more than offset by a superior innovation performance by New York Tel. However, a 10 percent differential would cause the user to embrace the bypass provider's offering.[41]

Objectives and Organization of This Report

The primary objectives of this project are to supply needed data and to offer a perspective on the bypass controversy. The study covers three areas: bypass technology, data collection, and policy responses--with the major focus on data collection regarding bypass usage.

Chapter 2 contains a review of current bypass technologies and a discussion of the potential uses of each.

The data section of the project focuses on responses to a telephone survey of a nationwide random sample of 394 large manufacturing and 167 financial institution locations. The survey methodology, sample selection, and some survey results are discussed in chapter 3. The results of the survey regarding the characteristics of bypassers, the reasons for bypass, and the services in which bypass is occurring are reported in chapter 4. A forecasting model developed from the survey results is presented in chapter 5. Policy responses to bypass activities are discussed in chapter 6.

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[41]Ibid.

CHAPTER 2

AN OVERVIEW OF BYPASS TECHNOLOGIES AND THEIR APPLICATIONS

Introduction

Among the major bypass technologies are microwave, satellite, fiber optics, CATV, teleports, local area networks, cellular mobile telephone, and digital termination systems. This chapter treats applications of each bypass technology, so that the policy maker can have a better understanding of how bypass systems are used in a communications network. A review of the hardware and engineering concepts of each bypass technology is presented in appendix A.[1]

Many business customers are evaluating bypass technologies to meet the threat of rising local rates and the demand for new voice and data services. Just as the gasoline price increases in the 1970s stimulated the development of alternative energy resources, any rise in local rates can increase the application of bypass technologies within the local public telephone system. As with all new technologies, the application and marketing of the technology plays a large part in its acceptance in the industry.

Many of the technologies have been in existence for over a decade and have been applied to long haul communications such as microwave and satellite communications. Many businesses require state-of-the-art

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[1]Mention of particular manufacturers in this chapter does not imply endorsement by NRRI. They are presented to the reader as references to suppliers of communication systems that utilize bypass technologies. Much of the information about specific current bypass systems is based on notes taken at a seminar given by Jerome Lucas, and from information in the accompanying seminar notebook, Telephone Bypass Technologies and Economics (McLean, Virginia: TeleStrategies, Inc., 1983).

technology to obtain advanced voice, data, and video services such as teleconferencing and high speed digital communications. Not until recently have the bypass technologies become economically competitive in the local telecommunications market.

With advances in electronics the cost of installing a communication system has dropped substantially. Communication systems have followed the same evolutionary path as today's computer systems. Systems are smaller with faster and more powerful communications processors. Low cost systems are now competing with established local wireline facilities in providing local communication services.

Design Considerations

A communications network is expected to reduce communications costs, improve communication reliability, and improve corporate productivity. The design of the network should be dictated by the user's business application requirements. Application characteristics that influence network design consist of such factors as terminal locations, transaction frequencies, growth parameters, computer locations, and security requirements. These design objectives should not be influenced by the available communications hardware and software.

The initial planning step involves determining the constants that identify the application parameters defining the geography and performance of the network. This requires that the designer estimate the following application parameters:[2]

1. Number and location of switching centers
2. Number and location of users
3. Information flow patterns between the remote and central sites
4. Types of information transmitted (voice and data)
5. Traffic volumes for the type of information transmitted

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[2]Dixon R. Doll, Data Communications: Facilities, Networks, and System Design (New York: John Wiley & Sons, 1978), p. 429.

6. Urgency of information transmitted considering blocking rates
7. Acceptable undetected error rate
8. Capacity reserved for traffic growth
9. Reliability and availability requirements
10. Security of network and information flow

The second design step is the assessment of variables which affect the design of the network. These variables will influence the cost/performance characteristics of the network. These parameters would be the following:[3]

1. Type of network organization (centralized or distributed)
2. Types of lines (dial-up, leased, or combination)
3. Line routings
4. Transmission speeds or capacities
5. Types of terminal equipment used at remote sites
6. Locations and types of line sharing techniques and devices
7. Locations and types of communications control procedures
8. Error control procedures and software

The most critical variable in the design of the network is its topology. A topology defines the physical and logical arrangements of access locations to the network. A poorly designed topology limits all other design parameters in producing an efficient, cost-effective network. The design must consider using switched or leased lines, and multipoint or point-to-point connections for different routing alternatives. The topology determines whether network control should be centralized or decentralized. The network must be intelligent enough to identify problems and perform diagnostics. Also, the topology may require redundant links for reliability.

Another important criterion is the transmission speed used on the links of the network. Transmission speed determines the throughput capacity and response time of the communication system. A high

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[3]Ibid., p. 430.

transmission speed will require more sophisticated receiving and transmitting equipment including higher grade transmission lines. If the network has a concentration of locations, a group of locations requiring low speed communications can share a high speed line using line sharing devices such as multiplexers and concentrators. These devices have economies of scale in the cost of bandwidth for a particular link, creating a greater utilization of the voice grade line.

The final criterion is communications control. Control of the communications network plays an important role in its operation and maintenance. Control can be distributed in various stages and the specific approach utilized for line, path, and network control. These control systems determine the most efficient paths to direct traffic through the network, optimizing usage and response time.

Network Topologies

A network topology can be pictured as a road map for communication signals to travel. Within the topology are nodes similar to the towns on a road map. Nodes are locations where the signal is processed by a receiving station. When a signal reaches a node, the signal can be either received or passed by the station before continung its journey to the next node. Some signals are controlled by a command station where signals originate for distribution. Topology design will be influenced by signal-control requirements, and signal paths for efficient communications. Figure 2-1 shows some examples of various topologies.

Communication networks are designed in a point-to-point or a multipoint configuration with the capability of carrying data or voice communications, or both. A point or node identifies an access location on the communications network. A point-to-point configuration is used

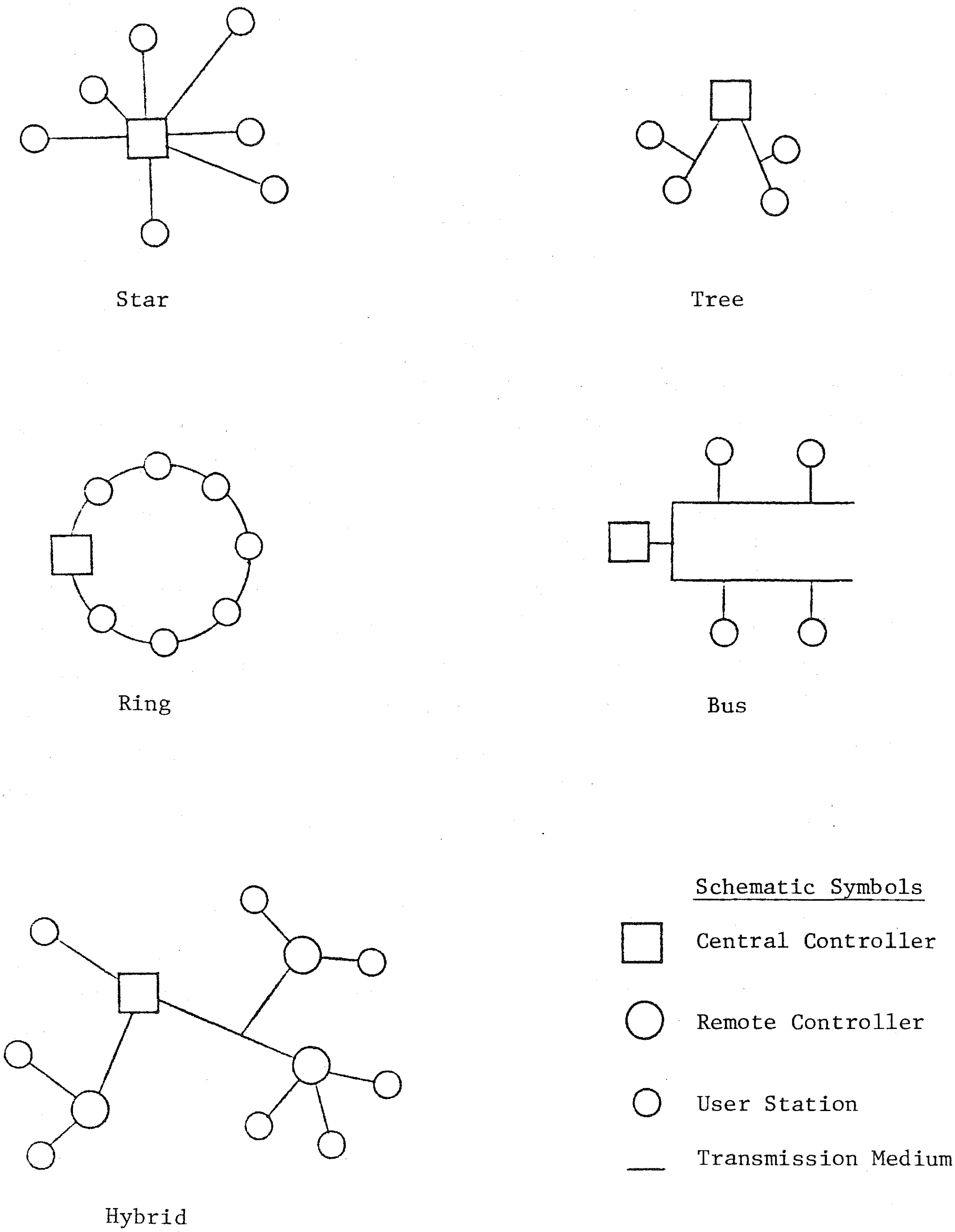

Fig. 2-1. Examples of network topologies

for establishing communications between two dedicated locations of high traffic concentration. A multipoint configuration is used for establishing communications between a group of locations with the capability of performing network switching or polling.

A point-to-point communications network is commonly used to provide a high speed data link between two locations. It is also an inexpensive method for providing voice communications along a high volume traffic route. This type of network does not require any costly switching equipment, and transmissions can be multiplexed to carry multiple communication channels. Multiplexing is a transmission technique that allows more than one channel to be transmitted over a single communications line. A channel represents the smallest subdivision of a circuit and provides communication along a single unidirectional path.

The telephone network is the largest multi-point communication network in the world. A multi-point communication network has the function of interconnecting locations through multiple switching centers for voice and data communications. A network can be designed in various architectural topologies: star, tree, ring, bus, and hybrid as shown in figure 2-1. Each topology has different effects on network reliability, cost, transmission characteristics, and expansion capability.[4]

The star topology is commonly used in the design of telephone networks in which all communication points are grouped and linked into a central switching center. The switching center directs communication traffic between network locations or between other switching centers. This topology has the advantages of being highly reliable and easily expandable. However, the star topology has the disadvantage of having a high construction cost due to the large amount of cabling required.

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[4]"Metropolitan Networking: Theory and Practice," Communications (Delran, New Jersey: Datapro Research Corporation, August 1983), p. CS20-470-101.

The star topology also lacks hierarchical optimization because of its heavy dependence on the central switching center. This can be overcome, as it is in the telephone network, by designing multiple star configurations into a tree topology, called a distributed star configuration. This type of topology is usually recommended for integrated applications involving voice, data, or video communications.

The tree topology is most commonly used in the design of cable television distribution networks. Communications in a tree network usually originate from a single source and are transmitted to all network locations. This network offers good wiring efficiency considering the average length of cable required for linking each network location. Its main disadvantage involves the application of two-way communication traffic that has addressing problems in identifying each network node.

The ring topology is a series of point-to-point paths which form a loop. It has the advantage of not being dependent on a central switching center. Transmissions can originate from any location and travel around the ring until they reach the designated location address. Ring topologies can span long distances because transmissions are regenerated at each network location or node. If a failure occurs at a network node, that node automatically closes its portion of the ring, passing on the communications stream as if the node was not there. Each network node transmits to and receives from only the adjacent nodes. This allows a simpler network design with lower tolerance requirements in the receivers and transmitters. The ring topology is used mostly for carrying data communications.

The bus topology is similar to a ring topology except a repeater is located at the end of the bus to send data back up the line to stations attached above the sender. Points on the bus do not break the cable like a ring topology. The major problem with the bus topology is the propagation delay caused by the time required to travel from one end of the bus to the other. The bus topology is also used mostly for carrying data communications.

The hybrid topology is primarily a distributed star topology. It is widely used in the telephone system as a citywide, integrated voice and data network. This topology offers high flexibility in adjusting the number of switching centers and the interconnecting trunks to expand and reconfigure the network.

Transmission Speeds

The transmission speed on the links of the network plays an important role in determining the performance and cost of the network. Signals can be transmitted in digital or analog (voice) format as shown in figure 2-2. For digital transmissions, the smallest piece of information that can be transmitted is a "bit" which represents an electrical signal of 1 or 0. The transmission speed is measured in bits per second (bps), commonly called the Baud rate. Most stations on a data communications network operate within 300 to 9600 Baud using leased lines. For voice or analog communications, the bandwidth determines the amount of voice communications that can be transmitted. The bandwidth is measured in cycles per second or Hertz (Hz), which is frequency. Voice communications are considered to have a frequency range between 300 to 3000 Hz and require a minimum bandwidth of 4000 Hz.

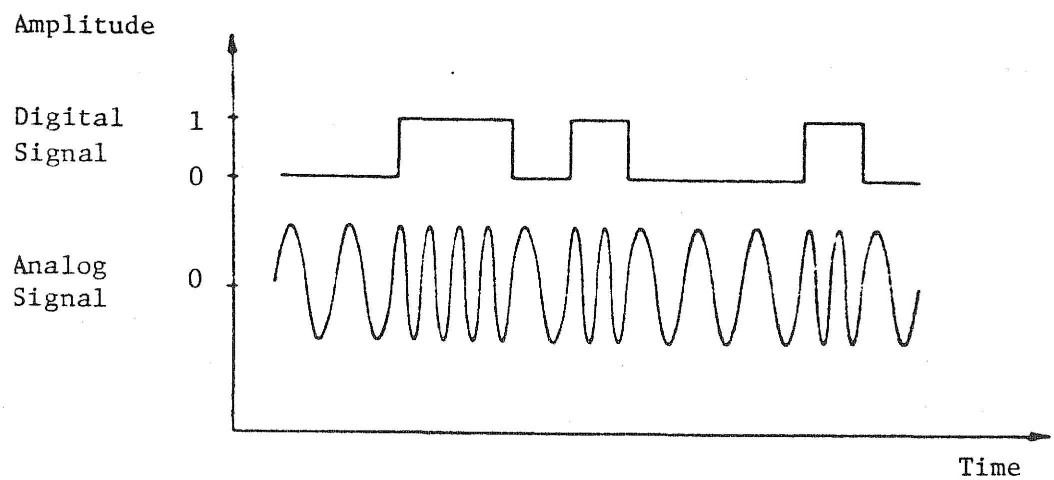

Fig. 2-2. Digital and analog signal formats

Digital communication networks can have transmission speeds as low as 50 bps or as high as 1.544 Mbps. Digital communication is well-suited for transmitting data because it is less influenced by noise and time delays inherent in voice or analog communications. For long transmission paths, signal amplifiers and repeaters can be installed to maintain the quality of the signal. Communication lines are typically divided into three groups: subvoice grade, voice grade, and broadband lines. Subvoice grade lines operate between 0 to 150 bps and are used mostly for low speed teletypes. Voice grade lines operate between 300 to 9600 bps and meet most data communication requirements. Broadband lines operate above 10,000 bps and are used for transferring bulk data between major computing and switching centers that serve as hubs in a network. Figure 2-3 shows the types of services available for data communications.[5]

Costs of communications from the established common carriers over a number of lines within a local location can be reduced by the application of multiplexers and concentrators. These devices reduce costs by combining lightly utilized lines into a single heavily utilized line, thereby eliminating the cost of additional lines. Multiplexers are always used in pairs to collect a series of lines into a single line, and then the data are transmitted and distributed in the same manner as they were collected. Multiplexers do not change the operation of the network, so they are transparent to the user. Concentrators are very similar to multiplexers except they work independent of each other, so that the communications protocol must manage the data flow.

Network Control

Network control has the objective of maintaining a high rate of utilization and quick response time combined with the ability to quickly diagnose and repair network failures. The location of the

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[5]Doll, Data Communications, p. 80.

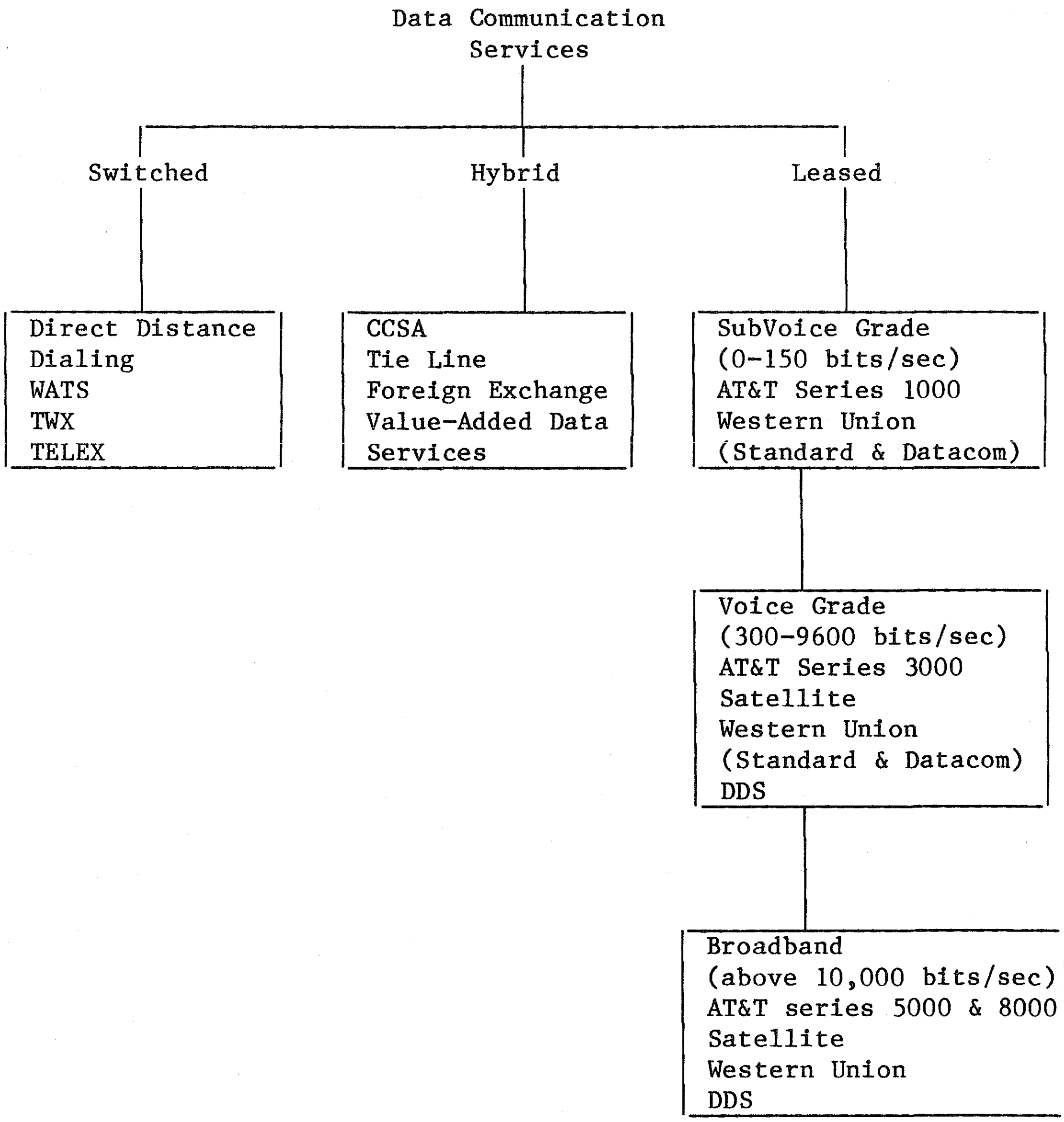

Fig. 2-3. Data communication services
Source: Dixon R. Doll, _Data Communications: Facilities, Networks, and System Design_ (New York: John Wiley & Sons, 1978), p. 80

control function of a network is based on the approach used in network, path, and line controls. Network control has a hierarchical structure of network, path, and line controls, where each type of control assumes error-free conditions at the lower levels. This assumption allows each control function to be modified according to network conditions without requiring changes in other control functions.[6]

Either centralized or decentralized control can be used as network control. Most control functions are handled at a central location in a network. A remote communications controller is only used when there exists a large cluster of remote locations in the network. Decentralized control allows remote locations to perform control functions, but this tends to escalate costs and is not common except for very large networks. The higher cost is associated with the remote controller requiring a more sophisticated processor at the central site. Most networks use a central control system to perform terminal identification, speed sensing, message/character assembly, code conversion, and error control.[7]

Path control can be established by having two types of communications paths (one for data and the other for control) or by embedding the control information in the data path. Path control determines the logical path of the transmission with the objectives being to maximize line utilization and to minimize blockage.

Two of the most commonly used methods for line control are contention and polling. Contention allows the network to allocate lines to users based on a first-come-first-serve basis. Once a user has control of a line, the line remains under the user's control until it is relinquished. Contention is used widely in switched networks. It has the disadvantages of being inefficient for high traffic areas

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[6]Network control used by small networks generally consists of generating line statistics to report line down-time and utilization. Usually, more advanced path and network controls are required for networks with more than ten lines or with multiple switching centers.

[7]Doll, Data Communications, p. 432.

and of lacking the ability to rank users for different levels of priority. Contention is suited for lightly loaded lines. Polling is more suitable for large networks where control of line usage is essential. It has the advantage of ranking transmissions for different levels of priority. However, it has the disadvantage that remote locations can not transmit at any time, but can only transmit when queried. The design of a polling system is more costly than contention systems in terms of hardware and software.[8]

Applications of Bypass Technologies

Eight basic technologies are currently being implemented: (1) satellite, (2) private microwave, (3) digital termination systems, (4) local area networks, (5) CATV, (6) fiber optics, (7) teleports, and (8) cellular mobile telephone. The remaining portion of this chapter will present various applications used to bypass the local public telephone network. An attempt will be made to address various cost and marketing issues facing each technology.

Satellite Communications

The use of satellite communications is very attractive to the high-data-volume user with sites a long distance apart. Sites should be located close to the local distribution areas served by the satellite carrier with distances between sites greater than 500 miles. Satellite communications carriers offer a wide range of services including shared and leased network services for teleprinter, data, facsimile, and voice communications, video teleconferencing, protocol conversion, and end-to-end network management services.

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[8]Ibid., p. 433.

A satellite network used for two-way communications would not be feasible for an organization with small, low-traffic-volume sites dispersed over a wide geographic area. However, it is feasible to use "receive-only" earth stations at remote locations in conjunction with broadcast satellites where the data flow is predominantly one-way. For voice communications, propagation delay causes a "tunnel voice" effect that may be unacceptable for highly interactive communications.

An organization can obtain satellite communication services by leasing a voice grade channel. If the sites are located within the carrier's distribution area, the minimum start-up costs can range between $100 to $300 and the minimum monthly operating costs can range between $600 to $800 for a 12-month contract.[9]

Organizations requiring a satellite packet-switching network might consider using a service such as the RCA Cylix. A configuration with one to six terminals communicating with remote host in the same network, using a line speed of 4,800 bps and a monthly traffic volume of 1.5 million characters would have the minimum start-up costs of $1,225 and minimum operating costs of $340 per month.[10]

For high volume transmissions using earth stations on the customer's site and satellite provided by, for example, Satellite Business Systems, three customer-site earth stations with transmission facilities would require minimum start-up costs of about $63,000. The minimum monthly operating costs would be approximately $97,000.[11]

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[9] Communications Systems (Cherry Hill, New Jersey: Data Decisions, 1982), File sequence nos. 910-A418-0106-10, 980-R290-0013-09, 490-W357-0138-09.

[10] Communications Systems (Cherry Hill, New Jersey: Data Decisions, 1982), File sequence nos. 980-R300-0138-01.

[11] Communications Systems (Cherry Hill, New Jersey: Data Decisions, 1982), File sequence nos. 980-S068-0030-01.

New small earth stations with disks measuring 2 feet in diameter and weighing 15 pounds are becoming available to provide local and long distance access to remote data bases, eliminating all telephone charges. These 2 foot earth stations are microprocessor controlled and designed for easy installation and maintenance. The use of microcomputer intelligence at the user site reduces large-computer time-sharing complexities and permits immediate local access to centrally updated data files from anywhere in the country. The application of low cost satellite networking will provide an economical method to distribute public data files such as for commodity exchange data, news, and weather reports. These applications will involve direct broadcast satellites for transmitting data and video information to homes and offices. Early-entry direct broadcast satellite providers include companies such as Satellite TV Corp., Interamerica Satellite Television, and United Satellite Communications, Inc.[12]

Private Microwave

Microwave systems operating at 18 GHz and 24 GHz are gaining market share due to the overcrowding of systems at 2 GHz to 12 GHz in most urban areas. Many manufacturers are developing and producing high frequency microwave systems for short haul applications as shown in table 2-1. They have a limited range of less than 10 miles and are better suited to provide local communications. These systems require an antenna dish of only 2-meter diameter which makes it ideal for small rooftop installations. They serve a growing market for private local networks, and provide multiple T-1 links with plenty of bandwidth for future expansion.[13]

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[12]Edwin B. Parker, "Satellite Micro Earth Stations--A Small Investment With Big Returns," Data Communications (January 1983): 97-100, 103-104.

[13]Twelve voice grade circuits (full duplex) or 1.544 Mbps.

TABLE 2-1

HIGH FREQUENCY MICROWAVE MANUFACTURERS

System Operating Frequency	Manufacturer
18 GHz	Farinon San/Bar Loral Terracom L.M. Ericsson
24 GHz	MA-COM General Electric RACON

Source: Jerome Lucas, Telephone Bypass Technologies and Economics (Virginia: TeleStrategies, Inc., 1983), p. 3-12

A 18-GHz microwave system is being offered by some manufacturers. The system has a 2- to 10-mile range. Installing a single T-1 link for two installations could cost between $31,000 and $60,000. Four T-1 links would cost between $39,000 and $82,000.[14]

A 24 GHz microwave system is being offered by manufacturers such as GE and M/A-COM. It has a range of a 1/2 mile to 3 miles and is applied to high speed building-to-building communications. These systems can handle local loop voice, data, and facsimile, operating at transmission rates of up to 3.152 Mbps. Hardware costs can range from approximately $8,000 for a small 9.6 Kbps system to approximately $18,000 for a system with two T-1 carriers.[15]

An example of a 24-GHz (K band) microwave system is the General Electric GEMLINK for voice and data communications. GEMLINK provides the capability to transmit at rates from 2400 Baud to 3.152 Mbps. With the available line-of-sight between locations, it has a communications range up to 10 miles depending on the application. A GEMLINK unit can offer a combination of up to 48 pulse code modulated (PCM) voice channels or 240 data channels. Table 2-2 shows the hardware costs and performance of various GEMLINK systems used for a range of 2.5 miles.

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[14]Lucas, Telephone Bypass Technologies p. 3-13.

[15]Ibid., p. 3-15.

TABLE 2-2

24-GHz GEMLINK HARDWARE COSTS AND PERFORMANCE

Model	Transmission Rate	Estimated Costs
LSD-082A	9.6 Kbps	$ 7,950
LSD-072A	19.2 Kbps	10,000
LSD-112A	1.544 Mbps	12,000
LSD-122A	Two T-1 channels	18,000

Source: Jerome Lucas, Telephone Bypass Technologies and Economics (Virginia: TeleStrategies, Inc., 1983), p. 3-15

Table 2-3 compares three microwave frequencies available for private networks. The higher frequency systems such as the 18- or 23-GHz systems have a better price-to-performance ratio than older low frequency 2-GHz systems. Lower costs are attributed to the lack of towers required to support the small high frequency dishes.[16]

TABLE 2-3

MICROWAVE FREQUENCY COMPARISONS

Frequency Band	2 GHz	18 GHz	23 GHz
Range	25 miles	7 to 10 miles	3 to 5 miles
Capacity (digital voice frequencies)	192	192	48
Radio cost	$ 60,000	$70,000	$15,000
Tower cost	$ 75,000	---	---
Multiplexer cost	$ 8,000	$ 8,000	$ 2,000
Installation cost	$ 50,000	$10,000	$ 4,000
Total fully equipped	$193,000	$88,000	$21,000

Source: George Pfister, "Going Downtown with Digital," Computerworld on Communications, October 3, 1984, p. 40

[16]George Pfister, "Going Downtown with Digital," Computerworld on Communications, October 3, 1984, p. 40.

The 18- or 23-GHz systems are appealing to the small user transmitting the equivalent of forty-eight to ninety-six voice grade circuits. Also, these systems require less stringent FCC filings and less detailed route and spectrum surveys. Their ranges are limited to a maximum of 10 miles.

Digital Termination Systems

Most Digital Termination Systems are either in the application or construction stage. Since August 1983, there have been 44 DTS applications for extended and limited carriers as shown in table 2-4. At that time, only 16 applications had been approved from a total of 230 construction permits.

DTS will provide three types of services. First, leased digital services will range from 2,400 bps to T-1. It would provide dedicated, full-time, private line service. Second, DTS will provide groups of twenty-four local voice trunk lines or access lines. This is aimed at heavy voice message traffic users having multiple locations within the DTS distribution area. Third, DTS will provide high speed measured service for customers with heavy peak traffic. This could be applied to computer backup, mass file transfer, remote laser printing, and high speed facsimile.

DTS provides digital metropolitan private line service in four primary applications areas: data communications, voice communications, video teleconferencing, and office automation communications. Currently, DTS is not competitive with standard telephone voice communications. It is competitive in providing digital communications by employing efficient microwave systems and by reducing installation bottlenecks commonly occurring in large metropolitan areas.[17]

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[17]Walter Ulrich and Ronald Bohm, "Digital Termination Systems," Computerworld on Communications, June 6, 1984, pp. 34-38.

TABLE 2-4

DTS APPLICATIONS (AUGUST 1983)

Applicant	Estended (E) or Limited (L)	Number of Cities	System Approval	Number of Construction Permits Granted
Bell of Nevada	L	1		
C&P (VA, MD, DC)	L	4		
Cable Associates	L	5		
Citicorp Digital Exchange	L	14		
Comven, Inc.	L	11		
Continental Digital Service	E	54	7/15/82	19
Cox Cable DTS	L	8	4/22/83	
Data Source, Inc.	E	50		
DEMS of DE Valley	L	9		
Digital Telecom	E,L	117	8/5/82	7
DTS, Inc.	E	79	8/5/82	
DTS, Inc.	L	21	10/13/82	
EP Data Sources	L	1		
Federal Express	L	15	5/3/83	13
First Communications Group	L	29	3/29/83	3
General Communications	L	3		
Graphic Scanning	E	70		
GTE Telenet Communications	E	41		
ICOM, Inc.	L	29	2/22/83	6
Illinois Bell	L	8		
Indiana Bell Telephone Co.	L	2		
ISA Communications Services	E	30	7/15/82	9
ITT World Communications	E	48		
Local Area Telecommunications	L	30	10/8/82	13
MCI Telecommunications	E	46	7/15/82	9
Michigan Bell	L	4		
National Digital Telecommunications	L	32	8/9/82	11
New England Telephone & Telegraph	L	1		
New Jersey Bell	L	4		
Ohio Bell	L	7		
Pacific Telephone & Telegraph	L	9		
RCA Network Services	E	54		
RCI Corporation	L	6		

TABLE 2-4-Continued

Applicant	Estended (E) or Limited (L)	Number of Cities	System Approval	Number of Construction Permits Granted
SBS	E	32	7/15/82	18
Southern Bell	L	1		
Southern New England Bell	L	7		
Southern Pacific	E,L	56		
Tymnet, Inc.	E	50	7/15/82	3
U.S. Telephone Communications Inc.	L	14		
Via/Net Co.	L	7	2/8/83	4
Warner Amex Cable Communications	L	15		
Western Telecom	L	3		
Western Union	E	42		
Wisconsin Telephone Co.	L	15		

Source: Jerome Lucas, Telephone Bypass Technologies and Economics (Virginia: TeleStrategies, Inc., 1983), p. 2-3-1 to 2-3-2

First-generation DTS systems operate with a relatively expensive master station that may cost from $100,000 to $200,000. The associated subscriber antennae cost between $10,000 and $15,000 each. The antennae can be installed within days. As the number of users grow, DTS will become more economically attractive.[18]

Local Area Networks

Table 2-5 lists fifty-seven computer and communications companies that offer seventy-one local architectures. Fifty-four companies are offering baseband networks and twelve companies are offering broadband networks. These networks use a variety of access methods to transfer data at rates up to 10 Mbps for basebands networks and over 10 Mbps for broadband networks.[19] Thirty-four companies use contention as their

[18]Pfister, "Digital," p. 40.

[19]Baseband networks carry only one digital transmission over the network at a given time, while broadband networks carry multiple analog transmissions over the network.

TABLE 2-5

COMPANIES OFFERING LOCAL AREA NETWORKS

A.B. Dick	Network Systems
Altos Computer Systems	North Star Computer
Amtel Systems	Ohio Scientific
Apollo Computer	Prime Computer
Apple Computer	Prolink
Compucorp	Proteon Associates
Computer Network	Racal-Milgo
Concord Data Systems	Scientific Data
Contel Information Systems	Sperry
Convergent Technologies	Standard Engineering
Corvus Systems	Starnet Data Systems
Cromenco	Stratus Computer
Data General	Syntech
Datapoint	Syntrex
DESTEK Group	Sytek
Digilog Business Systems	Teletype
Digital Equipment	Teltone
Digital Microsystems	Three Rivers
Gandalf Data	3COM
Gould	Ungermann-Bass
Hewlett-Packard	Valmet
Intercom	Vector Graphics
Interactive Systems/3M	Wang Laboratories
IBM	Xerox
Intersil Systems	Zeda Computers
Logica	Zilog
M/A-COM	Ztel
Molecular Computer	
NCR Corporation	
Nestar Systems	

Source: Communication Systems (Cherry Hill, New Jersey: Data Decisions, 1982), File sequence no. 711

access method while only thirteen companies use token passing.[20] Because of the lack of standards in the industry, twenty-eight companies are using their own proprietary access method. Also, some companies provide interfacing to communication gateways such as IBM SNA/SDLC, X.25, and Xerox ETHERNET.

The cost of implementing a Local Area Network (LAN) varies according to the type of cable used, the level of sophistication of the electronic interface, the method of installation, and the overall size of the network. Selecting the proper network topology for a LAN will influence its costs and performance. Cable costs can range from 20 cents per foot for twisted copper wire to $1.50 per foot for optical cable.[21] For a low speed LAN of less than 1 MHz, twisted copper wire is commonly used. For LANs operating over 10 MHz, coaxial cable or fiber optic cable is used.

The cost of the electronic interface is based on the amount of signal processing required. Baseband LANs operating below 1 MHz require an interface for each station with costs ranging between $400 and $800 per station. Baseband LANs operating above 10 MHz, such as Xerox's ETHERNET, require an interface costing between $600 and $2,000 per station. Broadband LANs such as Wang's WANGNET, require interfacing, and equipment costs range between $1,000 and $4,000 per station. Depending on the size of the LAN, other equipment may include repeaters, broadband network modems, and other equipment allowing users to share common resources on the network, such as printers and tape drives.

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[20]Token passing is an access method in which a token is used to carry a message from a transmitting node along a network path to the receiving node.

[21]"Fiber Optic Technology--Now and Tomorrow," Communications (Delran, New Jersey: Datapro Research Corporation, February 1982), pp. CS60-310-116 to CS60-310-117.

Installing a LAN can be the most expensive component in the implementation. Cabling through dense urban areas could cost up to $20 per foot of cable, although in simple applications cabling could cost as little as $1 per foot.

Other costs include software and hardware required to maintain and supervise the network. These will depend on the network topology and the complexity of its implementation.

Most networks have a maximum capacity to serve user stations based on data traffic conditions and types of services provided. For example, for a low speed LAN such as the Datapoint ARCNET, a network connecting one hundred stations could cost as little as $8,000 with the ability to expand up to five hundred stations at a cost of approximately $31,000. A 10-MHz baseband LAN using the Xerox ETHERNET would cost $150,000 to connect one hundred stations with communications, file, and printer server processors to manage the network. The LAN could cost up to $840,000 to accommodate four hundred stations. A broadband network similar to Wang's WANGNET ranges in cost from $82,000 for one hundred stations to $600,000 for five hundred stations. These examples are gross approximations and are presented to give a perspective on LAN costs. Costs are based on the LAN company product offerings and the type of network services provided.[22]

Coaxial Cable TV

The costs of building a cable system consist of the cable network and the broadcasting equipment. To install the main branch cable underground would cost between $16,000 and $20,000 per mile through a city the size of Columbus, Ohio. An overhead cable route costs from

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[22] Communications Systems (Cherry Hill, New Jersey: Data Decisions, 1983), File sequence no. 711.

$10,000 to $14,000 per mile. Short distance building taps from the feeder cables cost between $50 and $100 per foot. At each location, a single circuit data or voice modem must be installed to connect the subscriber at a cost ranging from $400 to $2,500 per unit. Multiple circuit modems may cost over $100,000 depending on their capacity. Based on the application of the cable system, broadcasting equipment can cost well over $100,000 for two-way communications. The earth station alone costs between $25,000 and $30,000.[23]

At the National Cable Television Association's annual trade show in Houston in June 1983, MCI Telecommunications Corporation demonstrated its CABLEPHONE concepts. CABLEPHONE gives a cable subscriber the ability to access long distance phone service through a two-way cable television network. A call originates at the subscriber location and is multiplexed to the head end of the cable network. The transmission then proceeds along a T-1 channel connecting the head-end station to the microwave transmitter. The microwave transmitter sends the transmission to an MCI switch, thus linking the cable network to the MCI long distance network. Transmissions can also be received by the cable network using the same technique. This system demonstrated the feasibility of using the MCI long distance network as a long haul voice interconnection between cable systems.[24]

Fiber Optics

Table 2-6 compares the costs of fiber optics and microwave systems. It assumes installation in a rural area. Construction costs

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[23] Telecommunications in Columbus City Government (Columbus, Ohio: Arthur Andersen & Co., December 1983), pp. 93-94.

[24] Robin Millington, "MCI Makes a Strong Showing in Houston: Further Implementation of Cablephone Planned," Telephone Bypass News (June 1983): 9-10.

in urban areas are higher, and are harder to predict, since they are so heavily influenced by congestion, zoning, and other local considerations. Fiber optics are very attractive with their high capacity and low costs. However, costs do not reflect the annual cost of conduit rental which may increase expenses to between $20,000 and $25,000 per mile.[25] The following are some applications of fiber optic networks.

TABLE 2-6

FIBER OPTICS AND MICROWAVE COSTS

Transmission method	2 miles	5 miles	10 miles
Fiber (672-voice frequencies)	$ 52,000	$ 97,000	$172,000
18-GHz Microwave (192-voice frequencies)	$ 88,000	$ 88,000	$ 88,000
2-GHz Microwave (192-voice frequencies)	$193,000	$193,000	$193,000

Source: George Pfister, "Going Downtown with Digital," Computerworld on Communications, October 3, 1984, p. 40

Station WNDU-TV, South Bend, Indiana's NBC affiliate, owned by the University of Notre Dame, uses fiber optics to link its studios with Notre Dame's sports facilities and Center for Continuing Education. The link provides both video and audio capabilities, and replaces conventional coaxial cables. The fiber optic cable was placed in 6,900 feet of conduit in steam tunnels under the campus.

KOVR-TV, an ABC network affiliate in Stockton, California installed fiber optic cable in its transmission tower. It is a five-fiber cable that replaces a rigid coaxial cable. The optical link

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[25]Pfister, "Digital," p. 40.

ensures a cleaner and more reliable signal, eliminates maintenance problems, and offers substantial circuit expansion capabilities. The cable is clamped to the tower without any conduit.

In December 1978, the City of Houston, Texas installed a bi-directional fiber optic communications link between its main library computer system and remote communications terminals. The single fiber optical waveguide replaced conventional telephone transmission methods in a move to reduce telecommunications expenses. The cable extends approximately 4,900 feet through ducts beneath city streets.

In May 1984, Southern New England Telephone Co. and CSX Corp. of Richmond, Virginia began construction of a fiber optic network to extend 461 miles from Jacksonville to Miami and Tampa. The network will be installed along rights-of-way owned by CSX's Seaboard Systems and Chessie System railroads. The network, called LightNet, will eventually link Chicago, Pittsburgh, Washington, Philadelphia, and New York, spanning 1,077 miles. Ultimately, it will link forty-three cities in twenty states. The network will use a single-mode, 90-mbps fiber system using cable containing thirty-eight to forty-eight fibers with the capability of carrying 30,000 circuits.

In June 1984, MCI completed its first long haul optical fiber system, a 210-mile link between New York City and Washington D.C. It uses single-mode optical fiber capable of transmitting voice, data, or video information at up to 405 MHz.

Teleports

Teleport facilities are being planned in over thirty cities. Table 2-7 lists the twenty teleport projects currently in progress. They are designed to provide communication services for businesses, residences, research and development firms, and educational institutions. The most ambitious project is being conducted by the Port Authority of New York and New Jersey jointly with Merrill Lynch and the Western Union Telegraph Co.

TABLE 2-7

TELEPORT PROJECTS IN PROGRESS

Project/Location	Size (Acres)	Type of Services
New York Teleport	350	Business
Columbus Teleport	200	Business and educational
Harbor Bay Isle (Oakland)	1,000	Business and residential
Las Colinas (Dallas)	1,200	Business and residential
Texas Plaza (Dallas)	90	Business and hotel
Miami Teleport	60 stories	Business and hotel
One Park Plaza (Chicago)	41 stories	Business and hotel
Boston Teleport	32	Business, research and development, educational
Science Park (Portland)	160	Business, research and development, hotel, and educational
Princeton Park	552	Business, research and development, and hotel
Ann Arbor Technology Park (Michigan)	820	Business, hotel, and education
The Midvale Park Commerce Center (Tucson, Arizona)	155	Business and residential
Gulf Teleport (Houston)	N/A	Business
Central Florida Teleport	305	Business and education
Harmon Meadow (New Jersey)	550	Business, residential, and hotel
New Haven, Connecticut	N/A	Business and education
Minneapolis, Minnesota	N/A	Business
Metrotech (Brooklyn, NY)	16	Business, research and development and education
Houston International Teleport	10	Business and residential
Texas Teleport (San Antonio, Texas)	3,500	Business, residential, research and development, hotel, and education

Source: Jerome Lucas, Telephone Bypass Technologies and Economics (Virginia: TeleStrategies, Inc., 1983), p. 5-27, and Edith Holmes, "Teleports Catch On But Face Competition," Data Communications, (October 1984): 66.

The New York teleport is a $255 million, 200-acre project aimed at halting the flow of back office computer operations from the expensive Manhattan real estate to the surrounding New York/New Jersey Metropolitan area. These operations include secretarial and clerical staffs, CRT terminal operators, technicians, and engineers. The office complex is located on Staten Island with fiber optic links to Manhattan. The first of these links will be to the World Trade Center in lower Manhattan and Journal Square in Jersey City, New Jersey. The cable will provide circuits at speeds of 56 Kbps and in multiples of 1.544 Mbps up to 45 Mbps, carrying voice, data, facsimile, and video. All buildings at the teleport will be interconnected in a fiber optic cable-based local area network. The teleport will initially have twelve 13-meter satellite dishes for communications with C band and K-band satellites. Tenants will have access to the forty-three existing or planned domestic communications satellites and plans are underway to include access to international satellites. Teleport tenants will save as much as 50 percent in rental costs by leaving Manhattan. The teleport rental rates are expected to be around $20 per square foot compared to $38 to $75 in Manhattan.[26]

For teleports designed to enhance telecommunications services for an office building, Jerome Lucas of TeleStrategies, Inc. predicts 140 buildings will be in operation by the end of 1984. He expects 290 buildings by the end of 1985 and 6,000 by 1994. There is still controversy over the advantages of shared tenant services, mostly in the areas of administration and control.[27]

Cellular Mobile Telephone

Currently, the FCC has well over a thousand applications on file for cellular licenses. For the top 30 cellular markets, as shown in

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[26]Bruce Hoard, "Teleport," Computerworld on Communications, September 28, 1983, p. 75-80.

[27]Edith Holmes, "Teleports Catch On But Face Competition," Data Communications, (October 1984): 64-68.

table 2-8, there are 196 applicants with 72 percent originating from nonwireline companies. Of these applicants, at least 21 licenses have been granted by the FCC as of December 1983. Applicants for licenses fall in 4 categories: wireline companies, Radio Common Carriers, specialized common carriers, and media firms. AT&T and GTE lead the list for wireline company applications. The estimated cost of preparing one application ranges from $80,000 to $475,000 because the application requires a complete engineering, marketing, and financial study. It is estimated that a 7-cell system would cost between $5 and $10 million, with the average cost of constructing a single cell being $1 million. Also, the switching equipment would cost another $2 million.

TABLE 2-8

TOP THIRTY CELLULAR RADIO MARKETS

Locations	
New York, NY/ New Jersey	Cleveland, OH
Los Angeles/Long Beach, CA	San Diego, CA
Chicago, IL	Miami, FL
Philadelphia, PA/New Jersey	Denver/Boulder, CO
Detroit, MI	Seattle/Everett, WA
San Francisco/Oakland, CA	Tampa/St. Petersburg, FL
Washington, D.C./Maryland/Virginia	Phoenix, AZ
Dallas/ Fort Worth, TX	Cincinnati, OH
Houston, TX	Milwaukee, WI
Boston, MA	Kansas City, MO/Kansas
St. Louis, MO/Illinois	Buffalo, NY
Pittsburg, PA	San Jose, CA
Baltimore, MD	Portland, OR/Washington
Minneapolis/St. Paul, MN/Wisconsin	New Orleans, LA
Atlanta, GA	Indianapolis, IN

Source: "Cellular Radio--A Management Overview," Communications, Delran, New Jersey: Datapro Reseach Corporation, October 1983), pp. TC41-007B-210 to 211

The AMPS' Chicago marketing tests showed that demand for cellular service would not be significant until the monthly service charge is approximately $45 to $65. The initial monthly cost is expected to be around $150 per month with the mobile telephone costing about $2,000.[28]

Comparing Bypass Technologies: A Summary

Most bypass systems incorporate many technologies in delivering state-of-the-art communications in a metropolitan network. These technologies can be classifed into three general categories: (1) radio frequency-based technology, (2) wireline-based technology, and (3) integrated systems technology.

Radio frequency technology involves the use of radio frequencies in the 2- to 30-GHz ranges to carry communication traffic. Radio frequencies are sensitive to atmospheric conditions, which limits their transmission range. As the transmission frequency increases, the transmission range decreases. A system operating at 2 GHz has a range of 25 miles, while a system operating at 24 GHz will have a range of 3 miles, depending on regional climatic conditions. Radio frequency-based systems include satellite communications systems, microwave point-to-point communication systems, and digital termination systems.

Wireline-based technology involves the physical connection of all access points in the network, for example, the local telephone system. The physical connection can be made by using various mediums such as copper wire, coaxial cable, or fiber optics. The type of medium chosen is based on the desired capacity of the line. Fiber optics has the greatest capacity with up to 50 GHz of bandwidth. Coaxial cable as used for CATV systems has a bandwidth between 250 and 350 MHz. Twisted copper wire has the lowest bandwidth, 1 MHz. All wireline systems

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[28]"Cellular Radio--A Management Overview," Communications, (Delran, New Jersey: Datapro Research Corporation, October 1983), pp. TC41-007B-210 to 211.

have the advantage of being reliable and can be used to construct very complex networks. Wireline-based systems include coaxial cable TV, local area networks, and fiber optics.

Integrated systems technology involves the application of radio frequency and wireline-based technologies. Interfacing these systems can provide the best of both technologies. Integrated systems include teleports and cellular mobile telephone.

In determining the most appropriate bypass system to use, bypassers typically consider the following factors:

1. Type of communications
2. Distance between locations
3. Traffic capacity required
4. Level of security
5. Total system cost

This is a very generalized approach and treats only communications between two points of access. Other factors to be considered are traffic patterns, type of terrain, and regional climate conditions. System maintenance requirements are also important.

The basic types of communications are voice, data, and video. Voice traffic includes voice grade lines used for data transmission. Data transmission includes digital traffic starting at 300 bps and above. Video transmissions include TV broadcasts and teleconferencing.

The distance between locations is categorized as local, short haul, and long haul. Local is typically within a metropolitan area and is less than 20 miles. Short haul represents an area typically within a state and extends for 20 to 500 miles. Long haul represents any distance greater than 500 miles.

Traffic capacity requirements must justify the cost of a bypass system. Some bypass systems can only be implemented for high volume traffic conditions.

The level of security is an important factor for sensitive data transmissions. Security measures are usually implemented previous to the transmission of the signal using a scrambler device.

Total system cost is a key factor in implementing any system. This represents the amount of capital required to obtain the use of a bypass technology.

Eight bypass technologies were compared: (1) satellite, (2) microwave, (3) digital termination systems, (4) CATV, (5) local area networks, (6) fiber optics, (7) teleports, and 8) cellular mobile telephone. Table 2-9 compares the the eight bypass technologies with the five factors used in selecting the proper technology. This table is designed to present some basic comparisons among the technologies.

Satellite communications is usually recommended for data and video transmission because of the tunnel or "echo" effect produced during voice transmission. It is recommended for users who have high volume traffic over distances greater than 500 miles. The cost of installing a system is low only if the end user's location is near the vendor's service area.

Microwave systems have been used for carrying voice, data, and video traffic mostly within the local area. Microwave links are used to extend the range to encompass short haul communications, in a manner similar to the way repeaters are used in wireline systems. A large amount of traffic is required to support a microwave system, with start up costs ranging from $15,000 to $200,000.

Digital termination systems are used for distributing local data and video traffic. The cost of the system is high, ranging from $100,000 to $200,000. However, the individual user can obtain access to the system for a cost of $10,000 to $15,000 with a set-up time as short as a single day.

CATV is a high cost system, made to deliver video and data traffic to subscribers. CATV has a large bandwidth. However, two-way communication cable networks are few, and are generally considered too expensive for residential use.

TABLE 2-9

MAJOR APPLICATIONS AND
CHARACTERISTICS OF BYPASS TECHNOLOGIES

Technologies	Application			Distance			Traffic Capacity	Security	System Costs
	Voice	Data	Video	Local	Short Haul	Long Haul			
Satellite		x	x			x	High	Poor	$ 20 - 30 million*
Microwave	x	x	x	x	x	x	High	Poor	$ 20 - 200,000**
DTS		x	x	x			Medium	Poor	$100,000 - 200,000
CATV		x	x	x			Medium	Fair	$ 20,000 - 30,000 per mile
LAN		x		x			Low	Fair	$ 5,000 - 50,000 per mile
Fiber optics	x	x	x	x	x	x	Very high	Good	$ 40,000 - 60,000 per mile
Teleports	x	x	x		x	x	High	Fair	$ 3 - 5 million***
Cellular	x			x			High	Poor	$ 2 - 3 million/central office

*Total network costs
**See table 2-3.
***For small to medium size applications
Source: Authors' assessment

Local area networks are used to interconnect independent computing devices primarily for data communications. The geographical scope of the network rarely exceeds 50 miles. Currently, the LAN industry is undergoing major changes in setting communication standards to provide some stability in the LAN market place. Even with the high cost of installation, LANs may be a viable solution in connecting dissimilar computing devices in a distributed information environment.

Fiber optics has the greatest potential to deliver integrated voice, data, and video communications over long distances. With its extremely wide bandwidth and immunity to noise, fiber optic cable will soon replace coaxial cable and microwave for many long haul applications. Currently the cost is high, but this is expected to descrease as fiber optic cable is produced in large quantitites.

Teleports are integrated systems with their capabilities dependent on the level of integration. Teleports used for intercity communications are highly advanced and expensive. However, teleports can be small to medium size systems, which can be used, for example, to enhance the value of real estate by supplying communications services in common to occupants of a multitenant facility such as an office complex.

Cellular mobile telephone is used only for voice communications. It is an integrated technology based on complex radio frequency transmissions and switching networks. The cost per user is high. However, it is expected to decrease as the technology of these systems matures.

CHAPTER 3

METHOD AND RESULTS OF THE SURVEY OF COMMUNICATIONS USERS

The policy debates regarding bypass at the time this study was initiated had typically taken place with relatively little factual information regarding the nature and extent of existing bypass activity and the reasons for engaging in it. Surveys regarding bypass activity had been conducted with respect to small or narrowly defined groups of customers, and the emphasis was typically on the extent of bypass activity. The reasons for bypass and the extent to which the use of bypass systems reduced a customer's use of telephone company services were given considerably less emphasis by most surveys. Therefore the existing information did not yield a broad perspective or nationwide overview of bypass activities.

The major objective of this project was to undertake a nationwide survey of a random sample of telecommunications users for the purpose of providing a broader perspective and supplying some of the missing information on bypass. In particular, the survey goal was to provide an objective source of information regarding reasons for bypass, the services which were being replaced by bypass, and the characteristics of business locations engaging in bypass.

Survey Procedures

Four major procedural issues were involved in planning and conducting the survey. These were the selection of a survey methodology, definition of the sample, construction of the survey instrument, and selection of the definition of bypass to be used in the survey. Five factors influenced the resolution of these issues. They were the requirement of a sample size sufficient to generate statistically valid results, the necessity of collecting enough information to meet the study objectives, a determination to minimize any possibility of inadvertent bias, budget constraints, and time constraints.

Survey Method

Both telephone and mail surveys were considered. The determination of which method to use was made on the basis of cost, time involved, and the minimization of bias. Discussions with several telecommunications users and analysts led to the belief that several other surveys had been, or were being, undertaken, and, therefore, the customer's willingness to respond to surveys had been reduced. This meant that a conservative assumption regarding the response rate to a mail survey would have been a 5 percent response rate.[1] For example, ten thousand questionnaires would need to be mailed to anticipate a return of five hundred. The cost of a mail survey of this size was estimated and found to approach the estimated cost of a telephone survey with a target of six hundred completed responses. There were also potentially serious time delays with a mail survey, due to the time lag between a respondent's receipt of a questionnaire and the completion and return of the questionnaire. In addition, there was concern over the amount of time it would take a mail survey to reach the appropriate person.

A telephone survey tends to minimize the possibility of time lags in receiving responses. In addition, a telephone survey would include one call to the office of the chief executive of the business location,

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[1]See for example, Stahrl W. Edmunds, <u>Performance Measures for Growing Businesses: A Practical Guide to Small Business Management</u>, (New York: N. Van Nostrand Reinhold, 1982), p. 98, wherein it is stated that "while response rates as high as forty to fifty percent have been achieved on mail surveys for topics of high interest the normal commercial market survey is likely to have more like a five to twenty percent response, and that depends on the simplicity and motivators in the survey."

for the purpose of identifying the person with whom the survey should be conducted, and this would further reduce time lags. A second call would then be made to interview the actual respondent. Thus, the decision was made in favor of a telephone survey as being more cost effective in generating timely results.

The Polimetrics Laboratory (Polimetrics) at the Ohio State University agreed to conduct the survey. Polimetrics is a research support facility, established in 1968, with expertise in survey and sampling techniques. Polimetrics tested the survey instrument, conducted the telephone survey, and coded the results. The instructions given to interviewers are contained in appendix B. Polimetrics participation added to the objectivity of the survey, since the use of skilled interviewers reduced the risk of unintentional bias.

Sample Selection

In determining the population to be sampled, it was assumed that the size of a company and the type of business the company engages in are the factors that exert the most influence on a company's use of telecommunications services. Therefore they were also assumed to be important in a company's decision regarding bypass. A complete picture of bypass activity would require sampling from a population including all sizes of all business and industrial classifications. However, budget constraints limited the sample size to a target of six hundred. This meant that in order to yield statistically valid results, the number of classifications had to be severely reduced. Four classifications were designated, but for reasons discussed later in this chapter only two strata were surveyed.

A review of the available bypass literature led to the hypothesis that four sectors of the economy were most likely to contain large numbers of entities utilizing bypass facilities. Those were manufacturers, financial institutions, utilities, and governmental units. The decision was made to survey manufacturers and financial institutions. Surveying governmental units raised several problems that could not readily be resolved within the project time constraints. Chief among these problems were difficulties both in identifying the appropriate respondent and in defining appropriate governmental units for the survey, given differences in organizational structures among states. Utilities were rejected because of the higher degree of uniformity in firm characteristics among utilities than among manufacturers and financial institutions. It was deemed more important to gather information on those sectors that had greater variability and, presumably, less predictability.

The next step was to decide whether to survey companies or individual locations of the companies. The choice of individual locations was made for four major reasons. The first is that the individual locations are of greater significance to a particular state public utilities commission than is the total company. That is, it is unlikely that a company's usage of bypass systems is uniform throughout all branches. Moreover, the impact of bypass on a particular telephone company depends on the extent of bypass within its franchise area.

The second reason for surveying locations is that the use of a user's company-wide data can be misleading. For example, a telecommunications user might report a rather high number of MTS minutes of use. This would then suggest a susceptibility to bypass systems that presumably would carry the traffic at a lower cost. However, if these minutes of use reflect company-wide usage then it is not at all clear that the MTS usage makes the company a potential bypasser. In other words, there may be many locations within that company where the amount of toll traffic is sufficiently limited that MTS is the most economical service. Yet an aggregation of all such locations could represent a significant amount of MTS traffic. Accordingly, in order to collect data that would be relevant to individual telephone companies and state commissions, the decision was made to survey locations.

Third, surveying companies rather than locations can create an upward bias in the amount of reported bypass. A large company might well engage in bypass at a few locations to meet local conditions. Given variations in the number of locations per company, the number of companies with bypass systems as a percentage of all companies may well be higher than the number of locations with bypass facilities as a percentage of all locations. Further, the bypass activity could be insignificant in terms of the totality of a company's operations.

A fourth reason for surveying locations was to search for indications of any regional differences in the nature or extent of bypass activity. A geographically stratified sample or a much larger sample would be needed to determine the degree of regional variation. However, a nationwide survey such as this one, conducted with no geographical stratification, can identify whether such further work would be useful. Indeed, the survey results do suggest the existence of regional variation (see chapter 4), and the implications of these results for policy are discussed in chapter 6.

Finally, a decision was made regarding the size of location to interview. Employment was used as the measure of size because there tends to be a correlation between the number of employees and the amount of telephone usage. It is commonly thought that the larger the firm, the more telecommunications traffic there will be, and consequently the likelihood of bypass is greater. For example, case histories of bypass by individual Fortune 500 companies have been frequently reported. It is also frequently claimed that bypass by a very large customer can have significant revenue effects on the telephone company.

Little or no public discussion regarding small to medium size companies has taken place. This can be a significant concern in formulating policy since policies designed to retain large customers could have an unintentionally negative effect on lesser sized customers, and the loss of many medium sized customers could have at least as great an impact as the loss of a few very large customers, depending, of course, on the type and amount of services that are bypassed.

One of the original goals of this project was to begin to collect information regarding the extent to which users other than the very large users are bypassing. Therefore, two strata sizes were designated for each industrial classification: locations with five hundred or more employees and locations with one hundred to five hundred employees. However, the strata of smaller locations could not be surveyed because the additional research funds were not available.

The sample population could have been drawn from either publicly available information or from telephone company customer lists. Two difficulties existed with respect to telephone company sources. One is that the information might not be available in all company service areas, either for reasons of proprietary interests, customer privacy, or incompleteness of the data. That is, a telephone company would not necessarily have the data regarding employment size and industrial classification of customer locations. In addition, the degree of company-by-company stratification necessary to insure that the nationwide sample would be statistically valid might well have proved impossible within the limited overall sample size. Therefore, the sample was drawn from a non-telephone company source. The sample names were purchased from Dun's Marketing Service, a subsidiary of Dun and Bradstreet. Two thousand names, the minimum, were purchased.

The sample consisted of one thousand locations with one hundred to five hundred employees and one thousand locations with five hundred or more employees.[2] The sample of smaller locations was reserved for possible future surveys. The population and sample size for each strata are found in tables 3-1 and 3-2.

Consideration was given to splitting the sample between the two sectors in proportion to the populations of the two sectors. This might have been a reasonable approach if the two sectors were to be treated as one group for purposes of analyses, and if there had been a

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[2]Appendix C contains a letter discussing the population from which Dun's drew the sample. While the intent of the study was to do a nationwide survey, the states of Hawaii and Alaska were omitted, due to an error in communication between the project team and Dun's Marketing Service. It is thought that this does not affect the validity of the sample or the results of the survey.

prior knowledge of the extent of bypass activity within each group. However, the project team believed that a proportional split between the two sectors would result in a sample of the financial institutions that would be too small to yield sufficient confidence in the results.

TABLE 3-1

POPULATION SIZE BY STRATUM

Location With	Manufacturers	Financial Institutions
100-499 employees	48,400	7,600
500 or more employees	9,200	1,460

Source: Dun's Marketing Service

TABLE 3-2

SAMPLE SIZE BY STRATUM

Location With	Manufacturers	Financial Institutions
100-499 employees	700	300
500 or more employees	700	300

Source: Results of authors' analyses

For this reason the sample was split disproportionately. While the target sample was 600 (450 manufacturers and 150 financial institutions) the additional 400 names were needed to allow for refusals to participate.

Survey Instrument

Due to the time constraints inherent in any survey, the primary informational goals were restricted to three. These are:

1. What are the reasons users are bypassing the network, and, to the extent that price is a factor, which prices are significant?

2. To what extent do bypass-provided services replace services previously purchased from the telephone company?

3. What are the major characteristics of bypassers and non-bypassers? What, if any, are the differences between them?

A copy of the survey questionnaire is found in appendix D.

Definition of Bypass

The remaining procedural decision was the definition of bypass to be used in the questionnaire. Chapter 1 reported on the variety of definitions in use and the contention of this report that bypass is primarily an example of alternative sources of supply or emerging competition in previously monopolized markets. However, a specific definition was needed for the survey, and several were considered. The final decision was to use the prevalent definition of bypass. That is, bypass is "the origination and/or termination of telecommunications traffic without the use of established telephone company facilities." This definition alone was not adequate to achieve all the information goals of the survey. This project was initiated with a major objective of gaining insight into the extent to which local telephone company services are being replaced by alternative sources. Therefore it was necessary to define the concept of traffic, as used in the above definition, to include all types of traffic. That is, interstate, intrastate interexchange, intraexchange, and intralocation. This was accomplished by using various examples of bypass systems to expand the definition. The exact wording used was:

> We are particularly interested in the growing use of bypass facilities. By bypass we mean the origination and/or termination of telecommunications traffic without the use of local telephone company facilities. Some examples of bypass facilities are: a privately owned "point to point" microwave system, a privately owned or TV company's cable network, a privately owned inter-office communications network or a direct connection between a customer's premise and an interexchange carrier. Bypass does not mean the use of a non-AT&T carrier such as MCI or SPRINT, unless that carrier is directly connected to the customer's premises rather than indirectly connected through the local telephone company.

Examples were necessary because of the degree of confusion over the meaning of bypass, even on the part of users. This is a broader definition than is used by many, but it is more useful for estimating activity in the markets for local telephone company services.

Some Survey Results

The telephone surveys were conducted by Polimetrics between June and August of 1984. The information from Dun's Marketing Service identified the chief executive of each location to be surveyed. The interviewers contacted that person and requested the name and telephone number of the person responsible for telecommunication services for that location. In the event that the appropriate person was located elsewhere in the company, the interviewer contacted that person and requested that the survey be completed relative to the location identified in the sample. All respondents were told that only aggregate results would be reported and that names of individuals and their companies would not be revealed.

Response Rate

The actual number of responses approached the target sample of 600. Of the 1,000 locations that were contacted for the survey, completed responses were obtained from 561. The detailed response rate is reported in table 3-3.

TABLE 3-3

RESPONSE RATE TO SURVEY

Status of Sample	Number of Respondents
Completed interviews	561
Partial interviews	22
Refusals	191
Mailed--not completed and returned	117
Ineligible/duplicates	109

Source: Polimetrics Laboratory

A completed interview is one in which a response was received to each question. However, that response may have been a refusal to answer the question, a "don't know," or a similar response which resulted in an entry of "missing data" for that particular question. The partial interviews are those wherein the respondent terminated the telephone interview before all questions received a response, or returned an incomplete questionnaire in the mail. The responses of these twenty-two incomplete questionnaires are not included in the data that are reported in the following sections and chapters.

One hundred forty-five respondents reported that as a matter of company policy they did not respond to telephone surveys, but would be willing to complete the questionnaire if it were mailed. Of these, only twenty-eight returned the completed survey by the end of August 1984.

The refusals include those who (1) refused to participate in the survey and (2) those who repeatedly requested a call back at a later date. After a reasonable number (a minimum of three, and often more) of call backs, this latter group were defined as refusals.

Finally, 109 of the sample names were deemed ineligible. This was generally for such reasons as: (1) the firm was too small, (2) the firm was no longer in business, or (3) there were duplicate names in the sample. Consequently, the completed response rate for eligible locations was 63 percent.

The responses to the completed interviews are reported in the remaining paragraphs of this chapter and in chapter 4. The sample size was sufficient to allow generalizations, within confidence intervals, on the extent of bypass for the total population of these two groups. However, the number of bypassers within the sample is relatively small, and, therefore, generalizations regarding the bypass activities of the total population of bypassers within a stratum are less certain. Additionally, it is well to remember that these results pertain only to manufacturers and financial institutions. Surveys of other economic sectors are needed to determine the extent to which these responses and patterns might be valid for other types of customers. As with any survey, application of any generalizations to the total population is subject to the assumption that there is no bias inflicted by the refusal rate, i.e., that the responses of those who refused to answer the questionnaire would have reflected the same pattern as those who did answer the questionnaire.

Extent of Bypass Activity

Table 3-4 reports the number and percentages of bypassers by stratum. Eighty-nine, or 16 percent, of those interviewed have some type of bypass facility. For purposes of this report, a bypasser is one who either has a bypass system in use or has made a firm commitment to install a bypass system. A firm commitment was defined as, at a minimum, securing a bid for the installation of a bypass system.[3] If those with no bypass system in place but with a firm commitment are excluded, then the number of bypassers falls to 76, or 13.5 percent of the sample. Those who had made a firm commitment to secure a bypass system were counted as bypassers primarily because of the relatively short time period needed to install the system once a bid is secured. Not defining these respondents as bypassers would underestimate the extent of bypass activity during the time period for which these survey results are relevant. These respondents were instructed to answer the questions on the basis of what services their bypass facilities will provide. Eighty-four percent or 472 respondents, are not considered bypassers.[4]

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[3]See appendix D, question number 11.

[4]To be considered a bypasser, the respondent had to answer "yes" to either question 11a, which asked about existing bypass installations, or 11b, which asked about firm commitments to install a bypass system. One respondent refused to answer question 11a and three respondents were recorded as either "don't know" or "no response" to question 11a. One respondent refused to answer question 11b and eight were recorded as either "don't know" or "no response" to question 11b. These responses to 11a and 11b may or may not be mutually exclusive. However, these respondents were presumed to be nonbypassers and counted in that group. This is the only presumption made with respect to survey results. All other responses are reported as received.

TABLE 3-4

NUMBER AND PERCENTAGE OF RESPONDENTS WHO ARE BYPASSERS AND NONBYPASSERS

Stratum	Bypassers		Nonbypassers		Total Respondents	
	Number	Percent	Number	Percent	Number	Percent
Manufacturers	64	16	330	84	394	100
Financial institutions	25	15	142	85	167	100
Combined strata	89	16	472	84	561	100

Source: Survey results

Based on the sample size, one can report there is a bypass rate of between 12.5 percent and 18.9 percent at 95 percent confidence levels for the combined population of large manufacturers and financial institutions. That is, there is a 95 percent probability that the true rate of bypass for this population is within this range. As with all surveys, this is based on the assumption that no bias was unintentionally created by the sampling method.

The percentage of respondents to the survey who bypass (16 percent) is smaller than the percentages reported by others.[5] Since no two surveys have covered the same population, there is no reason that the extent of bypass activity reported should be the same. Many of the other studies have involved narrowly defined populations of telecommunications users who are more likely to bypass, such as heavy users of all telecommunications services. This factor in part explains this difference in the percentages of bypass. However, at the same time, the definition of bypass used in this study is broader than that used by some other surveys because it includes all kinds of traffic. If a more narrow definition had been used, an even smaller percentage of bypassers would be anticipated.

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[5]See, for example Touche Ross and ICA results reported in chapter 1.

Indications of Growing Use of Bypass

Predicting the extent of bypass usage in the future is extremely difficult, if not impossible. It requires knowledge not only of future developments in technology and their costs, but also of regulatory responses to the use of bypass, and the responses of the telephone companies. Therefore, this survey does not predict future bypass activity. Nevertheless, there are four aspects of the survey responses that suggest that the use of bypass facilities is increasing over time.

One factor is that several of the nonbypass respondents are actively considering the use of bypass. Table 3-5 reports these results by stratum. Ninety or 16 percent, of the nonbypassers are now considering the use of bypass facilities. It is important to note that, while these respondents are considering the use of bypass systems, there is no evidence to indicate how many will actually decide to use such systems. It is also interesting to observe that while the percentage of current bypassers in each stratum is roughly similar, there is a significantly higher percentage of nonbypass financial institutions than of nonbypass manufacturers now considering bypass.

TABLE 3-5

NUMBER AND PERCENTAGE OF NONBYPASSERS CURRENTLY CONSIDERING THE USE OF BYPASS FACILITIES

	Considering Bypass		Not Considering Bypass		Total Nonbypassers	
Stratum	Number	Percent	Number	Percent	Number	Percent
Manufacturers	45	14	285	86	330	100
Financial institutions	45	32	97	68	142	100
Combined strata	90	19	382	81	472	100

Source: Survey results

The questionnaire contained two questions for nonbypassers related to their consideration of bypass systems.[6] As reported above, one question was whether the respondent had ever considered the use of bypass and rejected that alternative in the past. A second was whether the respondent is now considering the use of bypass facilities. Table 3-6 contains the number of respondents, by stratum, who have considered and rejected the use of bypass facilities in the past. Note that 64 percent (360) of all respondents have not considered the use of bypass facilities in the past, while 14 percent (77 respondents) have considered and rejected the use of bypass facilities in the past.

TABLE 3-6

NUMBER OF NONBYPASSERS WHO HAVE CONSIDERED BYPASS AND REJECTED IT IN THE PAST

Stratum	Have Considered and Rejected Use of Bypass in the Past	Have Not Considered Use of Bypass in the Past	No Response
Manufacturers	49	254	27
Financial institutions	28	106	8
Combined strata	77	360	35

Source: Survey results

This leads to the second factor suggesting that the use of bypass facilities will increase in the future. Twenty-nine of those who had previously considered and rejected the use of bypass (table 3-6) are now considering the use of bypass facilities. This may indicate that the costs of bypass systems have fallen, that telephone company service costs have risen, that customer needs have changed, or that there is some other explanation or a combination of explanations.

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[6]See appendix D, questions 36 and 37.

Another indicator of the growing use of bypass systems is the dates when the bypass facilities now in place were installed. Seventy-four respondents with systems in place now (excluding those with a firm commitment to install a bypass system) responded to the question that asked the date of installation of the bypass facility. Of these, fifty-eight reported their system became operational between 1980 and 1984, inclusive. Sixteen had systems installed between 1962 and 1979. These results are reported by stratum in table 3-7.

TABLE 3-7

NUMBER OF EXISTING BYPASS SYSTEMS BY DATE OF INSTALLATION

Stratum	1962-1979	1980-1984	No Response
Manufacturers	13	42	9
Financial institutions	3	16	6
Combined strata	16	58	15

Source: Survey results

The much larger number of systems installed from 1980 through 1984, as compared to the years prior to 1980, is a third factor that suggests the use of bypass systems is increasing.

The fourth factor that suggests the use of bypass systems is increasing is that several of those respondents with bypass systems in place have made firm commitments to install additional systems. Of those eighty-nine respondents considered to be bypassers within the definition of this report, seventy-six have systems in place and thirteen have a firm commitment to install a system. Yet the total number of those who have a firm commitment to install a system is thirty-five. This means that twenty-two of those who already have some bypass facilities are planning to add additional facilities. The results regarding commitments to install a system are found in table 3-8.

TABLE 3-8

NUMBER OF RESPONDENTS WITH EXISTING BYPASS SYSTEMS AND WITH FIRM COMMITMENTS TO INSTALL A BYPASS SYSTEM

Stratum	Number of Respondents with Bypass System in Place	Number of Respondents with Firm Commitment to Install a Bypass System	Total Number of Bypassers
Manufacturers	56	25	64
Financial institutions	20	10	25
Combined strata	76	35	89

Source: Survey results

Bypass Technologies

The bypassers were asked about the types of bypass technologies used. The results ranged from those who use only fiber optics or coaxial cable to those who use a combination of satellite/customer premises earth station, private microwave, local area network, digital termination system, teleport facilities, coaxial cable, and fiber optics. Table 3-9 contains a frequency count for each individual technology used. Eleven bypassers did not indicate the type of technology used. In addition to being asked about the use of these specific technologies, the bypassers were also asked if they used any other bypass technologies. Fourteen reported they did, listing such items as direct lines and cables to other locations, back-up systems, and CATV. Four of these reported they used only the "other" technology.

The least frequently used technology is the teleport. This is not surprising, since many areas do not have teleport facilities, and since few of the planned teleports are completed and operational. The most frequently used technology is coaxial cable, followed by local area networks.

TABLE 3-9

NUMBER OF RESPONDENTS WHO BYPASS, BY TYPE OF BYPASS TECHNOLOGY USED

Type of Technology	Number of Bypassers	Percent of Bypassers
Private microwave	36	40
Local area network	44	49
Satellite/customer premises earth station	24	27
Digital termination systems	35	39
Fiber optics	29	33
Teleports	15	17
Coaxial cable	52	58
Other	14	16

Source: Survey results

Whether the use of a local area network (LAN) should be considered bypass is a subject of controversy. A LAN can be as simple as connecting one or more computers within a building, in which case the only loss to the telephone company appears to be some intrabuilding cabling, which is even now reverting to customer ownership. Yet LANs can also be large and complex, carrying traffic within and between buildings. In the case of the more complex LANs, the loss to the telephone company can be much more extensive, depending on what specific services are being replaced. For example, if the LAN reduces the number of either PBX trunks or Centrex lines and consequently reduces the amount of switched traffic, then the impact on the telephone company can be substantial. The impact of LANs is uncertain. At present, the circuits replaced by LANs are thought to be predominantly unswitched circuits. However, the use of LANs for combined voice and data traffic is growing. This may mean that in the future LANs will divert increasing amounts of traffic (and minutes of use) from the switched network. Similarly the use of fiber optics or coaxial cable may represent either merely the loss of some interoffice or intrapremises cabling or the reduction of local switched traffic on the public switched network, either by serving as the direct connection to an interexchange carrier point of presence or by decreasing the number of PBX trunks, Centrex lines, or other local access lines.

This report makes no effort to enter the controversy regarding what technologies or combination of technologies constitute "bypass." This is a function of one's definition of bypass and one objective of this study was to discover the extent to which there are alternative sources for all telephone company services. However, it is important to note that nearly all respondents who reported using local area networks also reported the use of two or more other technologies. For example, twenty-five respondents with LANs also use private microwave systems and some other technology. Three bypassers use LANs, satellite, and one additional technology other than private microwave. Two bypassers use LANs and teleports. By contrast, one reported using only a LAN and coaxial cable, one reported using only a LAN and fiber optics, and only a single respondent reported using only a LAN. Regarding other controversial technologies, two respondents reported using only fiber optics, and one reported using only coaxial cable. For those readers who prefer a more narrow definition of bypass technologies, these numbers can be used to determine the overall percentage of bypassers in the sample for a more narrow definition of bypass technology.

In summary, the survey results show that a relatively small percentage of locations within the designated strata are bypassers, though there are several indications that the amount of bypass activity will increase in the future. Perhaps of greater importance than the number of locations using bypass are the reasons for using bypass systems and the impact of bypass on the use of telephone company services. The survey results relating to these issues are contained in the next chapter.

CHAPTER 4

CHARACTERISTICS OF BYPASS ACTIVITY: FURTHER SURVEY RESULTS AND SOME POLICY IMPLICATIONS

Eighty-nine of the respondents are considered bypassers. That is, they reported that they either have a system in place or have made a firm commitment to install one. Of these, sixty-four are manufacturing firms and twenty-five are financial institutions. The first section of this chapter details the corporate characteristics of the bypassers. Traffic characteristics of the bypass systems are reported in the second section. The third section contains responses related to the reasons for the use of bypass facilities; the fourth section discusses policy implications of the reasons given for bypass; and the fifth section reports information about the impact of bypass on telephone companies.

Corporate Characteristics of Bypass Locations

The 561 completed questionnaires were composed of locations in 47 states. The 89 locations that currently have bypass systems are located in 35 different states. Twenty-one of the states are represented by single bypass locations, while 2 of the 35 states have 23 (or 26 percent) of the bypass locations in the completed sample.[1] One could not project levels of bypass for individual states given the sample size, even if the sample had been stratified geographically. However, such extreme variance in the distribution does suggest that bypass activity is unevenly distributed throughout the country with

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[1]The states and number of bypassers are as follows: New York, 13; California, 10; Connecticut, 6; Wisconsin, 6; Illinois, 5; Pennsylvania, 5; Michigan, 4; Texas, 4; Colorado, 3; North Carolina, 3; Ohio, 3; Massachusetts, 2; Virginia, 2; Washington, 2. The remaining 21 bypassers each represented one state.

pockets of more intense bypass activity but no nationwide, uniform pattern of large numbers of bypassers. This is to be expected since industrial locations are not evenly distributed. State-by-state surveys or a much larger sample would be needed to verify this geographic pattern. To the extent that this uneven development is confirmed, uniform, nationwide policies may well be suboptimal.

The eighty-nine bypassers represent forty-seven headquarter locations (17.3 percent of all headquarter locations identified in the sample), and forty-one branch locations (14.7 percent of all branch locations identified in the sample). One location was unidentified with respect to this characteristic. This suggests that branch locations of this employment size are as likely to bypass as are headquarter locations.

Traffic concentration has always been assumed to be a major factor in the bypass decision. Since it was assumed that intracompany traffic is a major determinant of traffic concentration, several questions were asked regarding locations of the company as a whole. The respondents were asked for the total number of locations, the number of locations in the respondent's city, the number of locations in other areas of the respondents state, and the number of locations in adjacent states. The total number of locations for the eighty-two bypassers who responded to this question, ranged upwards to seven hundred, with only five reporting a single company location. Table 4-1 reports responses regarding the total number of companywide locations of the bypassers.

TABLE 4-1

NUMBER OF BYPASSERS BY TOTAL NUMBER OF COMPANY LOCATIONS

Type of Bypasser	Number of Locations							Not Available
	1	2-10	11-25	25-50	50-100	101-500	501-700	
Manufacturers	4	26	6	12	3	5	1	7
Financial institutions	1	3	2	3	6	7	1	2
Total	5	29	8	15	9	12	2	9

Source: Survey results

Forty-eight respondents reported additional locations in the same city, sixty-seven reported additional locations in other areas of the same state, and forty-three reported additional locations in adjacent states. Bypass locations tend to be part of multilocation firms, but there is a wide range of variation in the total number of locations.

The bypassers exhibit great variation, not only in the number of locations, but also in the size of the location being interviewed. Employment at the respondent location varied from 522 to 11,000, with a mean of 2,072. Table 4-2 contains details of the range of employment.

TABLE 4-2

NUMBER OF BYPASSERS BY NUMBER OF EMPLOYEES

Type of Bypasser	Number of Employees			
	500-700	701-1,000	1,001-1,500	Over 1,500
Manufacturers	13	18	12	21
Financial institutions	6	7	3	9
Total	19	25	15	30

Source: Dun's Marketing Service

Overall, the bypassers exhibit substantial variation in their geographic concentration, the total number of companywide locations, and employee numbers.

A similar variability was found with respect to the telecommunications traffic at the location. The respondents were asked to estimate the percentage of employees using the telephone. The estimates ranged from 1 percent to 100 percent with a mean value of 65 percent for the eighty-seven bypassers responding to this question. Table 4-3 has a detailed breakdown of the percentages of employees using the telephone. These responses show that bypassers consist both of locations in which only a small percent of employees use the telephone and of locations in which nearly all employees use the telephone. Forty-five percent of the bypassers represent locations at which more than 75 percent of employees use the telephone.

TABLE 4-3

NUMBER OF BYPASSERS BY PERCENTAGE OF EMPLOYEES WHO USE THE TELEPHONE

Type of Bypasser	Percent of Employees				No Response
	0-25	26-50	51-75	76-100	
Manufacturers	12	22	11	17	2
Financial institutions	-	-	2	23	-
Total	12	22	13	40	2

Source: Survey results

The respondents were asked to estimate the percentage of calls that are incoming versus outgoing and the percentage of data transmissions that are incoming versus outgoing. Tables 4-4 and 4-5 contain these results.

TABLE 4-4

NUMBER OF BYPASSERS BY PERCENTAGE OF CALLS THAT ARE INCOMING

Type of Bypassers	Percent of Employees				No Response
	0-25	26-50	51-75	76-100	
Manufacturers	4	35	10	3	12
Financial institutions	-	13	5	1	6
Total	4	48	15	4	18

Source: Survey results

TABLE 4-5

NUMBER OF BYPASSERS BY INCOMING DATA TRANSMISSIONS AS A PERCENT OF TOTAL DATA TRANSMISSIONS

Type of Bypasser	Percent of Data Transmissions				No Response
	0-25	26-50	51-75	76-100	
Manufacturers	18	23	6	7	10
Financial institutions	6	6	4	1	8
Total	24	29	10	8	18

Source: Survey results

The percentage of calls that are incoming ranges from 25 percent to 90 percent, and clustered at 40 percent and 50 percent, representing nearly half (forty-one of eighty-nine) of the bypass respondents. That is, sixteen bypassers reported 40 percent and twenty-five bypassers reported 50 percent. Thus, bypassers cannot be typically characterized as having a preponderance of either incoming or outgoing calls.

The percentage of incoming data transmissions ranges from 0 percent (for two bypassers) to 100 percent (also for two bypassers) with twenty-eight respondents reporting 50 percent. The fact that only eighteen (or 25 percent of those answering this question) reported that incoming data transmissions were more than 50 percent of total data transmissions suggests that the relative volume of outgoing data transmissions may be significant to the bypass decision. This issue is explored in further detail in chapter 5, but may require more data collection for a definitive explanation.

The respondents were asked to estimate the percentage of the company's total telecommunication bill that was generated at their location. Table 4-6 contains these responses. Seventy-two responded, with four reporting 100 percent. The mean estimate was 51.2 percent. Again there is no dominating pattern among the bypassers.

TABLE 4-6

NUMBER OF BYPASSERS BY PERCENTAGE OF COMPANY'S TOTAL TELECOMMUNICATIONS BILL GENERATED AT THE BYPASSER'S LOCATION

Type of Bypasser	Percent of Bill				No Response
	0-25	26-50	51-75	76-100	
Manufacturers	17	9	10	13	15
Financial institutions	5	5	6	7	2
Total	22	14	16	20	17

Source: Survey results

In summary, the business characteristics of bypassers reported here show no clear trend regarding the size, location, or traffic patterns of bypassers. At best, typical bypassers can be characterized as being part of a multilocation firm and tending to have more outgoing than incoming data transmissions.

The data reported in this section were also collected from the nonbypassers. Their responses are contained in appendix E. Statistical t-tests were performed on the means of some of these data to determine the existence of any statistically significant differences between bypassers and nonbypassers. Appendix F contains the computer printouts for these t-test analyses. The analyses were performed on the following variables:

1. Total number of locations
2. Number of locations in the city
3. Number of locations in the state but not in the city
4. Number of locations in adjacent states
5. The number of locations in the state but not in the city taken as a percentage of the total number of locations
6. The ownership (versus rental) of customer-premises equipment
7. The percentage of employees using the telephone
8. The percentage of telephone calls that are incoming as opposed to outgoing
9. The percentage of data transmissions that are incoming as opposed to outgoing

10. The percentage of the company's total telecommunications bill generated at the location

11. The average monthly bill from the telephone company in 1983, excluding customer-premises equipment

There were no significant differences in the variables tested between bypassers and nonbypassers considering bypass.

A second set of comparisons was between bypassers and those nonbypassers who are not currently considering bypass. Using a 5 percent significance level, a significant difference between the two groups was found with respect to the total number of locations, the number of locations in the city, and the percent of employees using the telephone. There was no significant difference found with respect to the number of locations in the state but not in the city, the number of locations in adjacent states, or the number of locations in the state but not in the city taken as a percentage of the total number of locations. While there was no significant difference in average monthly bills at the 5 percent level of significance, there would have been at the 10 percent level.

When the bypassers were compared with all nonbypassers, a significant difference was found only with respect to the total number of locations and the percentage of employees using the telephone.

Comparisons of those nonbypassers considering bypass with those not considering bypass show that there is a significant difference with respect to the total number of locations, the percent of employees using the telephone, the number of locations in the state, and the average monthly bill. Additional analyses of these data are found in chapter 5, which contains the results obtained in fitting a logit model.

Characteristics of Traffic Carried by Bypass Systems

One popular contention has been that bypassers are customers who install the systems primarily for high speed data uses and that the private system is necessary because adequate facilities are not available from the telephone company. Another contention is that bypass is used primarily for interstate toll services. To test these contentions and to gain a more complete picture of the ways in which bypass systems are used, several questions were asked regarding the type of traffic carried on the bypass facilities. Regarding data traffic, respondents were asked to estimate the percent of total traffic carried by the bypass facilities that is data communications. Eighty-four bypassers responded to this with answers ranging from 0 percent to 100 percent. Nineteen of the bypassers do not use the system for data, while nine report that all of the traffic carried on their bypass system is data traffic. An average of 29 percent of the traffic carried by bypass facilities is data. Details of these responses are found in table 4-7. Eighty percent of those who answered this question reported that 50 percent or less of their bypass traffic is data transmission. Thus, bypass facilities are being used for significant amounts of voice traffic, as well as for data. Even more interesting is the fact that 74 percent of the financial institutions answering this question report that 25 percent or less of the traffic on their bypass facilities is data. These are locations that presumably are large users of data transmissions, but are still using large amounts of bypass capacity for voice communications.

TABLE 4-7

NUMBER OF BYPASSERS BY PERCENTAGE OF TRAFFIC
ON BYPASS SYSTEMS THAT IS DATA TRANSMISSIONS

Type of Bypasser	Percent of Traffic 0-25	26-50	51-75	76-100	No Response
Manufacturers	33	13	6	9	3
Financial institutions	17	4	1	1	2
Total	50	17	7	10	5

Source: Survey results

Those bypassers who used their bypass facilities for data transmissions were asked to estimate the percentage of their data traffic that is high speed data transmission (as opposed to voice grade data). Thirteen reported that 100 percent of their data traffic is high speed data. A breakdown of these responses is found in table 4-8. The table suggests that bypass data traffic at a location will be predominantly high speed or predominantly low speed, but relatively few locations have large amounts of both. If anything, low speed data seems more common.

TABLE 4-8

PERCENT OF BYPASS DATA TRANSMISSIONS THAT
ARE HIGH SPEED DATA TRANSMISSIONS

Type of Bypasser	Percent of Data Transmissions					No Response
	0	1-25	26-50	51-75	76-100	
Manufacturers	6	12	3	4	14	7
Financial institutions	5	6	2	-	4	2
Total	11	18	5	4	18	9

Source: Survey results

The responses to these two questions suggest that the majority of bypassers use some amount of their system's capacity for data transmissions, and approximately half of the bypassers report that some amount of the bypass data traffic is high speed.

The bypassers were then asked, "Of the total traffic carried by your bypass facilities, what percentage do you estimate is/will be for long distance traffic?" This question was followed by one which asked "Of the total long distance traffic carried by your bypass facilities, what percentage do you estimate is/will be for interstate long distance?" These two questions are particularly important because of the heavy emphasis given to bypass of long distance services, and specifically the emphasis on bypass of MTS/WATS services that surfaced in the FCC access charge order.

More than half of the bypassers who responded to this question stated that 50 percent or less of their bypass traffic is long distance.[2] More details of these responses are found in table 4-9. The results in table 4-9 clearly indicate that bypass analyses and policies must consider the impact of local bypass as well as long distance.

TABLE 4-9

NUMBER OF BYPASSERS BY PERCENTAGE OF BYPASS TRAFFIC THAT IS LONG DISTANCE TRAFFIC

Type of Bypasser	Percent of Traffic				No Response
	0-25	26-50	51-75	76-100	
Manufacturers	19	11	5	24	5
Financial institutions	9	4	4	7	1
Total	28	15	9	31	6

Source: Survey results

Eight of the sixty-five bypassers who use their bypass facilities for long distance traffic reported that 100 percent of that long distance traffic is interstate. Table 4-10 contains more details of those responses.

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[2]Of the bypassers in this sample, seventeen stated that 100 percent of the traffic on their bypass facilities was long distance, while a nearly equal number--eighteen--reported that none of the traffic on their bypass facilities was long distance traffic. See table 4-14 below.

TABLE 4-10

NUMBER OF BYPASSERS BY PERCENTAGE OF BYPASS LONG DISTANCE TRAFFIC THAT IS INTERSTATE

Type of Bypasser	Percent of Long Distance Traffic 0	1-25	26-50	51-75	76-100	No Response
Manufacturers	3	14	7	7	16	0
Financial institutions	1	9	2	-	5	1
Total	4	23	9	7	21	1

Source: Survey results

Of the sixty-five bypassers who reported they use their bypass facilities for long distance traffic, thirty-six (or 55 percent) of these reported that 50 percent or less of that traffic is interstate long distance. These results, combined with responses to the previously reported question again emphasize the need to include the impact of bypass on both local and intrastate traffic in any analyses or policy decisions. These also serve to emphasize the extent of variability among bypassers.

The bypassers were also asked about the extent to which their facilities are used for video communications; intralocation traffic; and intracompany, interlocation traffic. It is important to note that location does not necessarily mean a single building. The importance of intralocation bypass traffic to a telephone company may well be a function of the number of buildings at that location, as well as the type of telephone company service being replaced.

Fourteen of the bypassers use their facilities for video traffic, with four of them reporting that 100 percent of their bypass traffic is video. Half (seven) of these report that video traffic represents 10 percent or less of their bypass traffic. The other three bypassers reported that video transmissions represent 40, 55 and 60 percent of their bypass traffic. These results are summarized by stratum in table 4-11.

TABLE 4-11

NUMBER OF BYPASSERS BY PERCENTAGE OF BYPASS TRAFFIC THAT IS VIDEO TRAFFIC

Type of Bypasser	Percent of Traffic					No Response
	0	1-25	26-50	51-75	76-100	
Manufacturers	53	5	-	2	4	-
Financial institutions	20	2	1	-	-	2
Total	73	7	1	2	4	2

Source: Survey results

Regarding intralocation traffic, 34 percent of the bypassers responding to the question report that none of their bypass traffic is intralocation, while 14 percent report that 100 percent of their bypass traffic is intralocation. Table 4-12 contains a breakdown of these responses. While it would be tempting to dismiss intralocation traffic as unimportant relative to interstate traffic with respect to its impact

TABLE 4-12

NUMBER OF BYPASSERS BY PERCENTAGE OF BYPASS TRAFFIC THAT IS INTRALOCATION COMMUNICATIONS

Type of Bypasser	Percent of Traffic					No Response
	0	1-25	26-50	51-75	76-100	
Manufacturers	23	13	6	3	17	2
Financial institutions	6	3	1	7	6	2
Total	29	16	7	10	23	4

Source: Survey results

on local telephone company revenues and plant utilization, this would be a mistake for two reasons. First, the impact of intralocation traffic is a function of the number of buildings involved and the types of telephone services being replaced, i.e., the extent that the use of local access lines and switched services is reduced. Similarly, the impact on telephone company plant utilization and revenues of long distance bypass traffic is a function of the type of telephone company service being replaced (private line vs. MTS/WATS).

More important, however, may be a question which has received little or no attention, namely, in which service does bypass traffic tend to first occur? Is it, for example, the installation of a sophisticated switch and customer-provided transmission channels in response to rising local rates? These types of facilities require greater expertise and expanded responsibilities for the communications manager and may in time generate increased interest in other types of privately supplied facilities. Similarly, the installation of private microwave facilities or satellite/earth station hookups for long distance traffic may create the need for greater responsibilities and thus generate interest in additional private facilities. Because the process that leads to the use of extensive bypass facilities is not clearly understood, it is not reasonable to dismiss any emerging competitive source as unimportant.

Twenty-two bypassers report that none of their bypass traffic is intracompany, interlocation traffic. Eleven bypassers report that it accounts for 100 percent of their bypass traffic. Table 4-13 reports the range of responses to this question.

The responses to these questions show considerable variation in the uses to which the bypass facilities are put. Table 4-14 presents a summary of responses to these questions, which clearly illustrates how much variation does exist. The fact that these categories are not mutually exclusive further illustrates the difficulties inherent in singling out any one traffic characteristic to describe bypassers.

TABLE 4-13

NUMBER OF BYPASSERS BY PERCENTAGE OF BYPASS TRAFFIC THAT IS INTRACOMPANY, INTERLOCATION COMMUNICATIONS

Type of Bypasser	Percent of Traffic 0	1-25	26-50	51-75	76-100	No Response
Manufacturers	16	18	8	7	12	3
Financial institutions	6	5	7	3	1	3
Total	22	23	15	10	13	6

Source: Survey results

TABLE 4-14

NUMBER OF BYPASSERS WHO REPORT EITHER 0 OR 100 PERCENT FOR THE TYPE OF TRAFFIC CARRIED ON THEIR BYPASS FACILITY

Type of Traffic	Percentages of Bypass Traffic 0	100
Video	73	4
Data	19	9
Long distance	18	17
Intralocation	29	12
Intracompany, Interlocation	22	11

Source: Survey results

More details on the uses of bypass facilities were gained by asking about the types of traffic relative to the jurisdiction of the traffic: intralocation, local, state, and interstate. Table 4-15 summarizes these responses. One respondent uses the bypass system only for international communications, and is not included in table 4-15.

TABLE 4-15

NUMBER OF BYPASS LOCATIONS BY TYPE AND LOCATION OF TRAFFIC CARRIED BY THE BYPASS SYSTEM

Type of Traffic	Location of Traffic			
	Intra-location	Local	Intrastate Long Distance	Interstate Long Distance
Voice	49	52	47	50
Voice grade data	43	43	36	38
High speed data	32	29	23	29
Video	11	11	10	11

Source: Survey results

The data in table 4-15 show that bypass is most frequently used for voice communications, followed by voice grade data. Relatively few of the bypassers are using their systems for video transmissions. The bypass traffic of each type is fairly evenly distributed among jurisdictions (intralocation, local, state, and interstate). Thus, the typical bypasser is using a multifunction, multi-jurisdictional bypass system.

Reasons for Bypass

One of the major controversies surrounding bypass concerns the reasons for bypass. Many contend that price is the major reason companies choose to bypass, while others contend that the major reasons for bypass are factors such as the reliability of telephone company services, the telephone company's inability to supply a particular technology, or the need for greater security or privacy.

It seems quite obvious that price must be a factor in the decision to acquire a bypass system. A rational decision maker considers price. However, there are two major issues relative to the role of price in the bypass decision. The first is the matter of which prices may be influencing the bypass decision. Second is the fact that price is not the sole factor in a decision between two products except for the case of homogeneous or identical products.

The choice between bypass systems and telephone company services is not a decision about identical products. These are products with varying degrees of product differentiation, and, therefore, it becomes very important to discover what, in fact, the consumer is choosing to buy at the price he is willing to pay. That is, what set of attributes of a communications system are important to the customer? The statement that price influences the decision is simply a statement that there is an upper limit to the amount that the customer is willing to pay for the attributes or that there is also a price sufficiently low that the customer will forego a set of attributes. Thus, an investigation of the reasons for bypass must undertake to discover the nature of the attributes which bypassers are buying and the size of the price differential involved. Uncovering the mix of reasons for bypass and the value attached to these reasons by customers is of utmost importance if optimal policy responses are to be designed.

The survey conducted by Bethesda Research Institute (summarized in chapter 1 of this report) has begun to look at this issue by including questions regarding the relationship of price and nonprice factors in the bypass decision. The questions referred to two price conditions, one in which the telephone company price is 5 percent higher than the bypass supplier's price and one in which the telephone company price was 10 percent higher. These relative price levels were then related to a variety of nonprice situations such as where (1) both sources have equivalent nonprice features, (2) all nonprice features are equivalent except the responsiveness to customer needs, and (3) the telephone company offers superior technical service qualities.[3] More research of

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[3]Bethesda, Study of Local Bypass.

this type regarding the set of attributes and the value attached to them by customers is needed if optimal policy responses are to be designed.

The NRRI survey reported here was designed to uncover the set of attributes that customers are seeking when the bypass decision is made. Therefore, several questions were asked of the bypassers regarding the factors that influenced their decision to bypass. The companies were read a list of six factors that have frequently been mentioned as important in the decision to bypass. They were asked to indicate whether each of these was "very important," "important," or "not important" in their decision. In addition, they were asked if there were any other factors in their decision and, if so, how important they were.[4] The six factors were:

1. Inability of telephone company to provide desired services (availability)
2. Greater reliability of bypass facilities (reliability)
3. Greater flexibility of bypass facilities (flexibility)
4. Concern over control, security, and/or privacy (security)
5. Price of telephone company services (price)
6. Stability of prices over time (stability)

The responses to this question are summarized in table 4-16.

Each of the factors named was considered very important by some respondents, and each was considered not important by other respondents. Price, as would be expected, was most frequently cited as very important. Flexibility had the next highest frequency as a very important factor, followed by price stability. Availability was cited as not important by more bypassers (42 percent) than any other factor, yet availability was important to nearly 60 percent of the bypassers. Thirty-six percent said security was not important.

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[4]See appendix D, question 20.

TABLE 4-16

NUMBER OF BYPASSERS BY THEIR RATING OF THE RELATIVE IMPORTANCE OF VARIOUS FACTORS IN THE DECISION TO BYPASS

	Relative Importance			
Factor	Very Important	Somewhat Important	Not Important	No Response
Availability	29	21	37	2
Reliability	32	27	27	3
Flexibility	41	25	21	2
Security	21	32	34	2
Price	49	24	15	1
Price stability	40	29	18	2
Other	25	5	0	59

Source: Survey results

Among the "Other" factors cited by respondents were several that could be reclassified as one of the previous six factors. Five respondents listed other reasons that related to the availability factor, reporting either "technology" or data speed as a reason for bypass. Two listed other reasons that are essentially price considerations, i.e., "economics," and the fact that high speed circuits are "very expensive without bypass." Eleven listed other factors that could be considered to relate to reliability, such as "lack of confidence in the telephone company," "quality," "maintenance," "speed and ease of installation," and "better and faster response to problems with bypass." Three reported the ability to communicate quickly as an "Other" factor. This was generally considered to relate to flexibility by the other respondents. Other reasons cited also included "growth," back-up system," "political," and "efficiency."[5]

Given the assumption that the bypass decision was influenced by more than one factor, and in order to get additional insight into the relative importance that each factor played in the decision to bypass, the bypassers were then asked to rank those factors that they had considered either somewhat important or very important. Table 4-17 contains the rankings for each factor.

Again, price is a significant factor in many bypass decisions since thirty-nine respondents (44 percent) ranked price first. The other factors received significantly lower and roughly similar numbers of responses for first place. That does not mean that the other factors can be disregarded, since with a differentiated product, some factor(s) in addition to price are important. Referring back to table 4-16, we see that all six factors were considered very important by many individual companies. Yet all six factors were also considered "not important" by some bypassers. For example, fifteen reported that price was not important. Since it is unlikely that the bypass decision was typically made on the basis of one factor alone, it is useful to note the cumulative frequency with which each factor appears within the first three rankings. Table 4-18 contains these cumulative frequencies. For example, seventeen respondents ranked availability either first or second.

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[5]Consideration was given to recoding these responses regarding "Other" factors and adding them to the frequency counts for the six listed factors. This was not done because of the project's concern for not introducing bias. The respondents themselves did not consider these factors to precisely fit the list of six factors. Therefore, rather than impute any special meaning to the respondents' answers, it was decided to report what was actually said.

TABLE 4-17

NUMBER OF BYPASSERS BY THEIR RANK ORDERING OF THE IMPORTANCE
OF VARIOUS FACTORS IN THE DECISION TO BYPASS

	Factor							
Rank	Availa-bility	Relia-bility	Flexi-bility	Security	Price	Stability	Other	No Response
First	8	10	7	6	39	4	12	3
Second	9	15	16	4	10	15	8	12
Third	9	7	14	7	8	17	5	22
Fourth	7	7	11	10	5	9	2	38
Fifth	4	9	6	9	3	5		53
Sixth	6	3	1	8	1	5		65
Seventh			2	1	2	1		83
Eighth						1		88

Source: Survey results

TABLE 4-18

NUMBER OF BYPASSERS BY THE CUMULATIVE RANKINGS FOR THE FIRST THREE LEVELS OF IMPORTANCE OF VARIOUS FACTORS IN THE DECISION TO BYPASS

	Factor							
Rank	Availa-bility	Relia-bility	Flexi-bility	Secur-ity	Price	Stabil-ity	Other	No Response
First	8	10	7	6	39	4	12	3
First or second	17	25	23	10	49	19	20	15
First, second, or third	26	32	37	17	57	36	25	37

Source: Survey results

Table 4-18 shows that fifty-seven of the bypassers (64 percent) ranked price as one of the top three considerations in their decision. Thirty-seven ranked flexibility within the top three and thirty-six ranked stability within the top three. If the responses to "Other" factors had been recoded then flexibility would have been even more significant. The ranking of the importance of price stability is particularly interesting. Only four respondents ranked it first, yet 40 percent considered it to be one of the top three reasons for bypass. It is also interesting to note that while more respondents (thirty-nine) ranked price as the number one factor, an even greater number (forty-seven) ranked any other factor as number one in the decision to bypass, and thirty-two (or 36 percent) did not even include price among the top three reasons. The conclusion to be drawn from this may be that while price is clearly important to bypassers, concentrating only on price may not result in a successful policy response to the full range of bypass activity.

Further information on the set of attributes that bypassers are seeking can be gained by looking at the combinations of factors that the bypassers cited. Therefore, the number of times each possible combination of three of the six factors appeared in the first, second, and third levels of importance was determined. This grouping ignores the individual rank assigned a given factor, that is, whether it was first, second, or third. These results are contained in table 4-19.

TABLE 4-19

NUMBER AND PERCENTAGE OF BYPASSERS FOR WHOM EACH COMBINATION OF THREE OF THE SIX LISTED FACTORS IS RANKED IN THE TOP THREE LEVELS OF IMPORTANCE IN THE BYPASS DECISION

Combination	Number of Bypassers	Percent of Bypassers
Price, flexibility, stability	12	14
Price, flexibility, availability	6	7
Flexibility, availability, reliability	6	7
Price, flexibility, reliability	4	5
Price, reliability, availability	4	5
Price, reliability, stability	4	5
Price, security, stability	3	3

Source: Survey results

Table 4-19 reports only those combinations that were selected by three or more bypassers. Thus, these responses represent only thirty-nine (or 44 percent) of the bypassers. Of the remaining bypassers, three did not respond to this question, nine ranked only one factor (five of whom mentioned price), and ten ranked only two factors. The remaining bypassers ranked combinations selected by one other bypasser at most. Once again, there is great variation in the combination of factors among bypassers, though price and flexibility occur with the greatest frequency. The conclusion is that a multidimensional policy approach is needed.

Further support for this conclusion is obtained from the responses of nonbypassers who are now considering the bypass option. They were read the same list of factors and asked to indicate which factors were causing them to consider bypass. Their responses are found in table 4-20. Again, price is most frequently cited, and stability and flexibility follow.

TABLE 4-20

NUMBER OF NONBYPASS LOCATIONS CURRENTLY CONSIDERING BYPASS WHO CITED EACH FACTOR AS A REASON FOR CONSIDERING BYPASS

Reason	Number of These Locations Citing Each Factor*	Percent of These Locations Citing Each Factor**
Availability	28	31
Reliability	32	36
Flexibility	54	60
Security	29	32
Price	78	87
Stability	56	62

*The total number of such locations is ninety.
**These percentages will total more than 100 percent since a respondent could respond to more than one factor.
Source: Survey results

Policy Implications

Price

The survey asked another series of questions related to the reasons for bypass. The respondents were asked for more specific information on the way in which each factor influenced their bypass decision. The companies were read a list of services and asked which telephone company service prices were most significant to their decision. They were also asked if any other prices were most significant. Table 4-21 summarizes these responses. The "Other" prices referred to in the table include foreign exchange, installation, service charges, equipment costs, and rates for data transmission. Two respondents also listed private line costs in this category, even though private line rates were included in the list of services.

TABLE 4-21

NUMBER OF BYPASSERS BY THE TELEPHONE COMPANY PRICES CONSIDERED TO BE MOST SIGNIFICANT IN THE DECISION TO BYPASS

Prices	Number of Bypassers Citing Each Price	Percent of Bypassers Citing Each Price*
State MTS rates	13	15
Interstate MTS rates	23	26
State WATS rates	23	26
Interstate WATS rates	28	31
State private line rates	36	40
Interstate private line rates	32	36
Proposed state end-user charge	34	38
Proposed interstate end-user charge	28	31
Centrex	17	19
PBX trunks	32	36
Within company trunks tie lines, off-premises extension rates	45	51
Local measured service	19	21
Other	10	11

*These percentages total more than 100 percent because a bypasser could respond to more than one price. (See question 23, appendix D.)
Source: Survey results

There are some useful and interesting observations to be drawn from the data in table 4-21. One is that both state and interstate MTS rates were cited by fewer bypassers as influencing the bypass decision than were nearly any other prices. Second, the proposed end-user charges have been cited as significant by a large number of bypassers--more than cited MTS rates. Third, private line rates were cited as important more often than WATS or MTS rates. Fourth, various local rates have been cited as significant a total of 113 times (excluding those in the "other" category), which strongly suggests the importance of looking at local service rates and examining the impact of bypass policies on the pricing and use of these services. Because many of these bypassers had ranked some other factor as being more important than price in their decisions, it is useful to look at what those 39 bypassers who ranked price first in importance said regarding the specific prices that influenced them. Table 4-22 reports these results.

TABLE 4-22

NUMBER OF BYPASSERS WHO RANKED PRICE "FIRST" AMONG FACTORS INFLUENCING THE BYPASS DECISION, BY THE TELEPHONE COMPANY PRICES CONSIDERED TO BE MOST SIGNIFICANT IN THE DECISION TO BYPASS*

Prices	Number of the Locations Citing Each Price*	Percent of this Subset of Bypassers**
State MTS rates	10	26
Interstate MTS rates	15	38
State WATS rates	14	36
Interstate WATS rates	18	46
State private line rates	20	51
Interstate private line rates	18	46
Proposed state end-user charge	17	44
Proposed interstate end-user charge	14	36
Centrex	8	21
PBX trunks	14	36
Within company trunks, tie lines, off-premises extension rates	25	64
Local measured service	12	31
Other (international communications, foreign exchange, service charges, and data transmission rates)	4	10

*The total number of such bypassers is thirty-nine.
**The percentages total more than 100 percent because a respondent could report more than one price. (See question 23, appendix D.)
Source: Survey results

Comparison of the two tables shows that the basic pattern is essentially the same. However, MTS rates were mentioned by a higher percentage of those who ranked price first in importance, as was the end-user charge. State private line rates, in both cases, were mentioned by a higher percentage of bypassers than either MTS or WATS. All four local services were cited by a significant percentage in each group.

It was thought that by observing the combinations of prices that were reported to be significant a clearer pattern might emerge. For this purpose, state and interstate MTS rates were combined, as were state and interstate WATS rates, state and interstate private line rates, and state and interstate end-user charges. The four local service rates were also combined in one group. Table 4-23 contains these results for those bypassers ranking price first in importance. Eighteen of these thirty-nine bypassers cited MTS rates. Eleven of those who cited MTS rates also cited WATS rates. Twenty-eight cited at least one local service price and fifteen of those who cited a local service price also cited end-user charges.

TABLE 4-23

NUMBER OF BYPASSERS WHO RANKED PRICE "FIRST" AMONG FACTORS INFLUENCING THE BYPASS DECISION, BY THE VARIOUS COMBINATIONS OF TELEPHONE COMPANY PRICES CONSIDERED TO BE MOST SIGNIFICANT IN THE DECISION TO BYPASS*

	MTS Rates	WATS Rates	Private Line Rates	End-User Charges	Local Service Prices
MTS rates	18				
WATS rates	11	19			
Private line rates	14	11	24		
End-user charges	11	7	13	18	
Local service prices	17	12	19	15	28

*There were thirty-nine of these locations, and most listed more than one price.
Source: Survey results

The bypassers are typically responding to several telephone company prices. The survey responses show that twenty of the thirty-nine reported that prices in at least three of the five categories of prices in table 4-23 were most significant. Only five of these thirty-nine bypassers reported a single price as being most significant. Three of those five cited interstate WATS; one cited international communications; and one cited intracompany trunks, tie lines, and off-premises extensions. One other of this group of bypassers cited only a combination of local services, and one did not respond to this question.

Since twenty-eight of these thirty-nine respondents cite local service prices as significant, more than in any other price category, one can conclude that rates for local services significantly influence bypass decisions. The frequency with which end-user charges were cited (as frequently as MTS rates) might be interpreted by some as reinforcing this conclusion. Indeed, the frequency with which private line rates were cited, suggests that these rates, too, may be more significant then MTS/WATS rates in the bypass decision.

These results point toward at least three conclusions relative to policy options. One, that to view any one price as being responsible for bypass is overly simplistic. Two, any attempt to adjust a given price (and consequently alter revenue requirements for other services) will risk retaining customers for one service at the expense of other services. Three, the number of times that local service prices were cited as significant suggests that local bypass may be increasing and, therefore, deserves more attention than it has received in the past. Given the variety of prices that influences the bypass decision, it would seem to be impossible to forestall bypass by manipulating any single price.

These conclusions are reinforced by looking at the prices considered significant by those nonbypassers now considering bypass. Table 4-24 reports these responses.

TABLE 4-24

NUMBER OF NONBYPASSERS WHO ARE CONSIDERING BYPASS, BY THE TELEPHONE COMPANY PRICES CONSIDERED TO BE MOST SIGNIFICANT IN THE DECISION TO BYPASS

Prices	Number of Locations Citing Each Price*	Percent of These Locations Citing Each Price**
State MTS rates	29	32
Interstate MTS rates	31	34
State WATS rates	40	44
Interstate WATS rates	38	42
State private line rates	51	57
Interstate private line rates	38	42
Proposed state end-user charge	53	59
Proposed interstate end-user charge	43	48
Centrex	21	23
PBX Trunks	45	50
Within company trunks, tie lines, off premises extension rates	59	66
Local measured service	34	38
Other	12	13

*The total number of such locations is ninety.
**These percentages total more than 100 percent because a respondent could report more than one price.
Source: Survey Results

Once again each price was cited by a large percentage of these locations. MTS rates were cited less often than any other prices except Centrex and "Other." State private line rates were cited more often than any other long distance price. Since these are locations that have not yet made the decision to bypass, their responses are particularly important.

Flexibility

The flexibility of bypass facilities was frequently cited as an important reason for bypass. Thirty-seven (41 percent) of the bypassers cited it as one of the three most important factors in their decision to bypass (see table 4-18), and forty-one bypassers cited it as "very important" (see table 4-16). The respondents were asked to explain the ways in which the bypass system provides greater flexibility. A great many factors were cited, some of which might be classified as either availability or reliability, but, for the reasons cited earlier, no recoding was done. The most frequently cited element of flexibility (twenty-one respondents) relates to the ease or speed or both with which the bypasser can reconfigure his network. Typical statements were: "expand or contract own network--would be able to add more lines, growth"; "ability to reroute facilities to meet traffic pattern"; "ability to allocate band-width to various functions on demand"; and "ability to change number and type of service transmitted." Other elements of flexibility included the ease and speed of reaching other facilities; the ability to "have information on readings, get reports on calls, destinations"; "integrated voice and data diagnostics"; "ability to integrate data network"; "excess capacity"; "ability to maintain own network"; "bypass provides for network equipment of non-uniform nature"; "can do more with bypass than with regulated company"; flexibility of cost; circuit quality; and ability to handle high speed data. Seven bypassers reported cost savings as an element of flexibility. Ten cited elements of flexibility relating to the greater speed of maintenance and/or the more individualized attention by the suppliers of bypass.

In reviewing the flexibility statements it appears that most relate to either the type of equipment available from the telephone company or the telephone company's ability to quickly meet the customer's needs. A regulatory response to this concern could be an examination of why these flexibility features are not available from regulated telephone companies.

Availability

In terms of services wanted, that is, the availability factor, ten bypassers cited high speed data facilities or digital facilities. Five bypassers cited quality and reliability of service. Other elements mentioned included better system configuration, enhanced services, video, integrated voice and data diagnostics, and the ability to easily and quickly reach other corporate offices. The responses regarding availability of telephone services are particulary interesting and somewhat inconsistent. The bypassers were asked whether the local telephone company offered services that were technologically equivalent to their bypass facilities and, if so, whether the respondent considered obtaining them. Eight either declined to answer the question or did not know. Forty-four reported that the telephone company did not offer technologically equivalent services, yet only twenty-nine bypassers reported that availability was a very important factor in the bypass decision, and only eight bypassers ranked availability first in importance to the decision. Additionally, eight reported that equivalent services were available but they did not consider obtaining them.

The information concerning availability is particularly important, because it relates to the need to upgrade telephone company facilities. The results of this survey suggest that while there are instances wherein such upgrades are currently necessary if the goal is to minimize bypass (forty-four or nearly half of the bypassers said equivalent services were not available), this is not a universal need. Since so few bypassers ranked this as the number one factor, it is possible that in some cases the bypasser would have accepted a less advanced technology if other attributes of telephone company services had been acceptable. Regulatory commissions may want to conduct surveys of their jurisdictional users to determine how extensive is this need and in which wire centers it is greatest.

Reliability

The Bell companies and AT&T have received considerable publicity regarding installation delays and related problems following the divestiture. Therefore, the responses regarding the bypassers' concerns about reliability are especially interesting. It must be remembered, however, that many of the bypass facilities were installed before the divestiture, and, therefore not all reliability concerns are a function of the divestiture. A summary of the responses to the follow-up question on reliability is contained in table 4-25. This question was asked only of those bypassers who said reliability was either somewhat important or very important.

TABLE 4-25

NUMBER OF BYPASSERS BY TYPE OF RELIABILITY CONCERN

Reliability Factor	Number of Bypassers*
Quality of telephone company service	37
Quality of telephone company maintenance	29
Speed of telephone company maintenance	35
Installation time	34
Quality of installation	21
Other**	13

*The total number of these bypassers is fifty-nine.
**The "Other" category of reliability concerns includes four references to the quality of telephone company circuits and lines, and such concerns as the cost of future enhancements; quicker problem identification and resolution with bypass; equipment reliability; and the inability of the telephone company to meet due dates.
Source: Survey results

Thirty-two of the bypassers cited reliability as a very important factor in their decision to bypass, and ten bypassers ranked it first in importance. The factors related to reliability are generally under the control of the telephone company. Therefore, to the extent that these factors cause idle plant due to bypass, it would not seem logical for ratepayers to bear the associated costs. Regulatory policy responses could include identifying these costs and removing them from allowable costs for ratemaking purposes.

Stability

Price stability was considered very important by forty bypassers. While only four ranked it first, 40 percent included it among the top three concerns. Price stability concerns reflected either dissatisfaction with persistent rate increases or the need for greater stability for planning and budgeting purposes. One respondent remarked about the apparent unfairness of being subject to significant charges for early termination of a service while having no protection against interim rate increases. Responding to this concern requires both company and commission action. The telephone companies could undertake more stringent cost containment policies--as do unregulated firms facing increased competition. The regulatory commissions could consider allowing more long term contracts with price stabilizing features (subject to appropriate safeguards for the monopoly customers) or other innovations that might limit the continuing rise in rates.

This is a particularly difficult problem since the response to some of the other factors leading to bypass may accelerate the increase in rates. In particular, changes in depreciation or the upgrading of telephone plant before the existing plant is fully depreciated may add to the pressures for continued rate increases. This is another reason why each commission may want to investigate bypass within its territory and to tailor its response to individual conditions.

Security

Security concerns were cited least often by bypassers, with twenty-one citing it as very important, and only seventeen (19 percent) citing it as one of the top three reasons for bypass. The security concerns generally related to the confidentiality of the respondent company's data and communications. Other concerns included phone abuse by employees, need for control over when lines are tested, and the need to solve problems more quickly. If the security concerns depend on the technology involved or the adequacy of telephone company responsiveness to security concerns, then any response to this factor lies with the telephone company. If the customers define security as having ownership and control of the communications system, then it may be much more difficult to devise strategies to induce them to stay on the public network.

Reviewing the responses regarding the reasons for bypass, each factor has been very important to a significant number of bypassers. Security was rated very important by the fewest number, but those still represented 24 percent of the bypassers. These results make it clear that no single policy response can be effective in reducing the bypass incentive and, in fact, that any one policy risks retaining some customers at the expense of others.

Because of the wording of the questions, it would be incorrect to say that any particular factor is the most important or ranks first. Instead one can only discuss the frequency with which bypassers cite any one factor as being very important or the frequency with which any one factor is ranked first. In this sense one can say that price, price stability, and flexibility are the factors most frequently cited as significant in bypass decisions.

Effect of Bypass Activity on Telephone Companies

The concern over bypass exists because of the potential impact on plant utilization (and hence cost to remaining subscribers) of the loss of large numbers of customers. The implication has often been that a company that bypasses reduces its use of all but the most basic local service. However, there have been questions raised about the extent to which bypassers do, in fact, reduce their use of telephone company services. Therefore, the survey contained questions designed to supply information on this issue.

Direct Connection to an Interexchange Carrier

One current type of bypass activity which, deservedly, generates much concern is the direct connection between a customer and an interexchange carrier, resulting in a loss of all access charge revenues to the local telephone company. The bypassers were asked the following question: "Have you installed fiber optics, coaxial cable, microwave, laser, or some other technology to extend transmissions from your premises directly to the facilities or switch of an interexchange carrier?"

Fourteen of the bypassers reported that they did have such direct connections. This represents 16 percent of the bypassers and 2.5 percent of the total respondents.

This is an important subset of bypassers, since the loss of their access charge revenues can be significant. One might expect that price was the most significant factor in making the decision to bypass for these fourteen bypassers. Yet, only five of these fourteen bypassers ranked price first in importance. Table 4-26 reports the order of importance of each factor for these bypassers.

While only five ranked price first in importance, ten of fourteen (71 percent) ranked price as one of the top three reasons for bypass. Therefore, it is useful to examine which prices were considered significant by this subset of bypassers. Table 4-27 reports these responses. Interstate private lines were cited most often among long distance services. Although the sample size of fourteen is too small to permit firm conclusions about the universe of such bypassers, it is notable that this group of bypassers also cited a variety of prices as influencing their decision. This is supported by other data reported

TABLE 4-26

NUMBER OF BYPASSERS WITH DIRECT CONNECTIONS BETWEEN THEIR PREMISES AND THE POINT-OF-PRESENCE OF AN INTEREXCHANGE CARRIER, BY THEIR RANK ORDERING OF THE IMPORTANCE OF EACH FACTOR IN THE BYPASS DECISION*

		Factor						
Rank	No Response	Availa-bility	Relia-bility	Flexi-bility	Security	Price	Stability	Other**
First		1	2	2	3	5	1	
Second	1	3	3	1		4	1	1
Third	4	2		2	1	1	3	1
Fourth	7		1	3	2		1	
Fifth	9		2		1		2	
Sixth	12	1				1		

*The total number of such locations is fourteen.
**The "Other" factors were "the ability to communicate quickly" and "the need for high speed circuits which are very expensive without bypass."
Source: Survey results

TABLE 4-27

NUMBER OF BYPASSERS WITH A DIRECT CONNECTION BETWEEN THEIR PREMISES AND THE POINT-OF-PRESENCE OF AN INTEREXCHANGE CARRIER, BY THE TELEPHONE COMPANY PRICES CONSIDERED TO BE MOST SIGNIFICANT IN THE DECISION TO BYPASS

Prices	Number of Bypassers Citing Each Price*
State MTS rates	3
Interstate MTS rates	6
State WATS rates	6
Interstate WATS rates	6
State private line rates	5
Interstate private line rates	8
Proposed state end-user charge	8
Proposed interstate end-user charge	7
Centrex	5
PBX trunks	7
Within company trunks, tie lines, off premises extension rates	9
Local measured service	5
Foreign exchange	1

*The total number of such bypassers is fourteen. This column totals more than fourteen because a respondent could respond to more than one price. (See question 23, appendix D.)
Source: Survey results

in this chapter that show the variety in types of traffic sent over the bypass systems.

A review of the comments of these fourteen bypassers shows that their concerns over security generally reflect those of all bypassers either concern over confidentiality of communications or concern over abuse of telephone usage by employees. Their concerns about price stability generally relate to dissatisfaction with rising rates, and concerns for budget and planning purposes. Other responses to reasons for bypass included: eight related to the technology of the bypass systems and its capabilities, such as high speed data and digital capabilities; five comments related to price and/or costs; six comments regarding the quality of telephone company services compared to the quality of bypass facilities; (usually referring to the quality of telephone company circuits); five comments regarding the "responsiveness" of the telephone company and the ease and speed with which customers' needs are met with bypass facilities; and one that cited the ability to make money with a bypass system.

There is no single pattern of reasons or prices that influences the bypass decision of this very significant subset of bypassers. The survey responses do raise questions that should be investigated with respect to this type of bypass. These include the extent to which these bypassers are users of MTS/WATS services as opposed to private line services, and the extent to which the effect of price differentials can be offset with improvements in telephone company services, including the responsiveness and timeliness of telephone company maintenance, installation, reconfiguration services, and the quality of the technology offered by the telephone company.

The responses by this subset of bypassers, regarding their reasons for bypass, are somewhat surprising. These reasons, of course, reflect the factors influencing their decision for all types of bypass facilities, not just the direct connection. A greater emphasis on price and on the price of MTS/WATS services might have been expected. It seems likely that as AT&T enters this market, with its ability to reach all locations in the country, the number of customers with a direct connection to an interexchange carrier will increase. By avoiding use of the local telephone company toll access facilities, all access charges (both traffic sensitive and nontraffic sensitive) would be foregone. Thus, the issue of direct connection to interexchange carriers could turn upon the question of whether the costs of the direct connections are greater or less than the access charges. This will depend largely on the customer's volume of traffic and his proximity to the interexchange carrier's point-of-presence.

The loss of more customers to a direct connection capability seems unavoidable, and the potential loss could be significant. Adjustments in the share of subscriber loop costs currently collected from toll customers can reduce the potential for this. The fundamental questions involved are: (1) what is the appropriate amount of reduction, and (2) who should incur the increases in local revenue requirements. These are discussed in chapter 6.

The fact that the survey responses indicate only a limited amount of direct connection should not be taken to mean that the potential problem is not important. However, this potential is difficult to measure, since it is a function of not only the customer's usage and location, but also of the interexchange carrier's capacity to provide direct connections. Such capacities are not unlimited. The creation of additional capacity over that existing today requires increased investment. The magnitude of these investment costs would also influence the amount of direct connection that occurs in the future. Finally, the potential for direct connection must be studied in conjunction with the potential that exists for large scale reductions in local services. Private networks for subsets of customers (such as neighborhoods, office buildings, or business and government complexes) could, in the future, substantially reduce the use of local access lines and local switched minutes of use. While a regulator cannot determine rate design solely on the basis of retaining a given set of customers, the potential loss of alternative groups of customers has to be considered.

Reductions in Use of Telephone Company Services by Bypassers

While only a few respondents have direct connections to an interexchange carrier, many more have bypass systems affecting other telephone company services. To measure the degree to which bypass reduces the use of telephone company services, the repondents were read a list of services and were then asked the following questions about each service:

1. Did you use this service prior to the installation of your bypass facilities?

2. Do any of your bypass facilities provide the same service?

3. Has your use of this service from the telephone company decreased as a result of your bypass facilities or not?

4. What was the percentage decrease in use?

The responses to these questions are found in table 4-28.

Table 4-28 contains much information, some of which may be difficult to interpret without a case-by-case analysis of each bypasser. However, there are many interesting results contained in this summary data.

The data in table 4-28, column 2, show that in no case did every bypasser who had used a particular telephone company service acquire bypass facilities capable of providing that service. With one minor exception (56 Kbps state private lines) the percentages of users of telephone company private line services who have the equivalent service capability in their bypass systems are typically significantly higher than the percentages of users of MTS/WATS services who have bypass systems with the equivalent service capabilities. This suggests that bypass facilities are more likely to be acquired to replace telephone company-provided private line services than to replace MTS/WATS services. See also table 4-23 above.

While every telephone company service has been reduced by some bypassers, column 3 shows that in no case have all bypassers with the

TABLE 4-28

NUMBER OF BYPASSERS WHO DECREASED THEIR USE OF TELEPHONE COMPANY SERVICES AS A RESULT OF THEIR BYPASS SYSTEMS, BY SERVICE AND THE PERCENTAGE DECREASES IN USAGE*

Service	Number of Bypassers Who: Column 1 Used the Telco Service Prior to Bypass	Column 2 Have the Service Capability in the Bypass System	Column 3 Have Decreased use of Telco Service	Column 4 Percentage Decrease in Use of Telco Service by Bypassers: No Response	Column 5 1-25	Column 6 26-50	Column 7 51-75	Column 8 76-100	Column 9 Number of Bypassers With More Than 50 Percent Decrease In use**	Column 10 Number of Bypassers With 100 Percent Decrease In Use**
Interstate private lines										
Analog	61	37	29	6	7	5	3	8	11	5
Digital (9.6 Kbps or less)	31	17	15	2	3	1	3	6	9	3
Digital (56 Kbps)	11	5	4	0	0	1	1	2	3	2
Digital (1.544 Mbps or T1/T2 carrier channels)	5	2	1	0	0	0	0	1	1	1
State private lines										
Analog	57	28	25	4	6	3	3	9	12	6
Digital (9.6 Kbps or less)	20	14	12	1	0	3	2	6	8	3
Digital (56 Kbps)	7	2	1	0	0	1	0	0	0	0
Digital (1.544 Mbps or T1/T2 carrier channels)	5	3	2	0	0	1	0	1	1	0
Interstate WATS lines (inwats)	60	18	11	3	2	4	2	0	2	0
Interstate WATS lines (outwats)	61	23	14	2	1	5	2	4	6	4
State WATS lines (inwats)	51	13	5	1	2	1	0	1	1	0
State WATS lines (outwats)	58	18	11	3	2	2	0	4	4	2
Interstate foreign exchange lines	33	11	7	2	1	0	1	3	4	3
State foreign exchange lines	30	9	6	0	1	2	1	2	3	2
Interstate MTS	30	11	10	2	2	4	1	1	2	1
State MTS	26	10	7	2	1	2	0	2	2	2
Intracompany trunks, tie lines, off-premises extensions	61	44	33	2	6	4	4	17	21	9
Centrex lines	25	15	13	1	1	1	1	9	10	6
PBX trunks	62	28	18	4	4	6	2	2	4	1
Other local trunks or lines	21	9	8	2	1	0	2	3	5	3

*The total number of these locations is eighty-nine.
**These numbers are also included in columns 7 and 8.
Source: Survey results

service capability reduced their use of telephone company services. This might imply that some percentage of bypass systems have been built to accommodate either growth in existing customer needs or new services needed by the customers. It also might imply that existing bypass systems have excess capacity and therefore pose a future problem to telephone companies. Clearly more research is needed on the capacity and usage of bypass systems.

The use of intracompany trunks, tie lines, and off-premises extensions has been reduced by more bypassers than has any other service (column 3). This is understandable in light of the number of bypassers with local area networks. The revenue loss to the telephone company from these services is typically assumed to be less significant than the revenue loss from some other services. However, the full effect of these decreases cannot be measured without knowing the ways in which the bypass facilities are being used. For example, to the extent that any of these bypass replacements for intracompany trunks, tie lines, and off-premises extensions result in reductions of local switched minutes of use, the effect could be significant.

As an example, consider a large factory consisting of several buildings scattered over many acres. If such a factory had its own switch and intralocation trunks or lines, it could carry all intralocations communications and significantly reduce the use of Centrex lines, PBX trunks, or other local lines. Similarly, any bank with several branches or business locations with several buildings could achieve the same effect. In fact, the percentage of bypassers with local service capabilities in the system who have decreased their use of telephone company facilities suggests this may be happening. In addition, table 4-21 reports that nineteen bypassers considered local measured service rates to be significant in the bypass decision. This would further support the view that local use of the public switched network is being reduced by bypass facilities. However, if local dial minutes decline, and toll minutes do not, then more of the traffic-sensitive costs will be allocated to toll services, since the relative use by toll services will rise. This would mitigate, somewhat, the effect of reduced local usage. Analyses of the full effect of bypass systems should include the changes in relative use in each jurisdiction.

Perhaps the most useful data for understanding the impact of bypass are the results of comparisons of the numbers in various columns of table 4-28. Typically, less than half of those who used a particular telephone company service acquired an equivalent capability in their bypass systems. Also, typically, 60 percent or more of the bypassers who did acquire an equivalent service capability reduced their use of telephone company facilities.

Although the survey found some instances of severe reduction in usage among the respondents, the overall impact was less significant. For example, 40 percent of those bypassers who reported the percentage decreases in their use of state MTS services, reduced their usage by 100 percent. Yet this 40 percent consists of two bypassers who represent 7.7 percent of bypassers using state MTS services prior to acquiring their bypass facilities, and only 2.2 percent of all bypassers. Four of those bypassers reporting the amount of decrease in usage of interstate WATS (outwats) reported a 100 percent reduction in use. These four bypassers represent 17 percent of bypassers with that service capability, and 4.5 percent of all bypassers. Five bypassers reduced their usage of interstate analog private lines by 100 percent. These five represent 21.7 percent of those who reported their percentage decrease, 13.5 percent of those bypassers with the equivalent service capability, and only 5.6 percent of all bypassers.

The numbers of bypassers reporting various percentage decreases are too small to draw conclusions. However, the data do suggest that there is considerable diversity in the degree to which the use of bypass systems displaces the use of telephone company services. Some bypassers substantially decreased their use of telephone company services, while others reduced their usage by limited amounts or not at all.

Therefore, the fact that a company uses bypass facilities does not always mean substantial drops in the use of telephone company services. The implication of these data is that, in some cases, bypass facilities are being acquired either for growth in customer needs or for back-up facilities. Where bypass is being used to meet growth in communication needs, the telephone company has lost future revenues or market share, but the impact on existing revenues and plant utilization is much less. In those cases where bypassers are reducing their use of telephone company facilities, the number who completely eliminated their use of a service is generally less than the total number who reduced their use of the service.

No more than 20 percent of the bypassers reduced their use of a particular telephone company service by over 50 percent in the case of thirteen of nineteen listed services. Since 20 percent of the bypassers represents only slightly more than 3 percent of the entire sample, it appears that the overall impact of existing bypass is not now severe and clearly does not approach its potential. Nevertheless, there are several individual examples of severe impact.

Revenue Effects of Bypass

Because of the great interest in the amount of revenue lost, the survey asked two questions relating to the amount spent on services. One question asked for the average monthly bill from the telephone company in 1983, excluding customer-premises equipment. This was asked primarily to identify the importance of the respondents as sources of telephone company revenues. These results can be found in table 4-29. The estimates of average monthly bills ranged from $500 to $12,000,000[6] with a median of $40,000. Most of these bypassers are, therefore, customers who could contribute significant revenues to the telephone company. The bypassers were also asked to estimate the monthly percentage savings in telephone company bills as a result of their bypass facilities. Table 4-30 contains these responses.

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[6]A second telephone inquiry was made to verify this amount.

TABLE 4-29

NUMBER AND PERCENT OF BYPASSERS BY THEIR AVERAGE MONTHLY BILL FROM THE TELEPHONE COMPANY IN 1983

Size of Bill	Number of Bypassers	Percent of Bypassers Responding to Question*
Less than $10,000	12	18
$10,000-49,999	22	34
$50,000-99,999	11	17
$100,000-999,999	16	25
$1,000,000 and above	4	6

*Twenty-four did not respond to this question.
Source: Survey results

More than half of those responding reported savings of 20 percent or less, and a fourth of those responding reported savings of 10 percent or less. Almost a third of those responding reported savings over 30 percent. The bypassers are clearly able to reduce their telephone company bills, but the reductions are not necessarily large in percentage terms.

A cross tabulation of the data in tables 4-29 and 4-30 was done to see whether there was any apparent relationship between the size of a bypasser's average monthly bill from the telephone company and the percentage savings resulting from the use of bypass facilities.[7] Table

[7]On the basis of a chi-square test on the data from this sample, one cannot reject the null hypothesis that there is no association between percentage of saving and monthly bill.

TABLE 4-30

AVERAGE PERCENTAGE SAVINGS IN MONTHLY TELEPHONE COMPANY BILLS AS A RESULT OF THE USE OF BYPASS FACILITIES

Percentage Savings	Number of Bypassers	Percent of those Who Answered the Question*
5% or less	8	14.3
6-10%	6	10.7
11-15%	10	17.8
16-20%	9	16.1
21-30%	6	10.7
31-40%	9	16.1
41-50%	3	5.4
Above 50%	5	8.9

*Thirty-three of the eighty-nine bypassers did not respond to this question.
Source: Survey results

4-31 reports the results of this cross tabulation for the forty-three bypassers who responded to both questions. Comparing tables 4-31 and 4-30 shows that four out of five who reported monthly savings greater then 50 percent had monthly bills of less than $100,000. (The monthly bill of the fifth was not reported.) Four of six who reported savings between 21 and 30 percent had monthly bills between $10,000 and $49,999.

Chapter Summary

Contrary to what might be expected, the data reported in this chapter show no single clear trend regarding the characteristics of bypassers, the type of traffic carried by the bypass system, or the

TABLE 4-31

NUMBER OF BYPASSERS IN EACH RANGE OF AVERAGE MONTHLY BILL FROM THE TELEPHONE COMPANY IN 1983, CROSS TABULATED WITH THE AVERAGE PERCENTAGE SAVINGS IN TELEPHONE COMPANY BILLS

	Average Monthly Bill				
Percentage Saving	Less than $10,000	$10,000 - 49,999	$50,000 - 99,000	$100,000 - 999,999	$1,000,000 and above
5% or less		1	1		
6-10%	1	1	1	2	
11-15%	2	2	1	2	
16-20%	1	3	1	2	1
21-30%		4			
31-40%	1	3	2	3	
41-50%	1			2	
Above 50%	1	3	1		

Source: Survey results

range of reasons for bypass. Price is the most frequently mentioned factor in the bypass decision, but many different prices influenced the bypasser's decisions. Private line rates were cited more often than any other long distance rates. Local service rates were cited very often, and end-user charges were reported to be significant more often than were MTS rates. There is great variation in the set of attributes valued by the bypasser. Flexibility and price stability are next most frequently mentioned, but a significant number of bypassers' comments related to the higher quality of bypass facilities and the greater responsiveness to customer needs by bypass suppliers.

The overall effect on usage of telephone company services is difficult to characterize. Some bypassers are either not reducing their use of telephone company services, or are reducing their usage by small amounts. Others, however, are reducing usage of telephone company services by significant amounts, up to 100 percent. While this latter group typically represents a relatively small percentage of all bypassers and an even smaller percentage of the total sample, it does indicate that there are several instances of severe impact from the use of bypass facilities. There is, however, no single pattern to the reductions in usage either among customers or services. One major conclusion is that there are alternative sources of supply for nearly every telephone company service. Another is that there appears to be a lot of bypass activity in private line and local services. More research is needed to determine the extent to which local service bypass results in reductions in the number of local access lines and in the amount of local switched minutes of use.

CHAPTER 5

A DISCRETE CHOICE MODEL ANALYSIS OF THE BYPASSING DECISION

The survey of manufacturing and financial companies provides, for each company, the basic information as to whether or not it currently does bypass, and, if not, whether or not it is considering bypassing in the future. If the reasons for such decisions could be elucidated and if the sample-based results could be extended to the whole population (that is, all manufacturing and financial companies), it is clear that such results would be extremely useful for assessing and forecasting future market changes resulting from technological changes as well as from alternative regulatory policies (cost allocations, pricing, competition, and so forth).

This chapter contains an analysis of the determinants of the bypassing decision that makes use of discrete choice models. The basic issue is outlined first. Next, a discussion of the methodology underlying discrete choice models is presented. The estimation technique is then described, and then the empirical results and examples of use of the models are presented. The final section outlines areas for further research.

The Basic Issue

Consider a company that either bypasses or not. Assume, for a moment that whatever the decision, it was reached in apparently random fashion; that is, we are unable to discern any clear reasons for this decision. Next, suppose that this is also the case for all the other companies in the survey sample and in the whole population. If the sample includes N_B bypassers and N_{NB} nonbypassers, then the share of bypassers is N_B/N (where $N = N_B + N_{NB}$ is the sample size). This share can then be taken as the best estimate, for the whole population, of the probability that any company selected randomly will bypass. This probability can then be used to assess the extent of bypassing in the existing market or in any future market. However, a situation in which no reasons can be proposed for the bypassing decision is obviously extreme. It is clear that such factors as the size of the company, its specific type of activity, and the type and importance of its telecommunications needs, among others, must influence that decision. The purpose of the present analysis is to determine which of these factors have an effect on the bypass decision, and to link, in a quantitative fashion, these factors to the probability of bypassing.

Discrete Choice Models Methodology

In traditional linear regression analysis, when one or more explanatory variables are dichotomous in nature, it is possible to represent them as dummy variables. Suppose, for instance, that household consumption, C, is a function of household income, I, and whether the household head has completed secondary schooling. Let D be equal to 1 if he has done so, and to 0 if not. The regression model

$$C = a_0 + a_1 I + a_2 D \qquad (1)$$

can be estimated by the ordinary least squares method, as all the variables besides D, and in particular the dependent variable, C, are continuous.

However, when the dependent variable is also dichotomous, the application of the linear regression model is no longer that simple. One very important case of dichotomous dependent variables is that of discrete choice data, wherein the data are observations of the decisions of persons or groups selecting alternatives from finite sets of mutually exclusive and exhaustive options. Examples of discrete choice problems abound. The commuter selecting his travel mode, the household searching for a residence, the shopper contemplating alternative shopping trip destinations--all may be viewed as facing discrete choice problems. If one wishes to make sense of such choices made by a sample of decision makers, a behavioral model explaining how the decisions are influenced by attributes of the decision makers and of their choice sets is useful in rationalizing the sample data, and, beyond the sample, in forecasting the choices that would be made by other decision makers facing the same or other options. More precisely, a major purpose of such a model is to determine the probability that an individual with a given set of attributes will make one choice rather than another.

The theoretical approach to discrete choice by consumers is rooted in microeconomic assumptions about their behavior. Consider a representative utility-maximizing individual (which may be a household or a consumer) indexed by i, facing the options of either taking some action, A, or doing nothing, N. If he does nothing, this individual derives a utility $U_i(N)$ from all his other actions, which are not considered here. Let $U_i(A)$ be the utility derived from taking action A. Assuming that utilities are additive, the individual will select A over N if

$$U_i(A) + U_i(N) > U_i(N) \qquad (2)$$

or

$$U_i(A) > 0 \qquad (3)$$

The utility function $U_i(A)$ is assumed to be a linear function of a vector of characteristics, Z_i, of individual i, with

$$U_i(A) = \beta Z_i \qquad (4)$$

where β is a vector of unobserved parameters.

However, real consumers differ from the representative consumer described above in that some characteristics of the consumer are not observed. These unknowns are assumed to follow some population distributions - $\varepsilon_i(N)$ and $\varepsilon_i(A)$ for the two action cases considered. The inclusion of these random elements in the utility functions means that we can analyze only the probability that a given action will be selected. The probability that action A will be selected is

$$P_{iA} = \text{Prob}\ [U_i(N) + \beta Z_i + \varepsilon_i(A) > U_i(N) + \varepsilon_i(N)] \tag{5}$$

or

$$P_{iA} = \text{Prob}\ [\varepsilon_i(N) - \varepsilon_i(A) < \beta Z_i] \tag{6}$$

If we denote the cumulative distribution function of the random variable $\varepsilon_i = \varepsilon_i(N) - \varepsilon_i(A)$ by G, then the probability (6) is

$$P_{iA} = G(\beta Z_i) \tag{7}$$

Depending upon the specific form of the function G, alternative discrete choice models can be derived. One common, and herein adopted, assumption is that the variables ε_i have independent Weibull distributions.[1] Under this assumption, the probability P_{iA} is given by

$$P_{iA} = \frac{\exp\ [\beta Z_i]}{1 + \exp\ [\beta Z_i]} = \frac{1}{1 + \exp\ [-\beta Z_i]}, \tag{8}$$

the so-called logit model. This model is the most widely used qualitative choice model. Indeed it is quite similar in form to the cumulative normal function (which characterizes a large number of random phenomena), and it is easier to use from a computational point of view than other models such as the probit model.

Estimation of the Logit Model

To understand how the unobserved parameters β of model (8) can be estimated, we transform it so as to isolate βZ_i, with

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[1]See, for instance, R.S. Pindyck and D.L. Rubinfeld, Econometric Models and Economic Forecasts (New York: McGraw-Hill Book Co., 1981), chapter 10.

$$\ln\left[\frac{P_{iA}}{1 - P_{iA}}\right] = \beta Z_i \qquad (9)$$

If we were to attempt to estimate equation (9) directly through standard regression techniques, a serious difficulty would arise. Indeed, with survey data where the basic observation unit is the individual consumer, P_{iA} has to be equal to either 0 or 1, and the odds $P_{iA}/(1-P_{iA})$ will be undefined. Thus, the application of ordinary least squares estimation to equation (9), where P_{iA} is set equal to 0 or 1, is clearly inappropriate. In this case, the most suitable estimation technique is the maximum likelihood method, where the objective is to find parameter estimators for β that make it most likely that the pattern of choices in the sample would have occurred.

It is important to remember that the individual P_{iA}s are not observed; instead, the measured dependent variable is $Y_{iA} = 1$ if action A is taken, and 0 if not. Assume now that action A is taken n_1 times and no action n_2 times ($n_1 + n_2 = N$), and that we order the data so that the first n_1 observations are associated with taking action A. The likelihood function that we want to maximize has the general form

$$L = \text{Prob}\ (Y_{1A}, \ldots\ldots. Y_{NA}) = \text{Prob}\ (Y_{1A})\ x \ldots. x\ \text{Prob}\ (Y_{NA}) \qquad (10)$$

under the assumption that the individual observations are all independent one from the other. Equation (10) can be rewritten as

$$L = P_{1A} \cdots P_{nA}\ (1 - P_{n1+1,A}) \cdots (1 - P_{NA}) \qquad (11)$$

$$= \prod_{i=1}^{n_1} P_{iA} \prod_{i=n_1+1}^{N} (1 - P_{iA})$$

It is more convenient to maximize the logarithm of L, with

$$\ln L = \sum_{i=1}^{n_1} \ln P_{iA} + \sum_{i=n_1+1}^{N} \ln (1-P_{iA}), \qquad (12)$$

where P_{iA} is to be replaced by the logistic probability functional form in equation (8). Thus

$$\ln L = F(\beta) = F(\beta_1 \ldots \beta_k \ldots \beta_M), \tag{13}$$

where the β's are the unobserved parameters, including the intercept. The maximum of lnL is reached when all the partial derivatives of lnL are equal to zero, with

$$\frac{\partial(\ln L)}{\partial \beta_k} = \sum_{i=1}^{n_1} \frac{\partial P_{iA}/\partial \beta_k}{P_{iA}} - \sum_{i=n_1+1}^{N} \frac{\partial P_{iA}/\partial \beta_k}{1 - P_{iA}} = 0 \qquad (k = 1 \rightarrow M) \tag{14}$$

or

$$\frac{\partial(\ln L)}{\partial \beta_k} = \sum_{i=1}^{n_1} \beta_k \cdot \frac{\exp(-\beta Z_i)}{1 + \exp(-\beta Z_i)} - \sum_{i=n_1+1}^{N} \beta_k \cdot \frac{1}{1 + \exp(-\beta Z_i)} = 0 \qquad (k = 1 \rightarrow M) \tag{15}$$

The system of M equations (15) is nonlinear and can be solved by iterative techniques, such as the Newton-Raphson algorithm.[2]

The maximum likelihood estimation procedure has a number of desirable statistical properties. All estimators are consistent and also efficient for large samples, and also have approximately normal distributions, so that the analog of the regression t-test can be applied. If we wish to test the significance of the entire logit model, a test using the chi-square distribution replaces the usual F test. To do so, we first evaluate the likelihood function L when all parameters (other than the constant) are set equal to zero. Let this value be L_o. Let L_{max} be the value of the likelihood function at its maximum. The likelihood ratio is defined as

$$\lambda = \frac{L_o}{L_{max}} \tag{16}$$

The test follows from the fact that

$$-2 \ln\lambda = 2\left[\ln L_{max} - \ln L_o\right] \tag{17}$$

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[2]See, for instance, J.M. Ortega and W.C. Reinbolt, Iterative Solution of Nonlinear Equations in Several Variables (New York: Academic Press, 1970).

follows a chi-square distribution with (M-1) degrees of freedom if the L_{max} model is not significantly different statistically from the L_O model. That being the null hypothesis of the test, the computation of $-2\ln\lambda$ will lead to either acceptance or rejection of this null hypothesis.

To use the maximum likelihood results to obtain a measure of goodness of fit analogous to R^2, one can calculate $(1-\ln L_{max}/\ln L_O)$, which will equal 0 when the unconstrained likelihood function, L_{max}, is no greater than the likelihood function in which all parameters are constrained to equal 0, and will increase towards 1 as L_{max} increases.

All the logit model estimations presented in the next section were performed using the procedure LOGIST of the SAS statistical computer package. This procedure can fit a single model or use a backward elimination or a stepwise expansion technique. Maximum likelihood estimates (MLEs) are computed by the Newton-Raphson method.

Empirical Results

The companies that were surveyed can be separated into two major groups: those that do currently bypass (or have already made an operational commitment to bypass) and those that do not. Among the latter, two groups can be distinguished: (1) those who are considering bypass as a possibility for the future (but without any current financial or technical commitment), and (2) those who are not now considering bypass. The two subsections below describe the logit analyses of the above two sets of decisions: (a) currently bypassing as opposed to nonbypassing, and (b) currently considering bypass as opposed to not considering it. The final subsection illustrates the potential applications of the results.

Logit Analysis of the Existing Bypassing Pattern

The purpose of this analysis is to explain the pattern of bypassing currently observed. The variables that might, a priori, be determinants of a decision to bypass made at some time in the past must be observable for both bypassers and nonbypassers. That information was requested by questions 2 to 10 and 47 to 55 of the questionnaire in appendix D. All the variables derived from these questions have been tested, both separately and in group, as possible determinants of the decision to bypass. The criteria for retaining variables in an equation include their individual statistical significances as well as the overall goodness of fit measured by the R proxy. The variable ABYP is defined to be equal to 1 if the company actually bypasses and to 0 if it does not. The best model obtained is then

$$\text{Prob (ABYP=1)} = \frac{1}{1 + \exp (U)} \tag{18}$$

where

	U = + 3.0885	− 0.00025 NEMPL	− 1.5438 VID
(t-value)	(7.00)	(2.63)	(3.46)
(sign)	(0.000)	(0.008)	(0.000)
	− 0.0041 NLT	+ 0.97 MF	− 0.37×10^{-6} BILL
(t-value)	(2.55)	(2.20)	(1.63)
(sign)	(0.011)	(0.028)	(0.103)
	− 0.995 CONC	− 0.0097PTUE	(19)
(t-value)	(1.72)	(1.59)	
(sign)	(0.086)	(0.113)	($-2\ln\lambda$ = 45.46)
			(R = 0.388)

The meaning of the variables is as follows:

NEMPL = number of employees at the surveyed location (these data are included in the Dun and Bradstreet file)

VID = 1 if the company is engaged in video telecommunications, and 0 otherwise

NLT = total number of locations of the firm

MF = 0 if the firm belongs to the manufacturing group, and 1 if it belongs to the financial one

BILL = average monthly bill in 1983 from the telephone company

CONC = index of geographical concentration of the firm's locations, measured as the ratio of the number of locations in the state to the total number of locations

PTUE = percentage of employees at the location using the telephone in their daily work

The t-values and their significances are indicated below the corresponding coefficients. The log likelihood ratio test (equation 17) clearly indicates that the selected variables do indeed contribute to the explanation of the observed decision pattern. The signs of the coefficients are as expected: the probability that a firm bypasses increases with the number of employees, the number of locations, the monthly telephone bill, and the percentage of employees using the telephone. All the previous variables are closely related to the volume of telecommunications activity, and the higher this volume the more likely it is that bypassing options prove attractive economically and otherwise. With regard to geographical factors, the results suggest that the closer the firm's locations (i.e., within state boundaries), the higher the probability of bypassing. This result makes sense because the closer the interconnected locations, the cheaper the bypassing system. Whether a company has been engaged in video telecommunications or not appears to have had a strong impact on the decision, with firms engaged in video transmissions much more likely to bypass.[3] Finally, financial companies are currently less likely to be bypassers than the manufacturing ones. This result suggests that, in the past, bypassing decisions and options were more likely to have been considered in the manufacturing sector. However,

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[3]Indeed, in the late 1940s and early 1950s, the long distance and local loop systems developed by the Bell System were not suitable for video transmission. Hence, companies with such needs had to develop their own systems.

this past pattern does not imply that the same phenomenon will characterize future markets, as suggested by the results presented in the next section.

The above analysis was made on 341 valid and complete observations. Of these 341 firms, 56 are currently bypassing (or about 16 percent), and 286 are not. The deletion of the other observations was due to missing values for some of the variables. Some statistics for the independent variables in the selected subsample are presented in table 5-1.

TABLE 5-1

STATISTICS OF THE INDEPENDENT VARIABLES IN THE CASE OF THE ANALYSIS OF THE VARIABLE ABYP (N = 341)

Variable	Mean	Minimum	Maximum
NEMPL (#)	1,353	515	12,000
VID	0.0880	0	1
NLT (#)	44	1	700
MF	0.34	0	1
BILL ($)	168,804	500	12,000,000
CONC	0.236	0	1
PTUE (%)	58.78	1	100

Source: Author's calculations

In view of the binary character of the variables VID and MF, their means can be interpreted as follows: in the selected subsample, 8.80 percent of the 341 firms are engaged in video telecommunications, while 34 percent of these 341 firms are in the financial sector.

Logit Analysis of Future Bypassing Patterns

This analysis focuses on those firms that do not currently bypass, and on whether they are now considering bypassing in the future. The variable CBYP is defined as equal to 1 if the company is considering bypass, and to 0 if not. A search for explanatory variables similar to that conducted in the previous analysis was performed here. The best model obtained is

$$\text{Prob (CBYP = 1)} = \frac{1}{1 + \exp (V)} \tag{20}$$

where

	V = 2.9619	− 1.5562 TLMT	− 0.00021.NEMPL	
(t-value)	(6.77)	(3.93)	(1.48)	
(sign)	(0.000)	(0.000)	(0.139)	
	− 0.00261.NLT	− 1.03×10^{-6} BILL	+ 0.581 CONC	
(t-value)	(1.33)	(2.03)	(1.04)	
(sign)	(0.184)	(0.043)	(0.300)	
(t-value)	− 0.017 PTUE			(21)
(sign)	(3.10)			
	(0.002)		$(-2\ln\lambda = 53.61)$	
			$(R = 0.418)$	

All the variables in equation (21) have been defined previously, except the variable TLMT, which is equal to 1 if the firm's outgoing toll traffic is carried by MTS service, and to 0 if not. The size-related variables--NEMPL, NLT, BILL, PTUE--have the same type of effect here as in equation (19). However, there are some important differences. For instance, financial firms are as likely as manufacturing ones to consider bypass, everything else being the same. This would suggest a shift towards more financial firms bypassing in the future. Also, the variable VID turned out to be totally insignificant, suggesting that, in the future, video needs might be much less important than in the past in influencing bypassing decisions. The direction of the effect of the variable CONC is also different: the higher the spatial dispersion of locations, the more likely is the firm to consider bypassing options. This may be due to some apprehension about future interstate long distance telephone costs, as well as to the recent availability of technologies that make such systems more economically feasible, such as satellites. Finally, those firms having their outgoing toll traffic carried by MTS service are much more likely to consider bypassing than firms without MTS service.

The above model was estimated using 286 complete observations. Of these 286 firms, 65 (or 23 percent) are considering engaging in bypass. The deletion of other observations was due to missing values. Some statistics for the explanatory variables are presented in table 5-2.

TABLE 5-2

STATISTICS OF THE INDEPENDENT VARIABLES IN THE CASE OF THE ANALYSIS OF THE VARIABLE CBYP (N = 286)

Variable	Mean	Minimum	Maximum
TLMT	0.1434	0	1
NEMPL (#)	1,221	515	12,000
NLT (#)	37	1	600
BILL ($)	111,050	500	4,500,000
PTUE (%)	57.18	1	100
CONC	0.23	0	1

Source: Author's calculations

Example of Applications

Consider a firm selected at random out of the reference population and for which we know the values of the variables of the logit model as shown in equations (18) and (19). We can then compute the probability that this firm does currently bypass. In fact, this computation is of little interest with respect to this specific firm, which either does or does not actually bypass. However, suppose now that we are able to segment the whole population of firms into a finite number of subpopulations of firms, each characterized by a representative firm whose characteristics are known. The probability of bypassing would be the same for each firm in a given subpopulation, and this probability would then represent the share of bypassing firms in the subpopulation. If the previous analysis were applied to all possible subpopulations, a knowledge of current bypassing patterns would be obtained. Naturally, the same kind of analysis can be applied to assess the characteristics of the group of firms that do consider bypass. However, while such an analysis may be of great qualitative interest, it is important to remember that a firm's consideration of bypass among other possible telecommunications options does not necessarily lead to actual future bypass.

To illustrate the above discussion, assume that all firms can be represented by three typical firms characterized by the mean A, the minimum B, and the maximum C values of the explanatory variables in the sample for model (18), as presented in table 5-1. The value of U in equation (19) is computed for each of these three sets of values, and the resulting probabilities of bypassing are then

$$P(A) = 0.1305 \qquad (U = 1.8963)$$
$$P(B) = 0.0499 \qquad (U = 2.9457)$$
$$P(C) = 0.9999 \qquad (U = -9.7603)$$

The above values illustrate the sensitivity of the estimated logit model, and the wide range of possible probability values. A firm with the minimum values (a small firm) would be quite unlikely to bypass, while one with the maximum values (very large firm with video needs) would almost certainly bypass. Only 13 percent of the "average" firms would bypass.

Conclusions

In this chapter we have applied logit model analyses to two decision making processes: (1) past decisions to bypass or not, which translate themselves into the currently observable bypassing pattern, and (2) the decision to consider bypass as a future possibility. Explanatory variables that bear upon the probabilities of taking the above decisions have been identified. Size variables turned out to be particularly significant: the larger the firm in terms of numbers of employees and locations, and the larger its telecommunication activity (including, in particular, video needs), the higher the likelihood that the firm will bypass. The applicability of such models has been illustrated numerically, showing how the extent of bypassing can be assessed for the whole market.

Further research in this area is clearly desirable. For instance, if the sample were extended to other types of activities, models could be developed for all sectors of the economy, such as manufacturing, government, services, or finance. Also, with a larger sample an analysis of the selection of alternative bypassing options could be conducted for those who do bypass.

CHAPTER 6

POLICY RESPONSES TO BYPASS ACTIVITY

Introduction

This chapter contains a discussion of possible policy responses to bypass and the constraints that exist with respect to these responses. Much of the discussion is based on the results of the survey and inferences that can be drawn from the data. A brief summary of key survey findings and a review of the difficulties associated with determining policy are included as introductory material.

Sixteen percent of those surveyed either have a bypass system in place or have a firm commitment to install one. The survey results suggest considerable variability in the effects of this bypass activity. For example, 26 percent of the bypassers in this sample were located in only two states, so there are indications of geographic diversity with respect to the intensity of bypass activity. (This is not unexpected since industrial locations are not spread evenly across the country.) There is also a diversity in the types and amounts of telephone company-provided services that are being displaced by bypass systems. The data in table 4-28 illustrate that bypass systems are being installed to replace nearly every type of telephone company service. Yet the survey results show that there is no consistent pattern among bypassers with respect to the traffic carried by their bypass systems (tables 4-7 through 4-15) and that both long distance and local services are being replaced. The results reported in table 4-28 further indicate no consistent pattern among bypassers with respect to the extent to which telephone company services are being replaced. The percentage decreases in the use of telephone company-provided services range from 0 to 100 percent.

There are several indications that the use of bypass facilities is increasing and will continue to increase. This means steps must be taken now to minimize future problems resulting from bypass. Most of the bypass facilities have been built since 1980 (table 3-7). Several current bypassers have firm commitments to expand their bypass facilities. Sixteen percent of the nonbypassers are now considering the use of bypass facilities, some of whom had rejected the use of bypass in the past (table 3-6). Therefore, it is important to begin now to develop policies and tools to deal with bypass.

The discussion in this chapter is based on the contention that bypass is the emergence of competition in telecommunications markets. As the data reported in chapter 4 indicate, there are customer-provided communications facilities in use that replace a wide variety of services provided by the telephone company. In effect, there are emerging sources of competition for virtually all services. This is the natural outcome of previous FCC decisions, the AT&T divestiture, and the recent advances in telecommunications technology. Consequently, the policy issues raised by bypass are those related to the transition from a monopoly market structure to a competitive market structure.

It will not be an easy task--indeed it may not be possible--to arrive at policy responses that protect the carrier, while at the same time allowing the gains from competition to accrue to the customers.

Determining the specific policy responses to these emerging competitive forces is complicated by several factors. One is that the telephone company is a multiproduct firm whose products frequently share common costs while being offered in markets that are in different stages of market development, including a monopoly market for basic local service.

There are alternative sources of supply for nearly every telephone company service, except the ubiquitously available basic local telephone service. In addition, subsets of customers or calling areas may be able to consolidate their communications traffic in order to utilize private systems and thereby reduce their usage of the public switched network.[1] This can raise problems regarding the future ability to sustain universal service at affordable rates.

The technology of local service may change, and the ownership or the structure of ownership of local facilities may change, but it is unlikely that the monopoly nature of this market will change in the near future. Even with the recent technological advances, there appears to be a social efficiency to the existence of a single provider of ubiquitous basic service. It is this element of ubiquity that distinguishes this service from other local service offerings, and it is this element that gives rise to the social value of this service. An extensive and pervasive communications network has long been recognized as an important element of a nation's infrastructure that is vital to economic development and well-functioning markets. Further, the current near-universal access to telephone usage is an important element in determining the well-being of the citizenry. Thus, maintaining near-universal access to telephone service has long been one objective of regulators.

The policy dilemmas are further complicated by the fact that (as mentioned) nearly all telephone company services share common costs in varying degrees. This means that policy responses to emerging competition are subject to the constraint that no excessive costs be placed on the customers of the monopoly basic service. Without this constraint the goal of universal service could be undermined. In addition, the development of competitive markets would be retarded if this monopoly service were overpriced and therefore became a source of

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[1]If such consolidations were connected to the basic telephone network, ubiquity of calling would be preserved, but the question would arise as to whether these consolidations were resellers, or common carriers and subject to section 201 (a) of the communications act, and equivalent sections of state statutes.

cross subsidy to competitive services. While it is easy to write and talk about the need for "correct pricing," in reality this is difficult to define when common costs are present and especially difficult when the common costs represent significant amounts of the total costs. Ideal responses to the emergence of competition would include a definitive method of allocating common costs, and this has yet to be found.

Finally, the choice of policy responses is further complicated because the services with alternative sources of supply are not in well-defined, mutually exclusive groups of services or customer classes. Due to the blurring of the lines of definition among services associated with the advances in technology and the accompanying fungibility of plant, it is becoming increasingly difficult to isolate a particular market. Furthermore, there is insufficient evidence as yet to indicate which of these markets will ultimately become workably competitive, and which will stabilize at some level of less than workable competition.[2] Until workable competition develops, regulatory policies will be needed that assist any movement toward workably competitive markets without damaging the customers in the monopoly markets. Those markets that remain monopolized, or that develop so few competitive attributes that they do not become workably competitive, will continue to require some degree of regulation. The nature and extent of this regulation may, however, be very different from the present regulatory practices, which were developed for use with firms that had true monopolies.

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[2]Workable competition denotes those markets that are not perfectly competitive, but that still exhibit sufficient market forces to derive many of the benefits of competition. Judgments regarding the attainment of workable competition are generally made on the basis of structural factors, such as the number of firms and entry conditions, and on various performance and conduct criteria for firms participating in the market. See, for example, F.M. Sherer, Industrial Market Structure and Economic Performance, 2nd ed. (Chicago: Rand McNally College Publishing Company, 1980), pp. 41-44.

The following sections discuss policy matters with respect to this developing competition. The policy discussion is focused on attaining two goals. One is that universal service should be maintained, and the other is that markets capable of becoming competitive should be allowed to do so. Both goals reflect current philosophies of most regulators. Either, of course, could become the subject of intense public debate, but are here taken as given.

It is tempting to choose as a policy goal the minimization of revenue loss to the telephone company. While this is a useful objective in some circumstances it cannot be a primary criterion for policy decision making. A higher goal, in our opinion, is to allow the public to reap the benefits of competition while protecting the customers of monopoly services. It may well be that the long term result of this competitive activity will be a reduction in the necessary size of the telephone company plant, in which case the regulators would be faced with difficult decisions regarding the resulting idle plant. Another possibility is, however, that the total market for telecommunications services will grow, and while the telephone company may, in the long run, be offering a different product mix, the problems associated with the reduction in needed plant size will be absent. It is simply not possible to predict the future market developments since they are a function of technology, innovation, telephone company responses, responses of the competitors, and changes in regulatory policies.

Policies for Limiting Avoidable Bypass

The fundamental problem is not one of responding to any one specific form of bypass, but rather it is the need to respond to the emergence of competitive sources of supply for virtually all telephone company services. Thus, the focus of discussion in this chapter is on certain problems arising from the onset of competitive sources in a multiproduct industry that was previously a regulated monopoly.

In those areas and services where competition is just starting to appear, there is time to make reasoned adjustments in policy to meet the increasing use of competitive suppliers. In areas or services with large amounts of bypass activity the reaction needs to be much swifter. It is important to identify the extent and types of competitive activity in each state and the reasons for its occurrence; this will indicate the speed at which other responses should be made. Ultimately, rate structures need to reflect the costs of the various services, and both the telephone company and regulatory commissions can work to remove the causes of avoidable bypass, as defined in chapter 1.

In order to determine the extent to which current bypass is avoidable, it is necessary first to determine why customers are using alternative systems. The survey results in chapter 4 show that there is a wide variety of reasons for bypass. Price is mentioned most frequently, but two important questions underlying this response are (1) which telephone company prices are significant, and (2) what qualities or set of attributes are customers buying for a given price from a competitive source. The responses to the first question were so varied that a rational regulatory response might require an examination of all prices as well as the overall level of costs involved. Regarding the second question, the survey responses indicate that the degree of importance attached to any one factor varies with the individual customer, but that factors such as price stability, flexibility, and reliability are very important. The data, discussed in detail in chapter 4, suggest that the regulatory responses to this emerging competition need to be varied and tailored to the circumstances facing a particular service area.

Rate Design Policies

The emergence of competitive forces in a previously monopoly market brings with it strong pressures for cost-based pricing. This is one of the most difficult of the problems in the transition to competitive telecommunications markets, since most of the services for which alternative suppliers are available share common costs with each other and with the monopoly services. The allocation of common costs has always been subject to debate, and in the absence of evidence of workable competition for all services of the firm, one cannot rely on the market to set prices reflecting an appropriate allocation of costs. At best, a regulator can hope to target a range of reasonableness in the allocation of common costs. If the established firm is subject to workable competition for all its services, then market forces can be depended on to move rates more nearly to a cost basis. However, as long as the multiproduct firm is operating in any monopoly market, then cost-based rates must be imposed by regulators to protect ratepayers in the monopoly services and also to prevent predatory pricing.[3]

The speed with which noncost-based rates are brought to a cost basis may depend on two factors, the degree of price elasticity of demand for the service and the extent and direction by which the existing price diverges from cost-based pricing. That is, a large difference between the existing and the cost-based price would typically call for a slower rate of change when an increase in rates is needed since regulators have tended to adopt a policy of gradualism in increasing rates. A small change in rates or a rate decrease might be accomplished more speedily. The application of this concept of gradualism, however, must be tempered by an awareness of the price elasticity of demand. As competition increases, the demand for any one service will become more price elastic because of the availability of

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[3]In monopoly markets the regulator should ensure that rates do not exceed costs. In competitive markets the regulator should ensure that any gains or losses from a divergence between prices and costs accrues to shareholders and not ratepayers, and that activities in competitive markets do not cause uneconomic expansion of the monopoly rate base. In regulated competitive markets, the regulator needs to balance the protection of ratepayers and competitors. Only if the regulator has (or assumes) responsibility for the promotion and preservation of competition should he be concerned with the actual rates charged in unregulated competitive markets (as distinguished from the effects of such rates upon monopoly rates.)

alternatives. Therefore a faster movement toward prices based on cost is needed. This is so for two reasons. First, it will deter inefficient entry of competitors (entry that is viable only because the telephone company price is set above costs) and will allow the telephone company to compete on an equitable basis. Second, cost-based rates act to prevent cross subsidies that can deter market entry through the underpricing of selected services.

The rate design discussion is focused primarily on end-user charges, and secondarily on other aspects of rate design.

End-User Charges

The end-user charges were designed as a response to MTS/WATS bypass alone. Yet the survey results reported here show that bypass is occurring in nearly all telephone company services.

It is the contention of this report that an optimal federal policy with respect to MTS/WATS bypass would be one that gives the states a great deal of flexibility with respect to any costs that are shifted from MTS/WATS, in order to deal with local competitive circumstances.

Extensive discussion and debate have surrounded the FCC's decision to assign part or all of the interstate share of subscriber loop costs to end users. Those supporting end-user charges contended that, by shifting the subscriber loop costs to end users, toll rates would be lowered and there would be less incentive to bypass the network. Further, it was argued that to assess a nontraffic-sensitive cost on the basis of usage was incorrect and caused heavy users of message toll service (MTS) to subsidize light users. This was said to lead to "uneconomic" bypass.

Several questions need to be addressed in considering the end-user charges as a policy response to bypass. These are: (1) is it an appropriate policy, (2) will it be effective in reducing "avoidable" bypass, (3) are there alternatives that would be equally or more effective.

Appropriateness: Regarding the appropriateness of the policy of an end-user charge, it has been argued that it is an economically correct policy. An end-user charge results in the subscriber loop costs being collected on a nonusage basis. Therefore, the subsidization of small users by large users no longer occurs. However, whether the fact that these costs are levied on a usage basis results in large users subsidizing smaller users is as much a function of the rate structure of the final good (MTS/WATS service) as it is of the allocation of common costs.

If one believes that the costs of the subscriber loops are created when end users choose to join the network, then the costs are correctly asessed to the "cost causer" with end-user charges. However, the loop cost is, ultimately, a common cost for the provision of local, toll, cellular, and other services. Therefore, there will be more than one appropriate method for allocating these costs among users. Moreover, to the extent that any loop costs are created for the purpose of providing improved toll services (such as direct dialing or improved transmission quality), then those costs should be collected from toll users. To do otherwise would be to underprice toll services (creating market entry barriers) and to overprice whatever local services receive that revenue requirement, thereby creating inefficient entry in local markets.

The answer to the first question is that end-user charges can be appropriate policy if two conditions are met. The first condition is that all loop costs created for the provision of toll services be collected from toll carriers. The second condition is that the costs recovered by end-user charges must be determined to be nontraffic sensitive. Mention was made earlier of the fact that there is some controversy over this, though current prevailing opinion is that most loop costs are nontraffic sensitive.

Effectiveness: The matter of the correct allocation of loop costs may never be definitively settled. Therefore, the second question becomes even more important: will the end-user charge be effective as a policy response to bypass? The end-user charge will reduce MTS/WATS rates and thus make toll bypass a less attractive option to users of MTS/WATS services, though it could make local bypass more attractive. A key issue with respect to effectiveness, is: how extensive is MTS/WATS bypass as compared with bypass of other services? The survey results show that while thirty bypassers (34 percent) used interstate MTS service prior to installing their bypass system, only eleven of these thirty have this service capability in their bypass systems.[4] Ten of these have reduced their use of MTS service, and two reported reductions in interstate MTS usage of greater than 50 percent. Sixty-one bypassers (68 percent) used interstate WATS (outwats) prior to the installation of their bypass facilities, and twenty-three of these have that service capability in their bypass system. Only fourteen bypassers reduced their use of telephone company-provided interstate outwats service, and six of the fourteen reported reduced usage of more than 50 percent.

Those bypassers with direct connections from their premises to an interexchange carrier do not exhibit a strong pattern of bypassing to reduce usage of interstate MTS/WATS, as table 6-1 shows. Three of these bypassers reduced their use of interstate outwats, one of whom reduced his usage by 100 percent, one by 50 percent, and one by 40 percent. Three reduced their use of interstate MTS, but none by 100 percent. By comparison, eight reduced their usage of interstate analog private lines, but again only one reported a reduction of 100 percent. It should be noted that the data in table 6-1 reflect the effects of the users' entire bypass facilities, not just the effects of the direct connection to an interexchange carrier. One of the more interesting results is that so few of this group of bypassers reduced their usage of long distance services by 100 percent.

The changes in usage by two other subsets of bypassers--those with average monthly bills of $100,000 or more and those whose bypass traffic is 75 percent or more long distance traffic are also important since these groups represent the customers who are typically

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[4]See table 4-28.

TABLE 6-1

NUMBER OF BYPASSERS WITH DIRECT CONNECTIONS TO AN INTEREXCHANGE CARRIER WHO DECREASED THEIR USE OF TELEPHONE COMPANY SERVICES AS A RESULT OF THEIR BYPASS SYSTEMS, BY SERVICE.*

	Number of Bypassers Who:			
Service	(Column 1) Used the Telco Service Prior to Bypass	(Column 2) Have the Service Capacity in the Bypass System	(Column 3) Have Decreased Use of Telco Service	(Column 4) Have Decreased Use of Telco Service by 100 Percent
Interstate private lines				
Analog	12	9	8	1
Digital (9.6 Kbps or less)	5	3	3	0
Digital (56 Kbps)	2	1	1	0
Digital (1.544 Mbps or T1/T2 carrier channels	2	1	NA**	NA
State private lines				
Analog	9	4	4	1
Digital (9.6 Kbps or less)	3	2	2	1
Digital (56 Kbps)	1	NA	NA	NA
Digital (1.544 Mbps or T1/T2 carrier channels	1	NA	NA	NA
Interstate WATS lines (inwats)	10	6	3	0
Interstate WATS lines (outwats)	9	5	3	1
State WATS lines (inwats)	8	4	2	0
State WATS lines (outwats)	9	5	4	1
Interstate foreign exchange lines	6	4	4	2
State foreign exchange lines	6	5	5	1
Interstate MTS	5	3	3	0
State MTS	4	4	3	1
Intracompany trunks, tie lines, off-premise extensions	11	10	7	1
Centrex lines	7	6	6	2
PBX trunks	10	6	5	0
Other local trunks or lines	2	0	NA	NA

*The total number of such bypassers is fourteen.
**NA means "no answer."
Source: Survey results

viewed as the most significant bypassers in terms of their impact on telephone companies. The responses of these two groups are found in tables 6-2 and 6-3. Their responses provide additional evidence that bypass is occurring in many services but that bypass of MTS service is of lesser importance when compared to other long distance services. Of those bypassers whose bypass traffic is mostly long distance, more (38 percent) have decreased their use of interstate private lines than have decreased the use of any other service. The use of interstate outwats was reduced by 30 percent of these bypassers as compared to 12 percent of all bypassers, indicating that WATS service is more significant to this group than it is to the total group of bypassers. Those bypassers with very large monthly bills also reduced their use of state and interstate private lines more than their use of MTS and WATS services.

Evidence regarding the extent to which MTS/WATS rates influence the bypass decision is found in tables 4-21, 4-22, 4-24 and 4-27. Table 4-21 shows that interstate MTS rates were cited as significant to the bypass decision by fewer bypassers than cited interstate WATS, interstate private line rates, or the interstate end user charge. Interstate WATS rates were cited by the same number as cited the interstate end-user charge. In addition, local rates were cited as significant by large numbers of bypassers. This raises the possibility that the end-user charge may reduce the amount of bypass in MTS/WATS service while increasing bypass in local service. The survey results suggest that the overall reductions in use of MTS/WATS are not currently as significant as are the reductions in the use of other services.

The answer to the question, will end-user charges be effective in reducing avoidable bypass? is that an end-user charge could be effective in reducing only the amount of bypass in MTS/WATS services and would not mitigate bypass of other services. Bypass is occurring in many services, and the end-user charge would increase the likelihood of bypass of local services.

Alternatives: The third question to discuss regarding end-user charges is whether there are better alternatives. This report contends that one preferable alternative is to reduce the interstate allocation of NTS costs by some appropriate amount, and thereby give the state

TABLE 6-2

NUMBER OF BYPASSERS WHOSE BYPASS TRAFFIC IS SEVENTY-FIVE PERCENT OR MORE LONG DISTANCE TRAFFIC, WHO DECREASED THEIR USE OF TELEPHONE COMPANY SERVICES AS A RESULT OF THEIR BYPASS SYSTEMS, BY SERVICE.*

	Number of Bypassers Who:			
Service	(Column 1) Used the Telco Service Prior to Bypass	(Column 2) Have the Service Capacity in the Bypass System	(Column 3) Have Decreased Use of Telco Service	(Column 4) Have Decreased Use of Telco Service by 100 Percent
Interstate private lines				
Analog	19	15	13	3
Digital (9.6 Kbps or less)	9	7	7	1
Digital (56 Kbps)	3	2	2	0
Digital (1.544 Mbps or T1/T2 carrier channels	1	NA**	NA	NA
State private lines				
Analog	16	9	8	1
Digital (9.6 Kbps or less)	3	3	3	0
Digital (56 Kbps)	1	1	1	0
Digital (1.544 Mbps or T1/T2 carrier channels	1	1	1	0
Interstate WATS lines (inwats)	22	7	7	0
Interstate WATS lines (outwats)	23	12	10	3
State WATS lines (inwats)	15	5	3	0
State WATS lines (outwats)	18	7	6	1
Interstate foreign exchange lines	9	4	3	2
State foreign exchange lines	6	2	1	0
Interstate MTS	8	4	4	0
State MTS	7	4	2	0
Intracompany trunks, tie lines, off-premise extensions	20	12	10	1
Centrex lines	7	5	3	2
PBX trunks	22	12	6	0
Other local trunks or lines	5	NA	NA	NA

*The total number of such bypassers is thirty-four.
**NA means "no answer."
Source: Survey results

TABLE 6-3

NUMBER OF RESPONDENTS WHOSE AVERAGE MONTHLY BILL FROM THE TELEPHONE COMPANY IS $100,000 OR MORE, WHO DECREASED THEIR USE OF TELEPHONE COMPANY SERVICES AS A RESULT OF THEIR BYPASS SYSTEMS, BY SERVICE.*

	Number of Bypassers Who:			
Service	(Column 1) Used the Telco Service Prior to Bypass	(Column 2) Have the Service Capacity in the Bypass System	(Column 3) Have Decreased Use of Telco Service	(Column 4) Have Decreased Use of Telco Service by 100 Percent
Interstate private lines				
Analog	19	9	8	1
Digital (9.6 Kbps or less)	12	5	5	2
Digital (56 Kbps)	3	1	1	1
Digital (1.544 Mbps or T1/T2 carrier channels	2	1	1	1
State private lines				
Analog	18	9	8	2
Digital (9.6 Kbps or less)	6	5	4	0
Digital (56 Kbps)	1	1	NA**	NA
Digital (1.544 Mbps or T1/T2 carrier channels	2	2	1	0
Interstate WATS lines (inwats)	18	3	NA	NA
Interstate WATS lines (outwats)	18	4	1	0
State WATS lines (inwats)	15	4	1	0
State WATS lines (outwats)	18	5	1	0
Interstate foreign exchange lines	14	4	2	2
State foreign Exchange lines	11	1	1	1
Interstate MTS	12	3	3	0
State MTS	10	2	1	0
Intracompany trunks, tie lines, off-Premise Extensions	18	14	10	3
Centrex lines	7	3	3	1
PBX trunks	17	8	5	0
Other local trunks or lines	5	3	3	1

*The total number of such bypassers is twenty.
**NA means "no answer."
Source: Survey results

regulators flexibility in assigning the increased jurisdictional revenue requirement. This flexibility is needed to deal with the diverse local market conditions.

Although there currently appears to be limited impact from bypass of MTS/WATS services, the possibility that increasing numbers of customers may directly connect with an interexchange carrier in the future must be considered.

While customers who bypass toll services by installing private systems need both substantial traffic concentration and traffic volume to make the sytem economically feasible, customers who bypass local access services by connecting directly to an interexchange carrier's point-of-presence usually need only sufficient traffic volume. Thus, the ability to use direct connections to an interexchange carrier's point-of-presence increases the number of potential bypassers. Whether such bypass is a viable option for a customer depends on such considerations as the volume of traffic and the distance to the interexchange carriers' point-of-presence. In addition, the number of customer locations that can connect directly to an interexchange carrier is dependent on the existing capacity of the interexchange carrier and the costs of acquiring additional capacity as compared to revenue generated by use of the additional capacity. It is unlikely that any price reduction for MTS/WATS would preclude all such bypass. Moreover, the respondents in this survey indicated that nonprice considerations such as speed of installation and quality of circuits were important to the decision.

Since there is a threat of increasing numbers of customers who connect directly from their premises to the point-of-presence of a toll carrier, and because several bypassers with large amounts of long distance traffic have decreased their use of interstate WATS, the price levels for MTS/WATS must be examined to determine the extent to which they reflect the costs of these services. The intrastate share of subscriber loop cost is a major component of the costs of MTS/WATS services.

The current allocation of subscriber loop plant to interstate MTS/WATS is done on the basis of "frozen SPF" (the subscriber plant factor, whose value, beginning January 1, 1983, was capped at a value based on the previous 12 months average.) The SPF factor increases the interstate share of subscriber loop costs. That is, the allocation that would result from subscriber line usage (SLU), a relative use measure, is inflated by the SPF formula.[5] The use of a formula such as SPF is hard to defend in light of the growing competitiveness of this market. The SPF factor was not intended to have any particular relationship to the relative costs of local and toll services although the SLU element was originally justified on the basis of avoided costs for the toll carriers who did not have to construct local loops. Therefore rates reflecting the SPF allocation cannot be said to be cost based. While there is clearly disagreement over the appropriate allocation of local loop costs, the use of any allocation measure that reflects relative use, relative demand, or some other accepted basis for allocating common costs would seem preferable to the SPF factor, which is an arbitrary allocator. The use of some other factor that would result in a decrease in costs allocated to interstate MTS/WATS would blunt the potential for bypass in the form of direct connection to an interexchange carrier's point-of-presence. Such a reduction could have the same impact on MTS/WATS rates as would an end-user charge. It would also allow for some undetermined amount of costs to remain with toll carriers to reflect the fact that some loop costs are associated with the provision of toll service.

The interstate share of subscriber loop costs is currently scheduled to go from frozen SPF to a 25 percent allocation over a period of time beginning in 1986. Yet even this allocation may need to be reexamined, if the ability to connect directly to an interexchange carrier becomes available to significant numbers of customers. One can determine only a zone of reasonableness for the correct allocation of common costs, and whether the actual allocation should be at the high or low end of the range depends largely on competitive considerations. Increases in the ability of a customer to connect directly to interexchange carriers will increase the price elasticity of demand for

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[5]The actual SPF formula is: SPF = .85 SLU + 2 (SLU)(CSR) where CSR is the Composite Station Ratio. The current SPF allocations of NTS plant to interstate range from 13 percent to 62 percent for Bell companies. NARUC, 1982 Report of the Committee on Communications, p. 37.

local MTS/WATS access services. Therefore, lowering the interstate allocation of subscriber loop costs is an alternative to end-user charges.

This alternative of reducing the interstate allocation of loop costs could be administered in such a way as to prevent the large users from subsidizing small users. The allocation to interstate could be levied on a flat rate basis and allocated among interexchange carriers on some appropriate basis such as market share or potential market share of each carrier. Other methods could also be identified for allocating these costs among carriers. An additional possibility is that the toll carriers could charge the interstate share of loop costs to their customers in a flat rate, resulting in some form of two-part tariff for their customers. As a variation, the implementation of such a plan could be simplified by applying the two-part tariff to large customers only, though this might raise questions regarding price discrimination. It is useful to remember that whether large users subsidize small users can be a function of either the cost allocation or the rate design.

Both the end-user charge and the alternative of reducing the interstate allocation by some appropriate amount will result in reduced MTS/WATS rates. They both can result in the interstate share being levied on a flat rate basis. However, the choice of simply reducing the interstate allocation of loop costs has a significant advantage--flexibility. Both will result in higher charges to customers of local service. The end-user charge specifies how and from whom those higher charges are collected. The alternative leaves that decision to the state regulatory commission, and thereby gives the states the ability to tailor local rates to meet local market conditions.

Market forces are developing in the states at an uneven pace. Over time all rates will move to a cost basis, but there is no evidence of uniformity either among states or services regarding the speed with which this must be accomplished. That is to say, the local service incurring the most competition in one state is not necessarily the same as in another state. Additionally, the relationships between local service prices and costs may vary among states. The services that are underpriced in one state may not be underpriced in another state, or underpriced to the same degree. The states need flexibility in assigning increases in local costs if optimal market development is to occur in all services.

The need for flexibility and a multi-dimensional policy response to bypass activity in each state again is shown by the responses from the bypassers who are large users of long distance services and those who have very large monthly bills. The prices considered by these two groups to be significant in the bypass decision are reported in tables 6-4 and 6-5. Those bypassers with large amounts of long distance traffic (table 6-4) cited interstate WATS rates most often, followed by interstate private line rates. Again, local services were cited often and, surprisingly, so were end-user charges. Those bypassers with very large monthly bills (table 6-5) cited MTS rates less often than any other rates except the interstate end-user charge. A variety of local rates were reported to be significant; state private line rates were most often cited as significant.

The large business customers' demand for local loops may have a higher degree of elasticity than the residential customers' demand, since there are alternative systems available for the business customers' communications. In fact, the survey results indicate that bypass facilities are replacing local as well as toll services and that a variety of local service prices are significant to the bypass decision. Further research is needed to determine the actual effects of this type of bypass on the use of local switched services. However, its potential is as clear as the potential for bypass by direct connection to interexchange carriers. The possibility that the impact of bypass in local services could be as significant as the impact of bypass in MTS/WATS services, at least for large telephone companies, must be considered.[6] If future technological innovations and

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[6]Some authorities think that small telephone companies that receive substantial amounts of their revenues from the interstate toll pool may suffer significant impact from MTS/WATS bypass, since this could result in a reduction in the size of the available toll pool.

TABLE 6-4

TELEPHONE COMPANY PRICES CONSIDERED TO BE MOST SIGNIFICANT IN THE DECISION TO BYPASS, BY THOSE BYPASSERS FOR WHOM 75 PERCENT OR MORE OF THEIR BYPASS TRAFFIC IS LONG DISTANCE

Prices	Number of Locations Citing Each Price*	Percent of This Group Citing Each Price**
State MTS rates	6	18
Interstate MTS rates	11	32
State WATS rates	13	38
Interstate WATS rates	17	50
State private line rates	11	32
Interstate private line rates	14	41
Proposed state end-user charge	12	35
Proposed interstate end-user charge	13	38
Centrex	5	15
PBX trunks	12	35
Within company trunks, tie lines, off-premise extension rates	12	35
Local measured service	6	18
Other	3	9

*The total number of such locations is thirty-four.
**These percentages will total more than 100 percent since each of these thirty-four bypassers could respond to more than one price. (See question 23, Appendix D.)
Source: Survey results

TABLE 6-5

TELEPHONE COMPANY PRICES CONSIDERED TO BE MOST SIGNIFICANT IN THE DECISION TO BYPASS, BY THOSE BYPASSERS WITH AN AVERAGE MONTHLY BILL FROM THE TELEPHONE COMPANY OF $100,000 OR MORE

Prices	Number of Locations Citing Each Price*	Percent of This Group Citing Each Price**
State MTS rates	2	10
Interstate MTS rates	2	10
State WATS rates	3	15
Interstate WATS rates	4	20
State private line rates	8	40
Interstate private line rates	4	20
Proposed state end-user Charge	5	25
Proposed interstate end-user charge	2	10
Centrex	4	20
PBX trunks	7	35
Within company trunks, tie lines, off-premise extension rates	11	55
Local measured service	3	15
Other	3	15

*The total number of such locations is twenty.
**These percentages will total more than 100 percent since each of these twenty bypassers could respond to more than one price. (See question 23, Appendix D.)
Source: Survey results

consequent cost reductions in facilities for local bypass are sufficient to allow small to medium size local customers to bypass, then there may be sustantial fragmentation of the market for local services. While it is not at all certain that small to medium size customers could in the future engage in local bypass, it is equally uncertain whether small to medium size customers could bypass MTS/WATS services in the future. Potentially, neighborhoods, subdivisions, office complexes, and other groups of customers could combine to bypass all but the most nominal usage of local service and significantly reduce the use of local switched services. Market developments of this sort, should they materialize, will not only lead to increased idle capacity of local plant but will also encourage the deaveraging of rates for local service.

The uncertainty surrounding the future scope of both MTS/WATS bypass and local service bypass makes it difficult to determine optimal policies.

One clear response to the potential for MTS/WATS bypass is to reduce the amount of subscriber loop costs paid by MTS/WATS users. The debate is largely over the size of the reduction and the appropriate method of cost recovery to be used.

The third question asked was: are there alternatives to the end-user charge that would be equally or more effective? The answer is that there is a better alternative. Reducing the interstate allocation of subscriber loop costs would blunt the incentive for MTS/WATS bypass, while giving the states needed flexibility. It is because of the growing development of local bypass that the states must have the flexibility to meet changing market conditions.

There is no single prevailing pattern of bypass activity; it appears to be developing at uneven rates across the country. Thus, the most logical policy approach would seem to be one that reflects the market development of particular states and regions. A uniform national policy risks distorting the development of particular local markets. In particular, the risk inherent in overpricing any one local service is that entry will occur as a result of false price signals.

This is entry that might or might not occur if services were correctly priced. To the extent that the competitive entry would not have occurred without the false price signals, then extra costs may be incurred by nonbypass customers.

Thus, the alternative of decreasing interstate subscriber loop cost allocations reduces incentives for MTS/WATS bypass and allows the state regulatory commissions the flexibility needed to tailor rate designs to reflect the actual status of market development, and the demand and cost relationships for various services in their states. This alternative also alleviates another potential problem associated with the effect of end-user charges on the price of business lines. The end-user charge could result in overpriced local business lines in some states, if they were already priced at, or near, their costs. If this overpricing did occur, then competitive entry would be expected. Yet, this entry might not occur if the local business lines were priced at cost.

Other Rate Design Policies

The emergence of competitive supplies of telephone services creates a need to examine existing rate designs and to move the rates toward a cost basis. Until recently, telephone company services were priced according to value of service rather than cost of service methodologies, and it is unlikely that all rates now are cost based. Although it is difficult to allocate costs among services, since there are significant common costs incurred by the various local and toll services, careful analyses should, at a mimimum, indicate a zone of reasonableness for the amount of common costs assigned to each service. If a reasonable estimate of costs can be made, then the key question becomes one of timing: how quickly should one move toward the new rates? Today, if one wishes to avoid sharp increases in rates (a traditional regulatory policy), one is constrained by the extent of competition in the market for any given service. Thus, it is incumbent upon telephone companies and regulatory commissions to monitor the growth of competition closely and systematically. Anecdotal case histories are insufficient for determining the existence and degree of competition.

In the long run, if these markets for local services become fully competitive there will be severe pressures to detariff specific services and to deaverage rates. These measures should be undertaken only when there is clear evidence of workable competition. Measures will need to be developed that prevent the use of monopoly services as a source of cross subsidy, which would both distort market development and reduce universal service by encouraging premature entry in the market of overpriced services. This problem has existed for years without resolution. The need to search for a workable solution will intensify as increasing numbers of customers, services, and calling areas become subject to competitive forces. Moreover, carriers may raise the issue of competitive necessity as a justification for diverging from cost-based rates. In this case the carriers will seek to charge rates equal to those of the most efficient competitor. From a regulatory point of view, as opposed to antitrust considerations the issue is whether gains and losses accrue to ratepayers or shareholders.

In the absence of fully developed competitive markets, detariffing should not be an issue. Yet there is a need for policies that enhance the transition from the monopoly markets to whatever degree of competition will ultimately occur in each market. In addition to moving rates to a cost basis, there are essentially two types of rate design policies that might be appropriate for services that are no longer provided under monopoly conditions, but whose markets are not yet workably competitive. These are quantity discounts and flexible pricing tariffs. The goal of the transition policy should be to enable the regulated firm to operate on an equal basis with competitors while precluding the use of anticompetitive practices by the regulated firm.

The use of bulk rates or quantity discounts may be justified by services that face competitive alternatives. The large user generates substantial revenue for a telephone company, while also being a major factor in determinating the capacity of existing plant. The problems created by the loss of large users or several medium size users have been discussed previously. Since the plant needed to satisfy the minimum requirements of a large user is already in place, it may be that the marginal cost of additional traffic units is low. If it is, then quantity discounts are supportable as cost-based pricing. Alternatively, competitive necessity may call for rate reductions below the costs of service including a full return on investment, but above the avoidable direct costs, so long as there is a positive contribution.

It is important to remember that in cases where the demand for service is inelastic, the use of quantity discounts would serve only to reduce the total revenue of the company. A company might seek to offer quantity discounts in the face of an inelastic demand, to preclude entry, but this behavior may pose questions about predatory pricing and anticompetitive behavior. The price elasticity of demand of large users will be primarily influenced by the number and prices of substitute services available. Therefore, the demand for services is not likely to become highly elastic until there is a high degree of competition within the market. However, telephone company services could serve as substitutes, and therefore cross elasticities of demand would exist among the company's own services. Therefore, in deciding to use quantity discounts or bulk rates, the impact on the use of other telephone company services must be considered. Any bulk rate or quantity discount should, or course, be subject to the constraint that the price not fall below marginal cost.

Flexible pricing was used in several states for customer-premises equipment prior to the deregulation of CPE. One type of flexible pricing involves approving a range of prices for a particular service and allowing the company to change rates within that range without a contested and lengthly rate case. The advantage of this process is that it allows a regulated firm to react quickly to changing market conditions, much as nonregulated firms do. The difficulties with this approach are two-fold. First, the floor of the range cannot go below the cost of the service appropriately defined. Without this restraint there could be predatory pricing with negative effects on market development and the consequent cross subsidies would be borne by another set of customers. Second, there is some market risk regarding the actual rate to be charged. That is, incorrect judgment regarding customer elastiticies and the degree of competition could lead to charging a rate which results in the loss of customers if too high, or a loss in revenues if too low. Any losses of this type that are a function of company decision making need not be recovered from the ratepayers.

Another type of transitional pricing is some form of long term contract service, which could be used to ease customer concerns about price stability. Contracts have an added risk related to the need to forecast future costs. This is a risk borne by any competitive firm. If contracts for competitive services were to be utilized by regulated companies, it would be necessary to isolate the monopoly customers from the risks and their associated costs.

Innovative rate designs may be needed as each franchise area faces increasing amounts of competition for a given service. In fact as markets become competitive, deaveraged rates--both local and long distance--may be necessary. Whatever rate designs are ultimately selected they will need to exhibit three basic characteristics. They must reflect the costs of the service, they must allow for quicker reaction for competitive services than is needed in monopoly services, and they must include mechanisms that isolate the monopoly services from the risks of the competitive markets.

Other Policies

Price was listed as a significant factor in the bypass decision more often than any other one factor. Rate design policies that result in cost-based rates (as discussed in the previous section) will help in reducing avoidable bypass. However, if the overall costs of a telephone company are excessive, then rate design measures alone will not alleviate the problem of avoidable bypass. Thus there is a need both to analyze the existing level of costs and to determine the extent to which cost containment policies can be effective and are being utilized. A firm in a competitive market will be forced to do this, and policies in this transition period should have the objective of emulating market forces. This need to contain costs and reduce excessive costs is clearly a telephone company responsibility, but it is also a responsibility of regulators. The necessary steps include determining whether existing costs are, in fact, excessive and seeing to it that measures are being undertaken to minimize costs. The commission's role could include monitoring the growth in costs as well as offering incentives for cost containment. Incentives can be positive incentives that share the benefits of cost savings among ratepayers and shareholders. Incentives can also be negative incentives that disallow excessive costs being placed on ratepayers. Cost containment policies can be effective in meeting both the price concerns and the price stability concerns of bypassers.

The bypassers in this study frequently mentioned flexibility as an important factor in their decision. In fact price, flexibility, and price stability (table 4-18) were most frequently listed in the top three reasons for bypass. Flexibility is possibly the most difficult factor to make policy responses to. Most of those citing flexibility as important referred to such characteristics as the ability to quickly and easily reconfigure their networks. This appears to be more a function of the technology or equipment used than of telephone company service quality levels. If the telephone company can offer the same capabilities as their competitors, then this is the logical market response. If the company cannot offer the same capabilities, there is virtually no market-oriented response to bypass occuring for this reason. To some extent regulatory restrictions on the offering of enhanced services may preclude the offering of these capabilities by the telephone company. When this occurs then there is a conflict of goals of regulatory policies, which will not be easily resolved. The prohibition on enhanced services had the primary objective of promoting competition. If this now should become responsible in some degree for the perceived greater flexibility of bypass systems, then it is not clear that markets are developing without distortions. The underlying problem is a function of technology and is related to the difficulty in drawing clear lines of distinction between types of services and consequently between unregulated and regulated activities. This report does not undertake to resolve the dilemma, but simply draws attention to the fact that this is an important area for study, especially in light of the importance bypassers attach to flexibility.

Reliability concerns were frequently cited as a significant factor in the decision to bypass (table 4-18). These concerns typically included such matters as the speed of installation and maintenance, quality of circuits, and a generalized feeling that the telephone company was not responsive enough to customers' needs. To a large extent, bypass occuring for reasons related to reliability may be avoidable bypass. A competitive firm will be attentive to customer needs in order to maintain or increase its market share. These concerns are the responsibility of the telephone company. The regulator has little opportunity to respond to them, apart from ensuring that regulatory rules or procedures do not impede the company's response. A commission can monitor the quality and timeliness of service, but the ultimate responsibility is the company's. If a commission could determine how much bypass occurs for reasons related to reliability, it might be able to determine that the cost of the resulting idle capacity not be borne by ratepayers.

Another factor that was frequently cited as a reason for bypass is availability. Only eight bypassers ranked it first in importance and twenty-six (29 percent) ranked it among the top three reasons for bypass. The types of services most often wanted and found unavailable were high speed data transmission and digital facilities. This factor could grow in importance as the communication needs of customers become increasingly sophisticated. Central office or outside plant upgrades may be needed to supply these services where they are currently unavailable. Upgrading the central office equipment may require premature retirement of existing facilities, which, in turn, creates upward pressure on rates. Indeed, more rapid depreciation to avoid premature retirements also puts upward pressure on rates. Higher rates could, in turn, increase bypass activity, so some judgment is needed to avoid a vicious circle. However, the survey results indicate that the need for such plant upgrades may not be currently widespread. Analyses in each market area of the bypass occurring because services are unavailable would allow a company to target the central office equipment replacements and outside plant upgrades to those areas with the highest demand for advanced technologies. This would minimize the costs to all ratepayers. In areas with limited demand for advanced technologies, the benefits or value of meeting this limited demand must be weighed against the costs that would be incurred by all ratepayers because of the early retirement of existing plant. While one can project that at some future date the entire local network will be updated, the fact that availability of services is not a highly ranked factor in the bypass decisions permits the gradual implementation of advanced technologies. An important role for regulatory bodies would be to ensure that plant upgrades are appropriately targeted.

Security was least frequently mentioned among the top three factors in the bypass decision (table 4-18). If the security concerns are a function of the technology (as an example, it is shown in appendix A that fiber optics is very secure from some risks), then a market-oriented response would be for the telephone company to offer these technologies. If, instead, security concerns cause the customer to want to have control over certain communications decisions, the telephone company may have but a limited ability to respond. Whether there is any appropriate regulatory response to security concerns will depend on the reasons for these concerns.

The "Stranded Investment" Problem

The problem of a mismatch between short run changes in revenues and costs (that is, revenues decreasing more rapidly than costs) is a generalized form of what is often referred to as the problem of "stranded investment." That is, the loss of sales volume in a quantity such that some or all of the existing plant that is not yet fully depreciated is left unused. It is generally assumed that for the regulated firm, the cost of such unused plant is then spread among remaining sales units, thus increasing their prices. The ultimate concern of regulators is that such price increases may, over time, be sufficient to cause customers--particularly residential and small business customers--to abandon telephone service. The existing basic local network may remain in place, but would be accessed by a much smaller customer base.

The problem may encompass more than investment costs and may, in fact, extend beyond the short run. Some of the noninvestment costs involved, such as the expenses associated with accounting and billing systems may be used by many services and may not be easily divisible. In addition, labor contracts may inhibit the immediate reduction in labor force that would otherwise be associated with a drop in sales volume. Thus labor costs and other expenses can exhibit "lumpiness" (indivisibilities), which prevents their immediate reduction and thereby creates pressures for higher rates in the same way that undepreciated standed plant exerts upward pressure on rates for the remaining customers.

This mismatch between decreases in revenues and decreases in costs is often considered a short run problem. The short run can be described as a time period long enough to change the degree of plant utilization, but not long enough to change the plant capacity. The long run is then described as a time period long enough to change or adjust plant capacity. Thus, in theory, in the long run the local telephone company should be able to adjust all costs of production to the changes in sales volume and thereby eradicate the short run mismatch between decreases in revenues and costs. In reality, this may not be possible, at least in any practical time frame. And, in fact, the short run, as defined, could encompass several years.

The ability to make long run adjustments in plant capacity is also limited to the extent that a company is required to function as a carrier of last resort. That is, if a company is obligated to provide services to all, then at any given point in time plant capacity must exceed current usage. This idle capacity is available for use by those customers who need back-up service for their private systems, those customers whose private systems are not adequate to meet sudden increases in usage, and for any other new customer or existing customer whose demand for service suddenly increases. Thus, the need for standby capacity carries over the problem of idle capacity to the long run, and raises three major policy questions: (1) to what extent should a company be required to serve as a carrier of last resort, (2) how should the appropriate amount of standby capacity be determined, and (3) who should pay the cost of this "standby" capacity. The short run policy questions are related only to the matter of who should bear the costs of plant idled by a decrease in demand for services. The long run policy questions need to be the subject of broad public debate since the growing use of bypass systems poses the question of whether the concept of "carrier of last resort" is still viable. The answers to these questions will affect the ultimate structure of communications services for the nation. This section treats only the short run problems associated with plant idled by bypass.

As a prelude to determining who should pay the costs of idle plant, it is obviously necessary to determine how much plant is stranded, what kind of plant it is, and why it is idle. The existence of bypass certainly raises the possibility of unused capacity. If the bypass occurs only in incremental services (services or quantities not previously obtained from the telephone company), then there is no resulting idle plant (over existing levels of unused capacity), though there is a reduction in the rate of growth of traffic. When the bypass results in a reduction in the use of telephone company services greater than that which can be accommodated by normal retirements of plant, then there will be unused capacity unless other customers increase their traffic in quantities sufficient to offset the loss to bypass. Although the survey results for this study indicate that currently the reductions in use of telephone plant are not generally severe when viewed in relationship to the total number of bypassers and to the total sample, there are customers who have significantly reduced their use of telephone company services. Further, there will undoubtedly be increases in bypass activity; therefore the problem of idle capacity should be examined. The amount of idle capacity will depend largely on two factors. One is the extent to which the costs associated with the reduced use of services are avoidable. Few of the existing switching, local loop, and outside plant costs are avoidable in the short run, but other costs may be. The second factor that will influence the amount of idle plant is the extent to which demand for other services or demand for the same services by nonbypass customers is increasing. Assuming the idle plant is, in part or all, capable of being used to meet the growing demand, then the net impact on the telephone company is much less. For example, the loss of business MTS traffic due to private bypass systems will in part be offset by increases in residential use of MTS. Any analysis or modeling of the impact of bypass should include the extent to which there are offsets from increasing demand by other customers.

Underlying the discussion of when bypass will result in stranded plant is the question of how much idle capacity already exists. In the past, regulatory commissions have seldom monitored investment decisions by telephone companies with the same degree of scrutiny accorded, say, electric plant expansions. Consequently, there may be insufficient knowledge of the degree to which the current plant is being utilized. This is a problem related to the long run issues discussed earlier, and should be a topic of research by parties concerned with the future development of the telecommunications industry.[7]

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[7]One recent study that began to look at this issue was presented at the Fourth Biennial Regulatory Information Conference by David Weiss of the California Public Utilities Commission. The report is entitled "Telephone Plant Underutilization," in Raymond W. Lawton, ed., Proceedings of the Fourth Biennial Regulatory Information Conference, (Columbus, Ohio: The National Regulatory Research Institute, Fall, 1984.) p. 1038.

After the amount of excess capacity is determined, the question of who pays the associated costs can then be considered. While most analysts of the bypass issue have implicitly or explicitly assumed that the costs of stranded plant would be spread among the remaining customers, there is no reason that this should necessarily happen. Under several rationales, the costs could also be assigned to stockholders or they could be shared by stockholders and ratepayers. In determining who should pay for idle plant there are at least three issues to consider. They are: (1) who is responsible for the idle plant, (2) who should bear the risk associated with bypass, and (3) can the stranded plant be considered "used and useful."

Determining who is responsible for the stranded plant resulting from bypass is largely a matter of determining why the bypass occurred. If the bypass is avoidable bypass, then the telephone company or the regulator or both may be responsible. A telephone company would typically be responsible for inadequate service, marketing, and attention to customer needs; and excessive overall costs. Regulatory bodies would typically be responsible for unnecessary restraints that affect the timeliness and quality of telephone company responses to customers. Bypass originating from poor rate design may well be the responsibility of both parties, depending on the role of each in the determination of a given rate design. Similarly, bypass originating from the unavailability of services could be the responsibility of either or both parties. The survey results reported in chapter 4 indicate that bypass arises for a mixture of reasons; this suggests that the resulting costs might have to be shared between ratepayers and stockholders.

Another factor to consider is the matter of the risk of bypass. If the risk is fully understood by investors and analysts in the financial markets, the market price of the stock has been discounted for this risk. If this has occurred, then the risk should be borne by stockholders and, consequently, so should the costs associated with bypass. If the financial markets expect the regulators to compensate or protect the telephone company, then the market price will not have been discounted, and imposing the cost of bypass on shareholders will depress the price of the stock.

Finally, the treatment accorded to stranded plant resulting from bypass may depend on whether it is simply excess capacity or whether it is abandoned plant. If it is excess capacity, then the question arises as to whether it is viewed as "used and useful" as, for example, standby capacity. Obviously this consideration will help determine how much of the idle plant should remain in the rate base. If the plant is considered abandoned plant, then it should be written off. The method used to write it off will depend on who bears the responsibility for the bypass that created the idle plant and who bears the risk associated with bypass.[8] An additional consideration, however, should be whether writing off the obsolete plant would improve the telephone company's competitive position and thereby, in the long run, benefit all ratepayers.

A case of the generalized stranded investment problem is the situation in which facilities with outmoded technologies must be replaced. The key question would appear to be when this upgrade should occur. Such upgrades may be appropriate even if they result in premature retirement of existing facilities and are properly assessed

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[8] Regulatory commissioners are increasingly facing similar problems with electric utilities - that is, problems of excess capacity and/or abandoned and canceled plant. The problems within the two industries will be somewhat different due to the shorter planning and construction time for telephone plant, and other differences. Also, the growing use of modular elements in switching systems helps to ease the problems of adjustments in capacity for central office equipment, though major problems could exist in the future in terms of unused local loop plant. Two new publications of The National Regulatory Research Institute discuss these problems in the electric industry. Since many of the policy principles and issues involved may be similar for the telephone industry, they are useful reading. Alvin Kaufman and Kevin Kelly, <u>Commission Treatment of Overcapacity in the Electric Power Industry</u>, (Columbus, Ohio: The National Regulatory Research Institute, October 1984). Robert E. Burns, Robert Poling, and Michael Whinihan, <u>The Prudent Investment Test in the 1980s</u> (Columbus, Ohio: The National Regulatory Research Institute, forthcoming, 1985).

to ratepayers. The correct timing of an upgrade is essentially a marginal cost/marginal benefit analysis, where all social costs and social benefits of the alternatives are weighed. This includes analysis of the extent to which bypass is occurring in a given central office area because of customer demand for advanced technologies, the costs associated with the loss of these customers, and the costs of the upgrade. There is no evidence that all network facilities need upgrading now, though they will over time. The critical issue is that each upgrade decision should include consideration of the strength of customer demand for new facilities and the cost of these facilities for all customers.

Summary and Recommendations for Further Work

At the time this project was initiated, the project team was optimistic that a clear-cut pattern of the reasons for bypass and its effects on telephone companies would emerge from the survey responses. This would then lend itself to the development of specific policy responses that could be effective in reducing avoidable bypass. The hoped-for result did not occur. Instead, it was found that there are bypass alternatives for virtually all telephone company services; that bypass occurs for a broad mixture of reasons; that there is, currently, no evidence of large nationwide reductions in the use of telephone company services, though there is evidence of individual instances of severe impact both geographically and among types of services; and that there is no dominant set of characteristics by which one can forecast bypass activity. While price was the most frequently cited factor, it is not clear whether bypassers are paying a higher price in order to obtain more attributes, are paying the same price in order to get more attributes, or are paying a lower price and obtaining the same or a lesser set of attributes.

The results show clearly that competition is emerging in all but the most basic of local services and that the customers' use of competitive alternatives is increasing. One policy conclusion drawn from these results is that policy responses should consist of those actions that remove market imperfections, and that the policies need to be tailored to the specific situations of the individual telephone companies.

There is an absence of uniformity among bypassers in the reasons for bypassing and in the impact of their bypass usage. Therefore a uniform policy for all states would not necessarily be responsive to the variations in market development occurring in the telephone company services. It is better that each state begin to assess the degree of competitive pressures in its jurisdiction and develop appropriate responses.

Moreover, it is important to develop an understanding of the amounts and effects of bypass in local services. The focus of most of the recent public debate has been on bypass of MTS/WATS services. The bypass of local exchange services has been either ignored or considered to be minimal.

Most of the recent debate regarding interexchange bypass has been based on its potential. The potential for local bypass is also great. Currently, much of the local activity is in intracompany trunks and lines, and in LANs. Yet there has been little analysis done to indicate the extent to which local loops and local switched traffic are being reduced by the use of local bypass systems. It may be that most of the current bypass of local services is in incremental traffic and is not displacing existing telephone company usage. However, recent trends in technological innovation create the potential for extensive local bypass, as switched voice communications can be routed through private systems, and as private systems are developed that reduce the number of local loops needed. Residential drop-offs have been the subject of much debate and analysis; it is important to continue to monitor these. It is also important to begin to monitor and study changes in the way small and large business customers are using local telephone company facilities.

This report can be viewed as one step in the work that is needed to understand and shape this transition to competitive markets in an orderly way. Among the additional studies needed are: (1) surveys on a regional or state basis that emphasize the reasons for bypass and the range of services in which bypass is occurring;[9] (2) additional models of the impact of bypass and, in particular, studies that reflect both local and MTS/WATS bypass developments as well as the growth in usage of telephone company services by nonbypass customers; (3) studies of the ways in which bypass of local services is developing and affecting the volume of local switched minutes of use; (4) investigation of the ways in which local measured service rates affect bypass, since several respondents reported that this was a significant price affecting their decision to bypass; (4) analysis of the investment decisions of telephone companies and the extent to which existing plant is underutilized; and (5) studies of methods to isolate the ubiquitously basic telephone service from the effects of detariffing or deregulating other services as they become competitive. Research on these issues will help to resolve the very difficult long run issues regarding the telephone industry and the ability to sustain universal service in conjunction with the increasingly competitive nature of the markets for many telephone company services.

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[9]A shorter version of the questionnaire used in this study could be used.

APPENDIX A

EIGHT BASIC BYPASS TECHNOLOGIES

A bypass technology is defined as a technology that is used to develop communication systems capable of replacing the services provided by the local public telephone company. Bypass systems can be used to carry intra- and intercity traffic and traffic to a point-of-presence of a long haul carrier. This appendix discusses the engineering concepts used to implement the following technologies: (1) satellite, (2) private microwave, (3) digital termination systems, (4) local area networks, (5) CATV, (6) fiber optics, (7) teleports, and (8) cellular mobile telephone.[1]

Satellite Communications

Satellite communication networks provide an economical method to supply long haul communications over large geographic areas. The network is designed as a star topology with the satellite acting as a central switching center. The satellite antenna receives electromagnetic energy from an earth ground station on a given frequency such as 6 GHz and filters out undesirable frequencies. The signal is

[1]Much of this appendix is based on notes from a seminar given by Jerome Lucas, and the seminar notebook entitled: Telephone Bypass Technologies and Economics (McLean, Virginia: TeleStrategies, Inc., 1983).

amplified and transmitted down to another earth station on another frequency such as 4 GHz. This process is similar to a simple repeater. A satellite is comprised of repeaters called transponders. Figure A-1 represents a typical end-to-end satellite communications link.

Satellites are designed according to their role in relaying communications. Table A-1 lists four categories of communication satellites: intercontinental, domestic, television broadcast, and mobile. The intercontinental satellites relay worldwide voice, data, and video communications to large, expensive, and reliable earth stations. Domestic satellites receive and distribute common carrier

TABLE A-1

MAJOR CATEGORIES OF COMMUNICATION SATELLITES

Category	Example	Services
Intercontinental satellites	INTELSAT I - V Russian Molniya Europe's Symphonie	Worldwide voice, data, and video
Domestic satellite	Canada's Anik Western Union's Westar RCA's Satcom COMSAT's Comstart SBS ARABSAT	Common carrier services Corporate communications Television distribution
Television broadcast satellites	Japanese System Canada's CTS NASA's ATS-6 COMSAT	Television broadcasting direct to home
Mobile	MARISAT	Telephone, data and telex

Source: Jerome Lucas, <u>Telephone Bypass Technologies and Economics</u>, (McLean, Virginia: TeleStrategies, Inc., 1983), p. 6-10

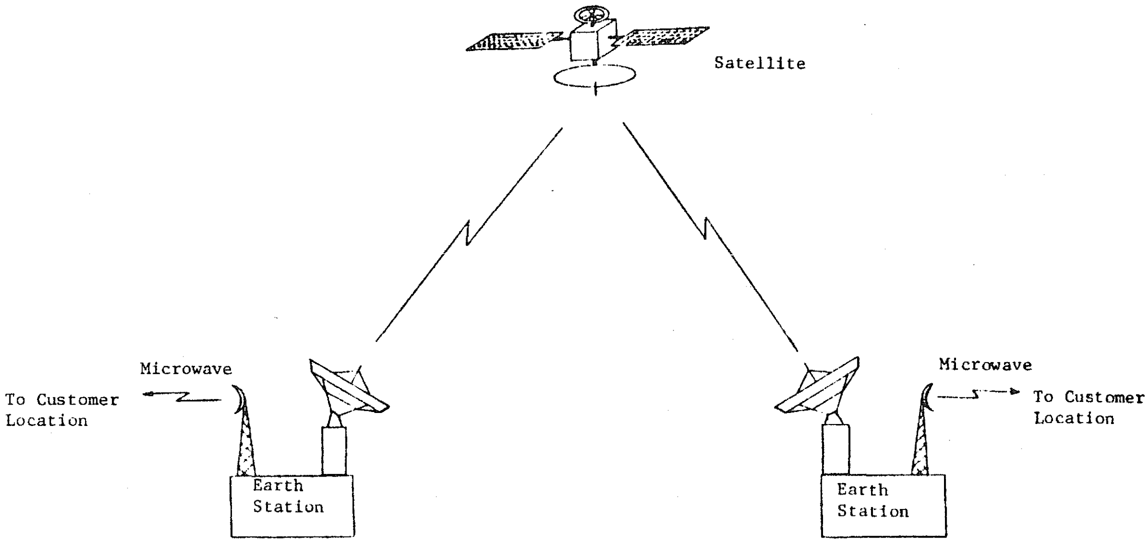

Fig. A-1. Typical end-to-end satellite communications link services, corporate communications, and television signals. Television broadcast satellites require a large transmittal station to broadcast television directly into the home with only a small receiving earth station. Mobile satellites relay telephone, data, and telex to very small UHF shipboard terminals for maritime use.

Communications Path

The basic satellite communications path would include an earth station transmitter, a satellite, and an earth station receiver as shown in figure A-2. The distance between an earth station and the satellite is approximately 24,000 miles and is considered as a single hop in the signal path. The entire transmission path requires two hops, or 48,000 miles. These long paths will cause a .5-second signal delay that makes it more difficult to carry highly interactive data and voice transmissions.

An earth station transmitter typically operates at 6 GHz as its up-link frequency. It requires large ground antennas of about 15 meters and high power ground stations. If higher frequencies were used, a smaller antenna could be installed at the earth station. For 15 GHz and 30 GHz, 2-meter or 1-meter antennas could be installed, respectively. There are many other trade offs when determining transmission frequency, such as information rate, signal-to-noise level, earth station gain, frequencies, rain attenuation, and interference.[2]

A satellite most commonly operates in the 6- and 4-GHz frequency band with some satellites operating at 14 and 12 GHz and 30 and 20 GHz. It has an orbiting distance of 22,000 miles that allows it to cover about 40 percent of the earth's surface.

Communications satellites are placed into geostationary orbits. Geostationary orbits are preferred over asynchronous orbits because

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[2]Jerome Lucas, Telephone Bypass Technologies and Economics, (McLean, Virginia: TeleStrategies, Inc., 1983), p. 6-1.

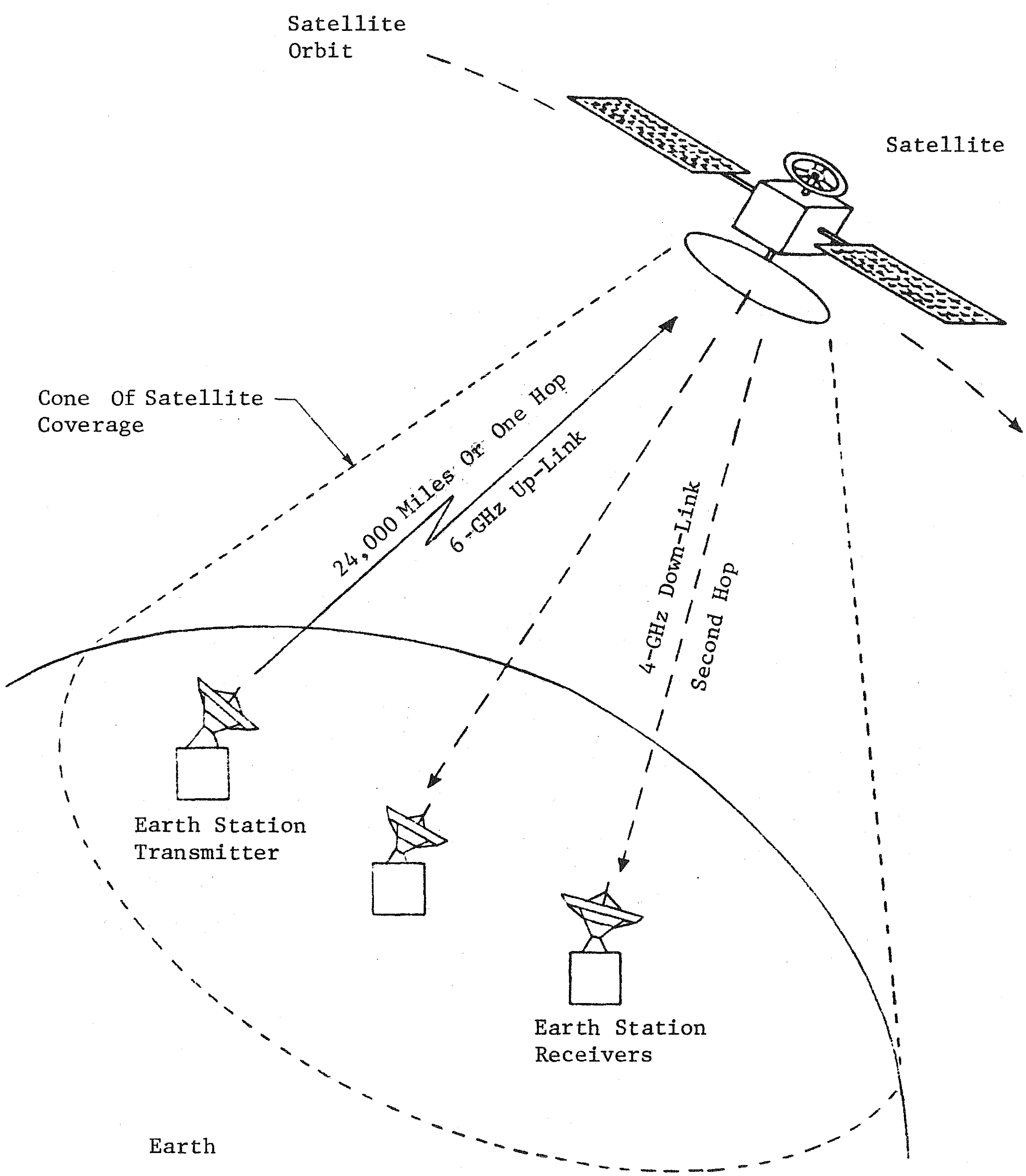

Fig. A-2. Basic satellite communications configuration they do not require any tracking devices, switch functions between satellites, and have no doppler shift problems. Three satellites in geostationary orbit spaced 120 degrees apart provide complete coverage of the earth's surface except for some polar regions. With each satellite covering a zone of one-third the earth's surface, interzone communications is accomplished by using international earth stations to relay traffic.

Signals from the orbiting satellite have a signal strength of about 10 to 12 watts and are received by an earth station, usually at 4 GHz. This completes the 48,000-mile transmission path.

Frequency Bands

Most satellites operate in one of the three different frequency bands: C band, KU band, and KA band. In the C band, the satellite transmits at 6 GHz and receives at 4 GHz. This is the most commonly used band except for MARISTAT and military satellites. In the KU band, the satellite receives at 11 to 12 GHz and transmits at 14 GHz. This higher frequency allows for smaller antenna receiving dishes. It is currently being used by Satellite Business Systems (SBS) and Intelsat V. In the KA band, the satellite receives at 19 to 20 GHz and transmits at 29 to 30 GHz. This is in experimental use by Mitshubishi for developing small earth stations for use with Japanese communication satellites.[3]

Transmission Techniques

Communication signals can be transmitted using various techniques such as Frequency Division Multiplexing (FDM), Frequency Division Multiple Access (FDMA), Time Division Multiplexing (TDM), Time Division Multiple Access (TDMA), and Single Channel per Carrier Telephony (SCPC).

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[3]Ibid., p. 6-7.

For FDM and FDMA, the transmitting spectrum is typically divided into bands of 36 MHz with 4 MHz of spacing between channels. There may be a 20-MHz command and control or telemetry channel. For a Western Union satellite, twelve communications channels are available plus one command control channel. A transponder, which is a receiver-transmitter pair, is used for each channel. FDMA uses the same technique except the channels are allocated to the earth stations when they are needed using the command control channel to notify each earth station.[4]

For TDM, all stations use the same carrier frequency, but their signal occurs at a specific time interval in a specific time slot. The time slot is usually allocated by demand. A central control notifies the members of the transmission path which time slot has been assigned, and receivers only look at the information at these specific times. TDMA uses the same technique except the channels are allocated when needed. This signaling technique requires a full transponder for effective use and the earth station is usually costly, with a 10- to 11-meter antenna.

SCPC allows one voice or data channel per carrier. It has the advantages of matching up the exact capacity to the traffic, having an excellent transponder usage for small traffic nodes, providing low cost for low traffic, and adapting to the demand assignment. The main disadvantages are the high cost for heavy traffic and inability to integrate voice, data, and video. This technique requires only partial use of a transponder, is most commonly implemented on the C band, and needs a low cost 5-meter antenna that can be installed on the customer's premises.

When two earth stations require the use of the same frequency, the satellite utilizes spot and polarizing beaming of signals. Spot beaming concentrates signal in a given location and multiplexes the signal by properly switching transponders to eliminate interference.

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[4]Don L. Cannon and Gerald Luecke, Understanding Communications Systems (Dallas, Texas: Texas Instruments Incorporated, 1980), p. 10-7.

The use of polarized radiation polarizes one pair of antennas vertically and another pair horizontally to separate transmissions and to eliminate interference. Also, satellites can transmit and receive on several different bands, allowing 14- and 12-GHz bands to operate concurrently with 6- and 4-GHz bands.[5]

Satellite transmissions are affected by delay and noise. The long haul distance of approximately 48,000 miles causes a delay of 480 to 540 milliseconds due to distance and atmospheric conditions. This poses a great deal of difficulty when transmitting highly interactive data transmissions, double hops, and IBM bisynch protocols. Noise in an antenna used only for receiving signals varies according to the antenna beam width. If the beam width of the receiving antenna is wide, the antenna detects stray electromagnetic radiation or noise. A signal to a small antenna (1 to 3 meters) requires a larger bandwidth than a larger antenna. For a 4-MHz TV signal, a 36-MHz bandwidth may be required for a reliable transmission. For a 4-KHz voice channel, a 40-KHz bandwidth may be required. This means that for a smaller earth station, the station cost is reduced, but the cost of transmission goes up because each channel requires a large bandwidth. Large bandwidths utilize satellite transponders very inefficiently.[6]

Design Factors

For a satellite system to be competitive, it must reduce the cost per channel on its carrier frequency. This involves maximizing the bandwidth and the number of channels for a satellite configuration. The launch vehicle used to place the satellite into orbit determines the maximum weight of the satellite. A satellite's weight increases as more power and channel capacity is incorporated. A heavier satellite would require a larger rocket, which would increase the cost of the

[5]Ibid., p. 10-22.

[6]Ibid., p. 10-21.

launch. Three rocket systems, Delta, Atlas/Centaur, and Titan III, have followed this trend with maximum weights of 500 kg, 900 kg, and 1,500 kg, respectively. Heavier satellites launched by the Titan III have a higher capacity per weight and a lower cost per channel due to advances in microelectronics.

Improvements in satellite electronic technologies of solar panels and electronic circuitry have been a major influence in the development of high capacity satellites. Solar panels are used to power the satellite by taking advantage of its exposure to direct sunlight. Electricity necessary to power the satellite is converted from the sun's radiant energy to electric current. The amount of power generated by the cells is a function of the amount of cell surface area exposed to the sun's energy. Solar cell technology has increased the efficiency of solar cells by more than 50 percent since they were first introduced. The increase in power has lead to more powerful satellite transmitters that can reduce the cost of the receiving earth station components. There are two types of solar cell mountings: one for a spin-stabilized satellite and one for a body-stabilized satellite.

A spin-stabilized satellite has its solar cells wrapped around the body of the satellite. The spinning satellite acts as a gryroscope to help the satellite maintain its orbit. Only 40 to 50 percent of the cells are exposed to direct sunlight at any given time, which reduces the effectiveness of the solar panels.

A body-stabilized satellite uses a spinning wheel for a gyroscope with the solar cell panels and satellite body fixed. The panels are fully exposed to the sun with a larger surface area that can generate thousands of watts of power, compared to only a few hundred watts for spin-stabilized satellites.

Electronics have become more weight-efficient since the introduction of microelectronics. It is possible to maximize the number of transponders by reducing the weight and size of all other associated electronics. The typical satellite receiver/transmitter block diagram is shown in figure A-3. A 6-GHz signal is received and amplified by the wideband receiver for conversion to 4 GHz. The

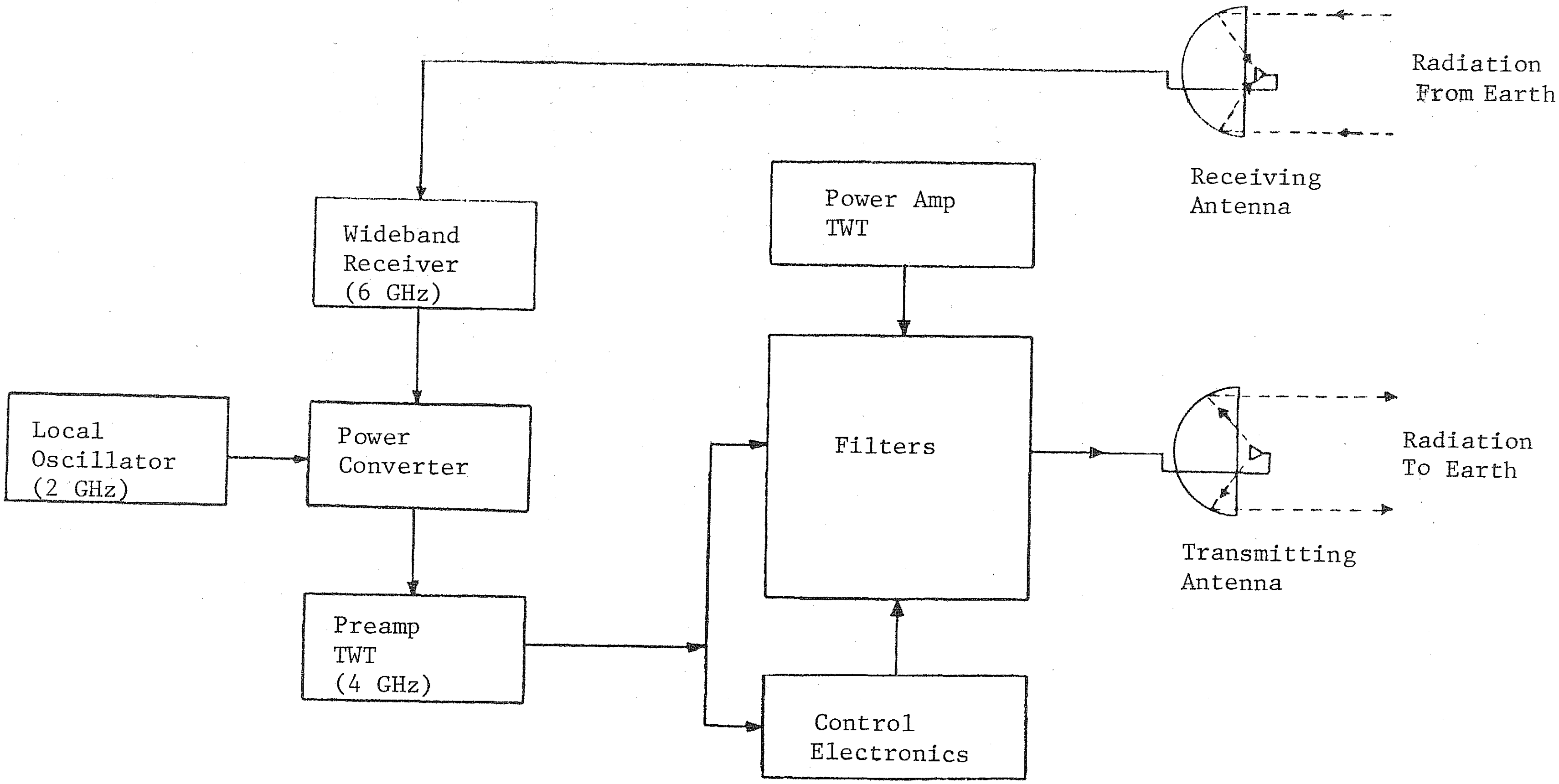

Fig. A-3. Typical satellite receiver/transmitter block diagram
Source: Don L. Cannon and Gerald Luecke, Understanding Communications Systems (Dallas: Texas Instruments Incorporated, 1980), p. 10-14

conversion is performed by mixing a 2-GHz local oscillator with the 6-GHz signals that are used to drive the traveling wave tube (TWT) preamplifier. A traveling wave tube is an electron tube that amplifies microwave frequencies. The 4-GHz signal is sent through a filter network to the power amplifier TWT for retransmission back to earth. The filter selectively shuttles the incoming signal to the appropriate transponder.[7]

Satellite performance and capacity depends mostly on the antenna's capability to transmit and receive radio frequencies (RF). The power of the antenna and the precision of its radiation pattern determines the effectiveness of the antenna. A large antenna generally can focus a more precise radiation beam that will emit a higher concentration of radiated energy over the surface of the earth. High radiated energy from a satellite would require smaller earth station antennas. If the pattern is well controlled, satellites of close proximity will not interfere with each other. This allows geosynchronous satellites to provide a wider total bandwidth for added capacity. A large antenna requires special electronics to send energy to it from the power amplifier.

Some satellites use separate antennas for global coverage and localized spot coverage as shown in figure A-4. This allows different transmission paths to use the same frequency. The reuse of frequency increases capacity without a significant increase in satellite costs.

Network Services

Satellite network services provide dedicated channels (leased lines) and switched network services for low speed to wideband transmissions. Transmissions have three classifications: low speed,

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[7]Ibid., p. 10-14.

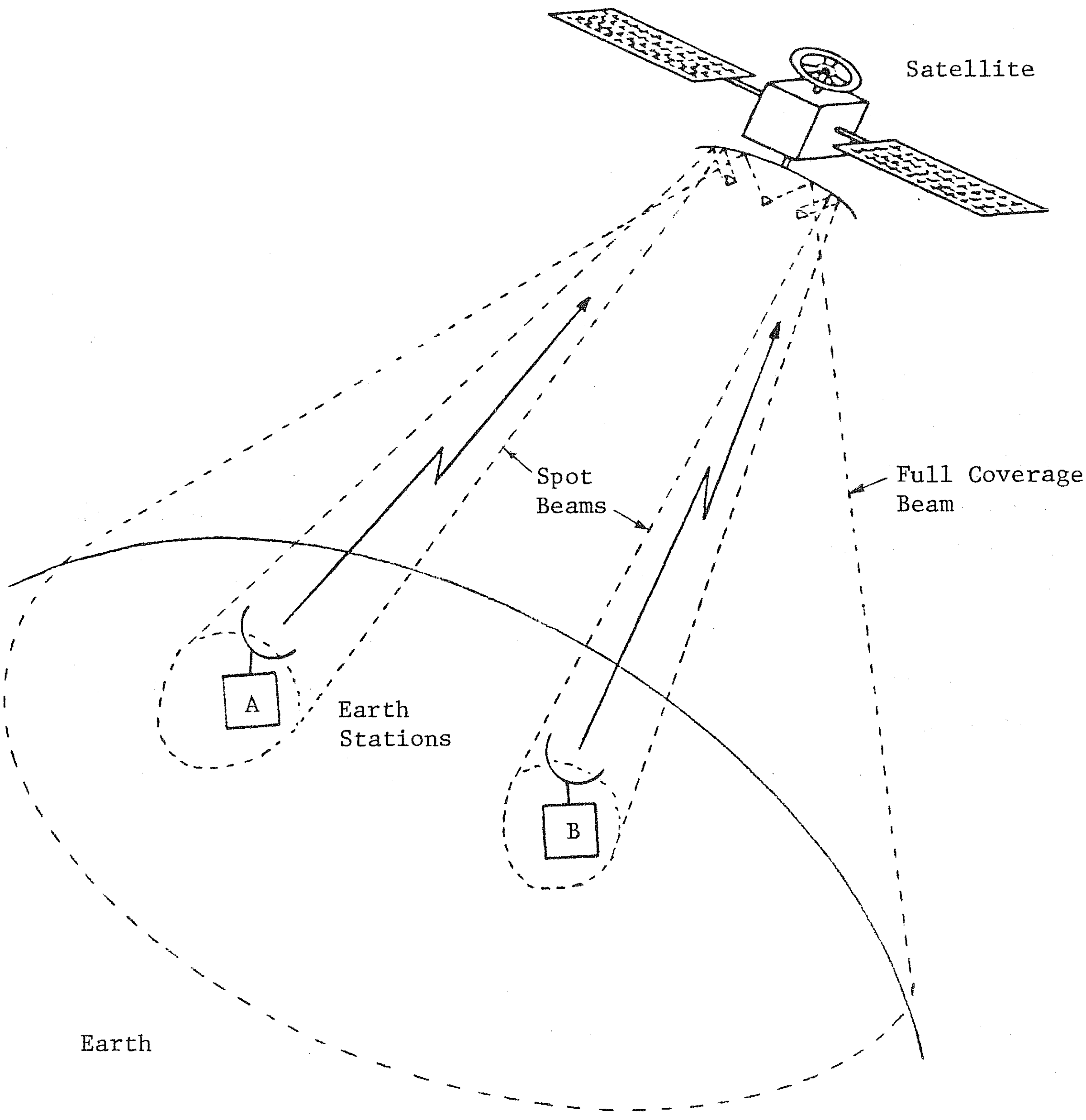

Fig. A-4. Frequency re-use by using spot beams voice grade, and wideband. Low speed data transmissions have a range of 0 to 300 bits per second. Voice grade data transmissions have a data rate of up to 4,800 bits per second. And wideband data transmissions have a data rate up to 3.088 million bits per second. Table A-2 lists companies offering dedicated channels and switched network services.

TABLE A-2

SATELLITE NETWORK SERVICES

Company	Dedicated	Switched	Voice and Data
American Satellite Corporation	X	X	Data only
AT&T	X	X	Yes
RCA Americom	X	X	Yes
RCA Cylix		X	Data only
Satellite Business System	X	X	Yes
Starnet Corporation	X	X	Yes
ITT Worldcom		X	Data only
Western Union	X		Yes

Source: Communication Systems, (Cherry Hill, New Jersey: Data Decisions, 1982). File sequence no. 810-03.

Approximately 16 U.S. domestic satellites are in operation as of December 1983, as shown in table A-3. These satellites have an approximate capacity of 340 transponders, with 283 transponders used for video, message, and private network applications. The remaining transponders are unassigned. Western Union, RCA, and AT&T satellites operate in the C band (6 and 4 GHz). Only some RCA and all Satellite Business Systems satellites operate in the KU band (14 and 12 GHz).

Private Microwave

Microwave systems provide wireless, point-to-point communications using radio frequencies to transmit analog or digital signals. The main advantage of microwave is the absence of any physical connection between

TABLE A-3

UNITED STATES DOMESTIC SATELLITE TRANSPONDER
DEMAND ESTIMATE (DECEMBER 1983)

Company	Number of Satellites	Number of Transponders			
		TV/Video	Message	Private	Unassigned
Western Union	4	58	18	-	5
RCA	5	62	43	-	11
AT&T	4	10	46	-	14
Satellite Business Systems (KU band only)	3	-	8	15	6
Hughes	2	20	3	-	21
Total	18	150	118	15	57

Source: Jerome Lucas, Telephone Bypass Technologies and Economics, (McLean, Virginia: TeleStrategies, Inc., 1983), p. 6-23

two points. Microwave is better than conventional wire systems in areas where it is difficult to install buried wire systems, such as highly populated metropolitan areas, mountains, or heavily wooded terrain. Microwave transmissions are carried on the common carrier radio frequency bands that are allocated by the FCC. In the past microwave was better suited to carry video signals than were coaxial cables. While this is no longer the case, microwave is still superior to twisted pair, or even shielded twisted pair cables for video applications.

System Characteristics

Microwave systems consist of two antennas and signal processing electronics for tranmitting and receiving information. Signal reception is limited by transmitter power, obstructions, path length, and antenna patterns. The design of a microwave system is determined by the characteristics of the transmission path. There are five path parameters:[8]

1. Frequency clearance
2. Line of sight
3. Range
4. Availability
5. Data rate

Microwave transmissions operate on frequency bands of 2, 11, 18, and 24 GHz. Analog microwave signals are multiplexed into four designated groups: group (12-voice channels), super group (60-voice channels), master group (600-voice channels), and jumbo group (3600-voice channels). A voice channel requires 4 KHz of bandwidth. This allows analog microwave systems to use the bandwidth more efficiently than digital microwave, which requires 64 KHz for each voice channel. Digital microwave signals are multiplexed into 6 code designations: DS-0 (1-voice channel), DS-1 (24-voice channels), DS-1C (48-voice channels), DS-2 (96-voice channels), DS-3 (672-voice channels), and DS-4 (4032 voice channels). Each voice channel on a digital transmission requires a bit rate of 64,000 bits per second. Usually, signals are modulated with 1 bit per hertz. Digital microwave can provide longer transmission paths than analog systems due to its greater immunity to noise.[9]

The frequency clearance determines the number of bandwidths available in a Standard Metropolitan Statistical Area (SMSA). A minimum usage requirement for all transmissions is determined by the FCC. The 2-GHz and 4- and 6-GHz frequency bands require a minimum use of ninety-six voice channels and over one hundred voice channels, respectively. Most urban centers are very congested at these frequency

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[8]Lucas, Telephone Bypass Technologies p. 6-1.

[9]Ibid., pp. 3-1 to 3-4.

bands. At 11 GHz, the FCC requires a 20-MHz channel and a T-1 digital channel for operation. The 12-GHz frequency band requires a minimum bandwidth of 10 MHz per slot for private users. Both 11 and 12 GHz are also congested in urban areas. The only frequencies not heavily used are 18 and 24 GHz, due to their recent introduction.

The line of sight between the two microwave antennas must be maintained for transmission to occur between the sender and the receiver. For some systems, antennas may be located inside or outside a facility. In selecting the line of sight, objects close to this pathway could cause unwanted signal reflections.

The range of a microwave system is dependent on climatic conditions and terrain features. As the frequency increases, microwave transmissions are more susceptible to losses due to attenuation in rain. Table A-4 shows the transmission range for each frequency band. The range of microwave systems is limited in high rain areas such as the southeast United States from eastern Texas to Florida.

TABLE A-4

DIGITAL MICROWAVE RANGE

Frequency (GHz)	Range (Miles)
2	20-30
11-12	10-18
18	5-8
24	1-4

Source: Jerome Lucas, Telephone Bypass Technologies and Economics (McLean, Virginia: TeleStrategies, Inc., 1983), p. 3-1.

Microwave systems are usually available 99.5 percent of the time. Outages occasionally occur due to rain. When outages occur, alternate transmitting facilities are used to reroute processing. System reliability can be increased by using sophisticated control techniques in the signal coding process.

Data rate is dependent on the available bandwidth and channels a microwave system can support. It can range from 64 Kbps to 3.152 Mbps. A T-1 channel operates at 1.544 Mbps while a voice channel operates at 64 Kbps.

Digital Termination Systems

A digital termination system (DTS) supplies local data communications services using a microwave transmitter as a central distribution center to remote user stations. DTS has applications in crowded urban areas where high speed data communication is limited and expensive. The FCC has approved over thirty-five DTS applications from telecommunications companies such as MCI Telecommunications, Inc., Satellite Business Systems, and GTE/Telenet.

System Overview

DTS is a broadcast microwave system that consists of a centrally located, omnidirectional microwave transceiver that communicates with remote user stations via shared 1.5-Mbps, full duplex channels as shown in figure A-5. Full duplex channels allow simultaneous communications between the remote station and the central transceiver. The limitation of DTS is the narrow bandwidth of the serving spectrum. The maximum effective spectrum offered between two points is only 1.5 Mbps. This is only economical for data circuits in the 20-Kbps to 200-Kbps aggregate range. Voice circuits would be economically served on local loops due to the limited bandwidth of DTS.

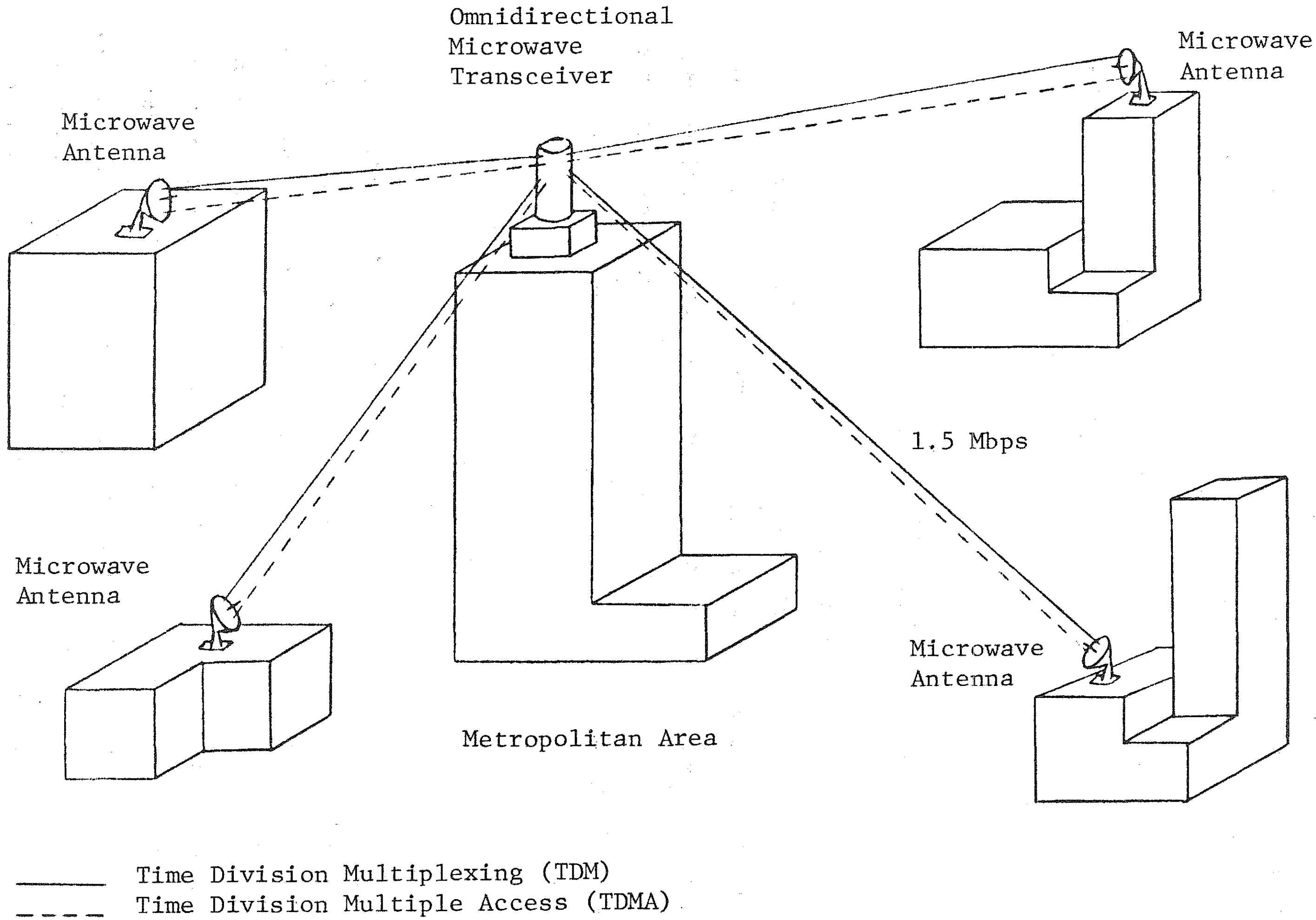

Fig. A-5. Example of a digital termination system

DTS has a main broadcasting station, normally located on the highest structure in a city. This allows a direct line of sight between the broadcasting station and the remote user stations. The DTS antenna system consists of three transmitting cells with each cell having a 120-degree coverage for complete citywide distribution as shown in Figure A-6. Each transmitter operates at a different frequency with a designated type of polarization. An electromagnetic wave can be polarized in the horizontal or vertical directions. The broadcasting signals have a range of up to 4 miles. With these limitations, frequencies can be re-used every 8 miles with varying antenna positions to limit interference. Figure A-7 shows a frequency re-use plan where A, B, and C are 1.8-Mbps subchannels, and H and V are polarization assignments.

Data are transmitted to user stations using a time division multiplex (TDM) process. TDM allocates a time slot in the transmission path to a channel on a cyclic basis, allowing multiple channels to share the same path. Data transmitted back to the broadcasting station uses a time division multiplex access (TDMA) process. TDMA uses time interfacing to receive transmissions from multiple locations simultaneously as shown in figure A-8. Depending on the modulation methods, channelization othe 5 MHz can range between three to six channels at a bit rate of 1.7-1.8 Mbps.[10] The advantage of a DTS is the small, 2-foot diameter receiving antenna dish required for a remote user station. It receives data at 1.5 Mps and costs approximately $11,000.[11] The entire receiving station can be installed in a day.

There are two types of DTS authorized by the FCC-extended carriers and limited carriers. Over sixteen extended carriers have been approved by the FCC. Extended carriers can operate with a 5-MHz bandwidth each way and up to seven carriers for a total band usage of 70 MHz. The extended carrier must serve thirty SMSAs and has 5

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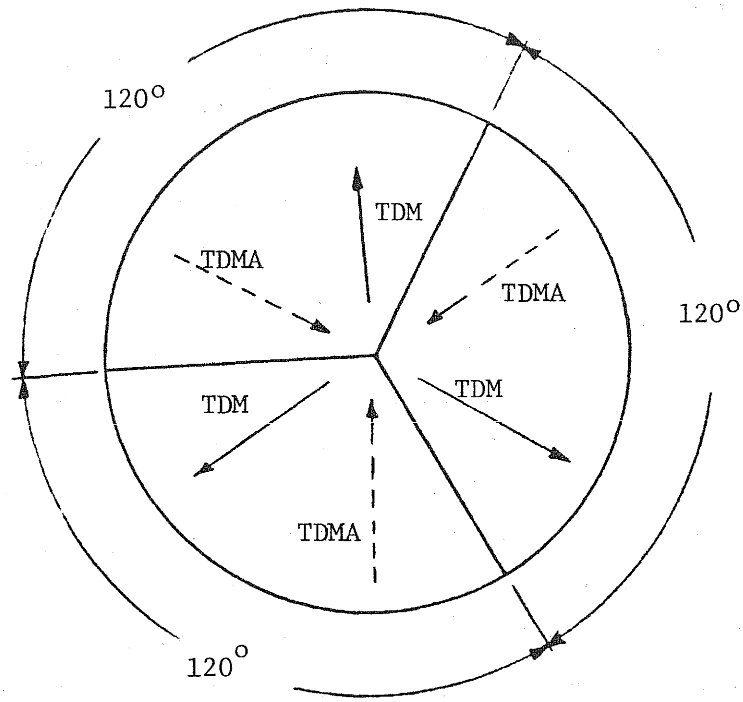
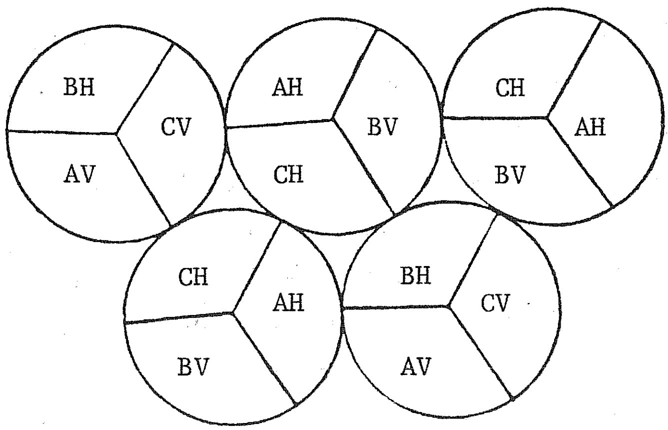
[10]Ibid., p. 2-11.

[11]Ibid., p. 2-12.



TDM = Time Division Multiplexing
TDMA = Time Division Multiple Access

Fig. A-6. Transmission cells for DTS antenna



A, B, C = 1.8-Mbps Subchannels
M, V = Polarization Assignments

Fig. A-7. Frequency re-use plan

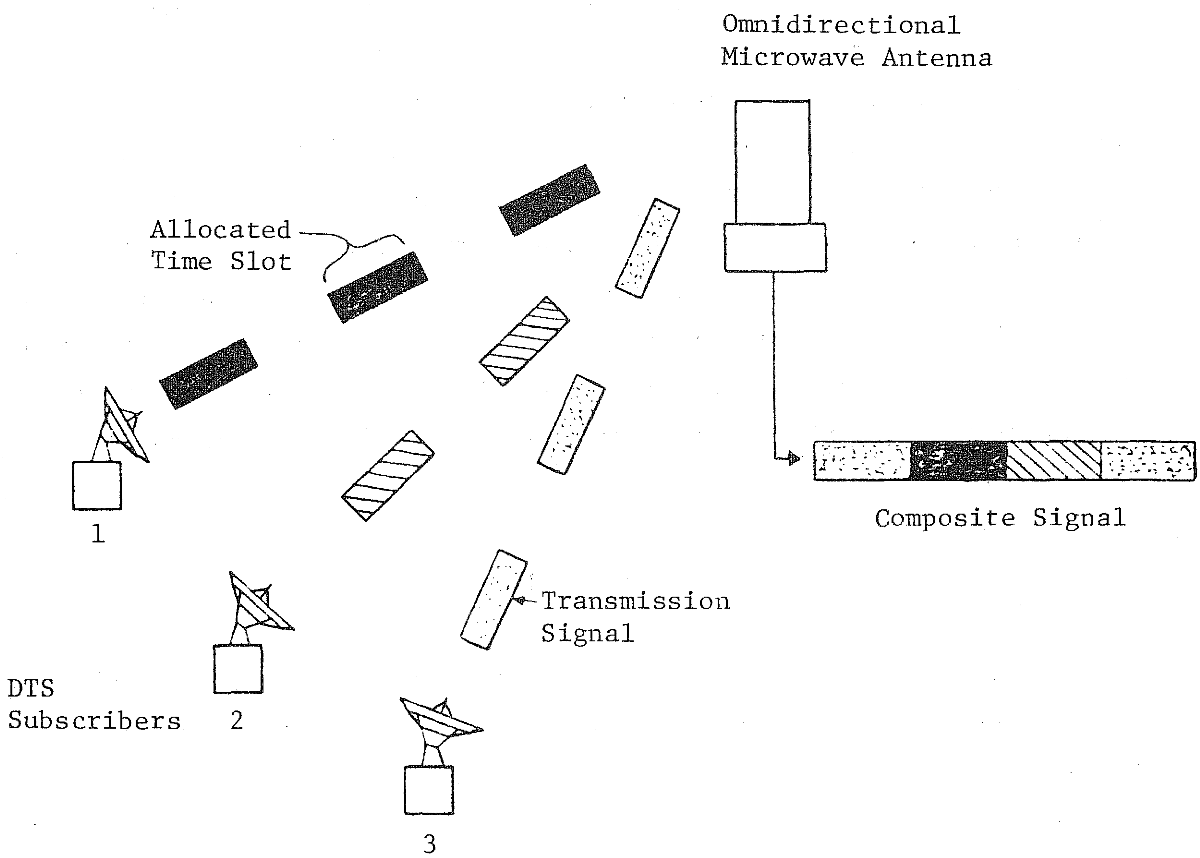


Fig. A-8. Example of a TDMA transmission years to implement the service. The FCC has approved over twenty-three limited carriers. Limited carriers can operate with 2.5-MHz bandwidth each way and up to six channels for a total band usage of 30 MHz. The limited carrier has up to 2 1/2 years to implement the service.

Local Area Networks

A local area network (LAN) interconnects communication devices that are owned and administrated by a single organization. The network physically connects all devices with a continuous medium such as coaxial cable or copper wire. Most networks have a geographical scope of less than fifty miles and are comprised entirely of nonmobile components. Communications over the network are provided so every user is able to communicate with all other users. One of the main features of a LAN is its high speed of communications which ranges from 500 Kbps over copper wire to 1 billion bps over fiber optic cable. Currently, the LAN market is still in a growth stage with continual gains in industry acceptance.

Topologies

The topology defines the physical and logical arrangements of user stations on a LAN. Each user station in the LAN is considered a network node. A node is a location on the LAN where transmissions are received and processed. There are many different LAN topologies. The most common topologies are linear bus, ring, and star as shown in figure A-9.

A linear bus has its stations located on a single cable length. Network transmissions are broadcasted to all stations with each transmission encoded with a station address. Transmissions can travel up to 50 Mbps depending on the communication medium used (copper wire, coaxial cable, fiber optics). Each station receives the transmission and copies only signals transmitted with its address. If a station

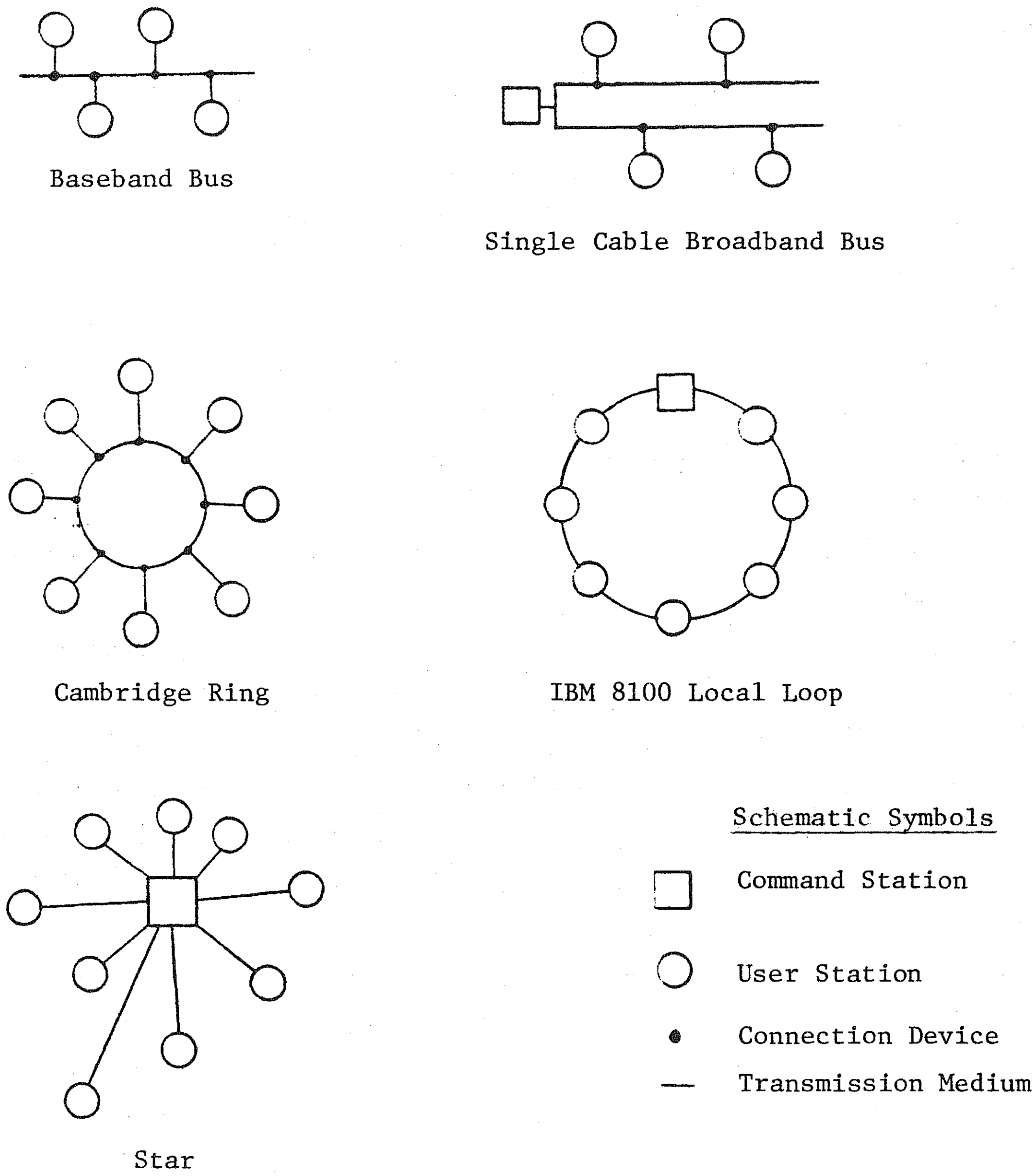


Fig. A-9. Local area network topologies

fails on the network, it will not affect the rest of the network, making the bus topology very reliable. The cost to build a linear bus network is generally lower per user than star networks but higher than ring networks. Growth of a linear bus network is not limited by the topology. Many baseband and broadband systems use a linear bus topology.

A ring topology has its station nodes along a cable that forms a closed loop. Transmissions are passed from one station to another station along the network until the message reaches the designated station address. The waiting time required to receive a transmission is a function of the number of nodes in the network. Most ring network stations contain bypass circuitry to disconnect stations from the ring when a station failure occurs. Generally, transmissions do not exceed 10 Mbps and the size of the network is limited in total distance with limits on distances between stations. A ring network has a lower cost per station than other networks. This type of topology has been pioneered mostly in Europe.

A star topology relies on a central node to process all transmissions. Each station is connected by a point-to-point link to the central node. Since all transmissions between stations must pass through the central node, the network relies heavily on the central node capacity and speed. If the central node fails, the whole network fails. However, failure of user stations have no effect on the network. Heavy traffic conditions could cause blocking in the network, which is dependent on the central node's ability to serve user stations. A star topology has a high initial cost for the central node with a low incremental cost to add user stations. Its physical size is limited by the distance between the central node and any user station. It performs well in hierarchical networks where there is a master/slave relationship between star networks, as in AT&T's long distance toll network.[12]

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[12]"An Introduction to Local Area Networks," Communications (Delran, New Jersey: Datapro Research Corporation, December 1983), p. CS20-450-111.

Media

A LAN medium is the physical component used to interconnect network stations. Three types of media are used for LAN: twisted pair of copper wire, coaxial cable, and fiber optic cable, as shown in figure A-10. Each medium has different transmission characteristics, and cost and performance benefits.

Twisted copper wire is the most inexpensive medium used in a LAN, ranging from 5 cents to 30 cents per foot. It is also the easiest to install and is readily available as common telephone cord. The disadvantage of copper wire is its susceptibility to electrical interference and its attenuation loss over long distances. To reduce noise, the wire is usually shielded and repeaters are used at intervals over the path of the wire. The function of a repeater is to receive an incoming signal and amplify it to a specified level, thus regenerating the signal. Twisted copper pair is used for low cost and short distance applications. It can carry data rates up to 1 million bits per second for up to several thousand meters.

Coaxial cable is the most commonly used medium for LANs. The cable contains a central conductor which is surrounded by a non-conducting insulator, wrapped by a solid or woven metal shield layer, and protected by an outer insulated cover. Since the cable is shielded, it has high immunity to electrical noise and can carry transmissions over long distances. There are two types of coaxial cable applications: baseband cable and broadband cable.

Baseband coaxial cable carries one signal at a time. Baseband signals are always digital and travel at a rate of 1 to 10 million bits per second. Time division multiplexing can be used to process the signal for transmission. A baseband signal is broadcast away from the sending station. Baseband networks are easy to install and best suited for small to medium size data processing or office automation applications.

Broadband coaxial cable can carry many signals at a time. The signal transmission method is analog and uses different frequencies at lower data rates than are found on baseband networks. Usually a

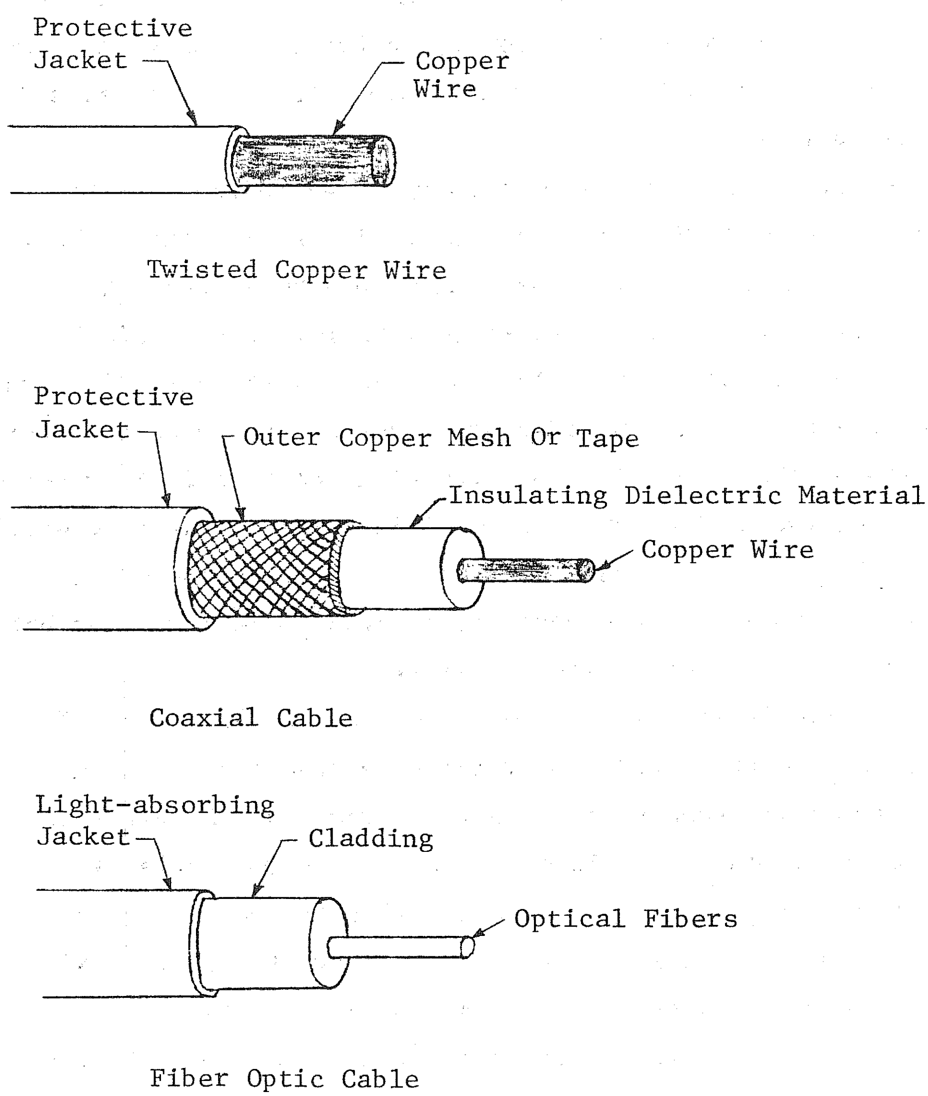

Fig. A-10. Local area network transmission media broadband network will have between twenty and thirty channels with each channel capable of carrying data at a rate between 1 and 5 million bits per second. Throughput is always higher on a broadband network. Broadband signals are effectively unidirectional due to the nature of the method to carry the radio frequency signal. To send and receive information, a channel is reserved for each direction, using two different frequencies.

Fiber optic cable has the greatest potential in the LAN market. It has the capability to carry many times the bandwidth of coaxial cable. Even though it is currently the most expensive medium available, it is expected that the price of optical fiber will decrease due to wider use in telephone applications. The advantages of optical fiber are its high immunity to noise, its resistance to taps in the transmissions, and its wide bandwidth of up to 50 Mbps at a 10 kilometer distance. Fiber does have the disadvantage of its cost and the difficulty of installation compared to other cable systems. Fiber optic cable can easily support voice, data, and video applications simultaneously.[13]

Access Methods

A network's access method is the procedure used to deliver information to the network nodes. The access method controls traffic flow in the cable medium with the objective of optimizing bandwidth usage and station response time. Access can either be centralized or distributed depending on the topology configuration. Most computer networks use a main computer system to provide central access and control. Most LANs use a distributed access method with each station having some control over the network. There are two basic classes of distributed access: random (or "contention"), and deterministic.

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[13]"Local Area Networks--Products and Specifications," Communications (Delran, New Jersey: Datapro Research Corporation, January 1984), p. TC41-007A-107.

A random access method allows each station to transmit when the data channel is free. If the channel is busy, the station will wait a random time interval and then test for a free channel. This technique is called Carrier Sense Multiple Access (CSMA). One of the main problems with this technique is what happens when two stations sense a free channel at the same time. A "collision" will result as both transmissions interfere with each other. Many CSMA networks provide a collision detection mechanism (CSMA/DC) which allows a station to recognize a collision. The station will automatically stop transmitting and wait a random interval to try again. CSMA and CSMA/CD are used mostly in bus and tree topologies.

A token passing network is an example of a deterministic tranmission method. It is circulated through the network, passed from station to station. The station that receives the token may transmit the message or pass the token to the next station. If the message is transmitted, the token is then passed to the next station. Token passing is a polling technique and is more difficult to implement. All stations must have a logical address and a logical position in the token passing sequence.

Another deterministic access method is the slotted access used in ring networks. Slotted access is similar to token passing except an empty data frame is passed between stations. When a station desires to transmit a message, it fills the empty data frame when it arrives at the station. This technique not only dictates when the message can be transmitted but also how much data a station can transmit.

The network access method determines the performance of the network. When comparing methods, deterministic methods perform better under uniformly heavy traffic conditions. CSMA networks perform well under sporadic traffic patterns with lengthy transmissions. Short transmissions for constant periods of time can increase the probability of collisions that will degrade a CSMA network.[14]

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[14]Ibid., p. TC41-007A-109.

Standards

Standards can be determined by an industry organization through legislation, or by industry acceptance of a de facto standard. In 1982, the Institute of Electrical and Electronic Engineers (IEEE) first issued Draft Standard 802.3 which described a baseband CSMA/CD bus network similar to Xerox ETHERNET. Later Draft Standard 802.4 described a token passing, baseband or broadband bus network. Also in Draft Standard 802.2 specifications were developed for a Logical Link Control, a protocol to be used for the two networks. Most vendors endorsed the CSMA/CD standard because it closely resembled the ETHERNET specification.

The only other vendor to market a nonstandard architecture was Datapoint Corporation with the ARCNET specification. ARCNET was supplied as a low cost, ready-to-install interface that grew with wide acceptance with Nestar Systems, Tandy's Radio Shack, and Interactive Systems/3M. It is also expected that IBM will introduce a LAN in the near future, producing another de facto standard.

Coaxial Cable TV

Cable TV has been the main thrust of the cable industry over the past 9 years. Initially, these systems were developed to provide TV reception in remote areas of the country. Now they have approximately 25 million subscribers in nearly 30 percent of all homes. Growth of the cable industry was mainly due to the development and availability of satellite communications. Cable networks are currently being developed for residential and institutional applications, with more cable applications being applied in industry to provide advanced wideband communications.

System Overview

A cable TV system receives television signals from earth station antennas into its head-end station where the signals are amplified and distributed onto the cable distribution network as shown figure A-11. The distribution system consists of trunks extending from the head-end station and feeder cables branching from the trunks along streets and alleyways. A drop cable from the feeder line connects the subscriber with the network. All transmissions are carried over a coaxial cable.

Coaxial cable is a highly cost-effective medium for transmitting a large number of signals for a distance of up to 10 miles. A cable may contain one coaxial tube or sets of multiple tubes (commonly 8, 12, 20, or 22). Cable attenuation loss is about 4 dB per mile at 1 MHz. It is also highly immune to noise and can support a wide bandwidth for voice, data, and video comunications.[15]

TV signals are received through an antenna system and transmitted to the head-end station. The head-end station processes the signal for distribution on the network, performing the following functions:[16]

- Amplifying each signal
- Filtering out unwanted signals
- Translating signals to UHF or VHF
- Demodulating incoming microwave signals
- Demodulating incoming cable signals
- Combining all signals into one composite signal for distibution

Studio facilities and special scrambling equipment are also located at the head-end station to minimize cabling requirements.

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[15]Technical Staff and the Technical Publication Department, Bell Laboratories, Engineering and Operations in the Bell System (Indianapolis: Western Electric Company Incorporated, 1977), p. 127.

[16]Walter S. Baer, Cable Television: A Handbook for Decision Making (Santa Monica, California: The Rand Corporation, 1973), p. 15.

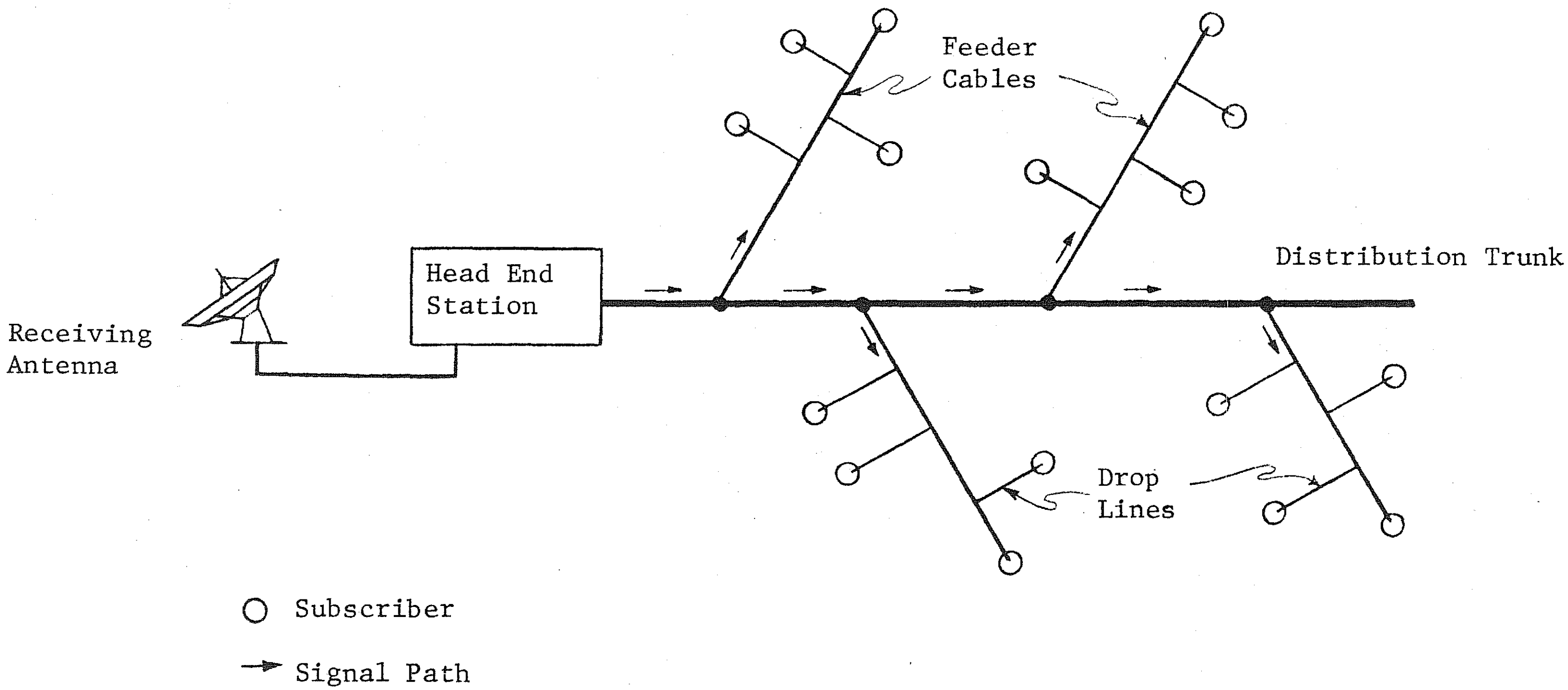

Fig. A-11. Typical one-way cable distribution network

Cable distribution plant includes the main trunk and feeder cables. When a signal loses strength as it travels through the cable, it is called attenuation. To reduce some of the attenuation, a larger cable can be used, such as a 3/4- to 1-inch cable for the main trunks or feeder lines. Large cables are more expensive and difficult to install. Attenuation can also be overcome by installing trunk or feeder amplifiers. Amplifiers are used to transmit signals to the feeder from the trunk. Only a certain number of amplifiers can be placed along the path of a signal before the signal becomes unacceptable for reception. Amplifiers always add some distortion to the analog signal.[17]

A subscriber location is linked to the cable network through a drop cable from the feeder line. The drop cable usually connects to a small transformer that matches the characteristics of the cable to the receiving station. This is the weakest link in the cable network due to the difficulties in matching various station characteristics and cable signals for optimal performance.

Residential Cable Systems

Residential cable systems have been serving small towns and remote rural areas for the past decade. Over 20 million U.S. households subscribe to cable TV and nearly 96 percent of all households have televisions. Most cable systems are operating in small to medium size cities with systems in the large metropolitan areas such as Boston and Washington, D.C. now under construction.

Almost all cable systems operate under a franchise through the local municipality to obtain rights of way. A franchise allows a cable company to operate within the boundaries of a given jurisdiction with an obligation of providing specified services. Residential systems are required to have 100 percent area coverage. Currently, franchises are requiring cable companies to offer two-way communications capability. Two-way communications have the ability to provide transactional and interactive services such as the following:

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[17]Ibid., pp. 15-16.

- Home shopping
- Home banking
- Information retrieval
- Security and polling
- Utility meter reading
- Direct connection to a long haul carrier

A residential cable network has the bulk of its transmission capacity directed downstream away from the head-end station. This capacity is used to transmit a large number of TV format programs to residential subscribers. Sophisticated systems would use the frequency range between 54 MHz and 300 MHz for downstream transmissions for a bandwidth of 246 MHz. A 246-MHz bandwidth could supply approximately thirty television channels with each channel consuming 6 MHz. For upstream communications to the head-end station, the subband frequencies below 54 MHz are generally used, particularly those between 5 and 30 MHz. Only two or three channels can be transmitted upstream due to the interference caused by radio signals. This type of transmission technique is called a "subsplit" technique. Currently, equipment to extend bandwidth is now available to provide operating bandwidths above 320 MHz so there may be fifty to one hundred TV channels.[18]

Institutional Cable Systems

There has been growth in institutional cable television systems for business and local government. These private networks are used mainly for data transmissions and teleconferencing. These are usually midsplit or dual systems which provide two-way communications and use a separate cable for each direction of traffic. Most of the service is point-to-point circuit service for data such as CPU-to-terminal link, for voice such as voice trunking, and for video such as teleconferencing and broadcasting video events. Many business such as large

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[18]Telecommunications Management Corporation, Design of a Prototype Interconnection System (St. Paul, Minnesota: Minnesota Cable Communications Board, March 1980), pp. 8-11.

national companies, large local banks, utilities, and retail stores are adopting cable as the basis for network data and voice facilities. The cable network can provide many public services to local government, public schools, hospitals, colleges, and universities.

Midsplit or dual cable systems allow more upstream capacity than a subsplit system. These systems allow a more equal split in the bandwidth of the downstream and upstream path. A midsplit cable system uses a single cable with a bidirectional signal. Dual cables can be used for added capacity with each cable transmitting in opposite directions.

Factors other than capacity determine the need for a separate network, such as geographical coverage, signal privacy, and multimode communications. Most institutional systems cover a small geographical area in the industrial and commercial districts and are usually not integrated into residential networks. Privacy of communications is a high priority for most institutions implementing closed-circuit television or transmitting confidential data. Multimode communications mix the video, voice, and the data signals to provide the integrated communications that are required for teleconferencing. A separate institutional cable system from the residential cable system is required for businesses' special needs. However, most cable systems are interconnected at the head-end station for internetwork communications.[19]

Interconnecting Cable Systems

Cable systems are interconnected to exchange programming and to provide greater coverage of voice or data communications. There are two categories of interconnection--wire or wireless transmission. For most practical purposes, broadband capacity must be provided by interconnecting systems to accommodate TV signals which require a 6-MHz

[19]Ibid., pp. 11-12, 21-26.

bandwidth for each channel. The interconnecting systems are microwave, cable, and fiber optics.

The most popular wireless transmission method is microwave. Since the FCC controls wireless transmissions, the only available systems are provided by common-carrier microwave links such as AT&T and GTE, and by the "Cable Television Relay Service" or CARS, which is authorized by the FCC to provide cable links. Common-carrier links are available for single-channel transmissions and are relatively costly. They are only used for special cases. CARS utilizes the 12.7- to 13.2-GHz bandwidth for single-channel and multiple-channel transmissions. This is the most popular method of interconnection.

Coaxial cable is the most common short haul interconnection method for transmitting broadband signals. It has a very high capacity for short haul but for long haul, capability is limited because of attenuation losses.

As previously mentioned, optical fiber cable has the greatest potential for cable interconnection systems. Fiber has a larger bandwidth and lower attenuation losses than coaxial cable. As fiber becomes more reliable and is mass produced in larger quantities, it will become more competitive with conventional transmission methods.[20]

Fiber Optics

Fiber optics technology is only 14 years old, dating back to the early sixties with the invention of the laser. The first successful fiber optic communications system was demonstrated in 1970. This technology merged semiconductor and optical waveguide technology to produce a transmission medium, the optical fiber cable.

Characteristics

Fiber optic cable has many advantages over current transmission mediums including copper wire, coaxial cable, and microwave. Fiber

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[20] Ibid., pp. 12-13.

optic cable has the following attributes:[21]

- Immunity to electromagnetic interference and crosstalk
- No electrical ground loop or short circuit problems
- Small size and light weight
- Large bandwidth for size and weight
- Safety in combustible areas (no arcing)
- Immunity to lightning and electrical discharges
- Longer cable runs between repeaters
- Flexibility and high strength
- Potential high temperature operation
- Nuclear radiation resistant
- Security against signal leakage and interference
- No electrical hazard when cut or damaged

Fiber optic cable systems have more bandwidth available than current transmissions systems, including coaxial cable systems. Bandwidth varies according to the distance of the transmission, based on the attenuation losses, which are now below 1 dB/km. For up to 10 kilometers, a fiber cable could have up to a 50 MHz bandwidth and for up to 8 kilometers a bandwidth of 140 MHz could be obtained. For a single-mode cable, a bandwidth of 50 GHz per kilometer is normally expected. A wide bandwidth allows a greater capacity to carry voice, data, and video transmissions over a single fiber optic cable. This provides greater expansion capability without the high cost of installing additional cable.

Properly protected, signals transmitted over a fiber system will have no degradation in the signal. This provides an advantage in overcoming cable routing problems over hazardous terrain, such as in dense metropolitan areas. A fiber can withstand temperatures up to 1,000 degrees Centigrade and is not susceptible to lightning in aerial

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[21] Innovators: Fiber Optic Reprint Series (Geneva, Illinois: Belden Fiber Optics Dept., 1982), p. 3.

applications. However, fiber optical cable must be protected against water seepage because the formation of ice would introduce attenuation and damage the fiber.

Transmissions over a fiber cable are immune to electromagnetic interference (EMI), radio frequency interference (RFI), and electromagnetic pulse (EMP). Also, the signal does not have any crosstalk, echo, or ringing. Fiber optic systems offer a high quality signal with repeaters spaced only 10 to 30 kilometers apart. The nonflammability of fiber optics is an important characteristic when installing systems in harsh environments involving corrosive and flammable chemicals. Only hydrofluoric acid poses any danger to the fibers because the acid attacks glass. Even if chemicals other than hydrofluoric acid penetrated the jacket, the transmission would not be interrupted and there would no sparking.

Fiber optics can be installed in the same manner as other cable systems. The cable is lightweight (approximately 30 pounds per kilometer versus 200 pounds per kilometer for standard coaxial cable) and thin, which allows it to be installed in existing ducts and cable runs. Many fiber optic cables are now reinforced to withstand large amounts of physical stress, just like existing cable systems.

Because of its optic-based transmission source, the cable does not emit any radiation and is virtually untappable without detection. Any break in the cable can be detected immediately and its location determined within a few inches. These high security features make it ideal for military installations.

Because of its high immunitive properties, transmissions errors over a fiber optic system are as low as one in a billion bits. This value is still decreasing as fiber optic technology advances.[22]

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[22]"Fiber Optics--A Management Overview," Communications, (Delran, New Jersey: Datapro Research Corporation, September 1983), p. TC41-007A-201.

The Cable

A fiber optic cable consists of a core, a cladding, and a jacket. The core is located in the center of the cable and consists of thin strands of glass or plastic fibers. Each fiber is usually 50 to 125 microns in diameter. Each fiber has its own cladding that coats the fiber and has special optical properties. The jacket encloses all of the fibers and is reinforced to protect against moisture, crushing, and other damaging forces. It is constructed to meet the environmental requirements of the installation. The cable can also be enclosed in a buffer such as a polymer tube or hard casing for added protection. All three fiber components vary in thickness (see figure 2-14). The core and cladding are designed according to the applied technology. The jacket is designed according to the application.

There are three basic types of optical fiber cable: multimode step index, multimode graded index, and single-mode, as shown in figure A-12. They all carry light through the core using different techniques that affect the available bandwidth, method of installation, and the ease of manufacture.

The oldest type of fiber optic cable is the multimode step index which has the lowest bandwidth, 10 MHz to 100 MHz per kilometer. The core of the cable is surrounded by a glass cladding with a lower refractive index than the core. This discontinuity creates a boundary where light hits it at a glancing angle and is reflected back into the center of the core. Light is guided through the core using this internal reflection technique. Each light path through the core will vary in length.

A multimode cable can be tens of micrometers to a millimeter in diameter. This large core causes the light to disperse and to spread out along its path. Dispersal reduces the amount of available bandwidth and is called pulse spreading. Pulse spreading increases as the diameter of the fiber core increases.

Most multimode step index cables are found in short distance applications with low bandwidth requirements. They are easy to install because the core is easy to align.

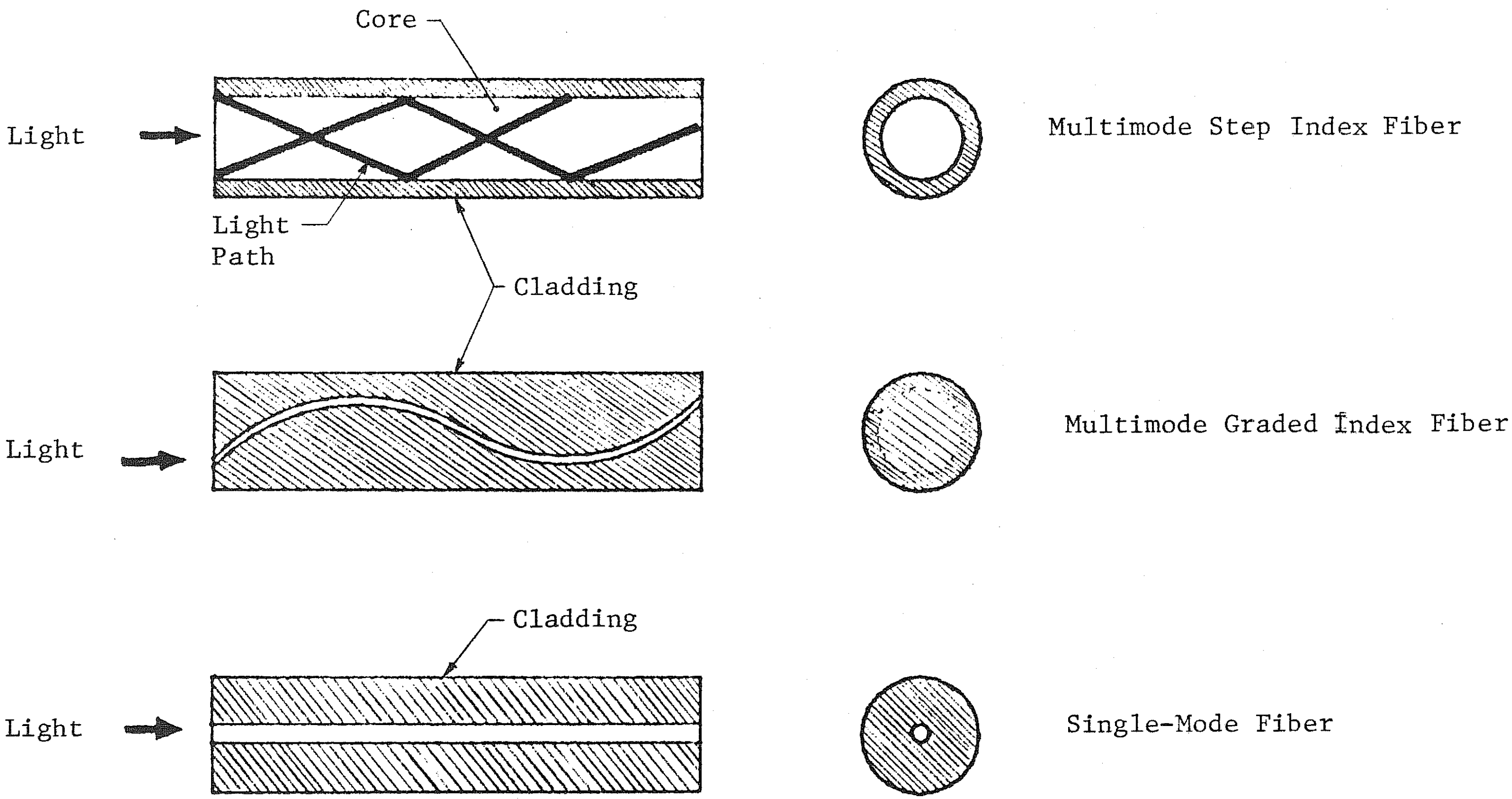

Fig. A-12. Types of optical fiber

Easier to mass produce, the multimode graded index cable uses a more complex light-carrying technique than the multimode step index cable. It also has a higher bandwidth--from 200 MHz to 1,000 MHz per kilometer.

Light is guided through the multimode graded index core using refraction instead of reflection. The core is comprised of fibers whose refractive index gradually decreases from the center to the outer perimeter. Thus, the boundary between the core and the cladding is gradual, not sudden. The refractive index becomes more of a slope and when light attempts to pass from the core to this "graded" area it is gradually bent back toward the center. All light paths are almost identical in length; minimizing pulse spread and loss of bandwidth.

Currently, multimode graded index cable is used for most long distance fiber optics telecommunications links. It is often less expensive because it requires less material to manufacture than multimode step index cable. Most cores have a diameter of 50 microns with a cladding 125 microns thick.

Now in the final stages of development, the single-mode fiber optic cable will have a bandwidth potential of up to 50 GHz per kilometer. The core of the fiber is only a few microns in diameter, which limits the light path to a single direction. This eliminates pulse spreading, providing a smooth guide path for the light wave to travel and resulting in a very high bandwidth. It has the advantage over multimode cable in size, performance, economy, reliability, and design flexibility. Its major disadvantage is in the splicing and light transfer to the core because of its small size. Currently, a single-mode fiber optic cable is more expensive to manufacture than multimode cable.

Single-mode fiber optic cable systems have the greatest potential in serving high density traffic areas such as the Boston to Washington, D.C. corridor. A fiber network could handle between 60,000 and 80,000 calls.

Fiber cable systems are usually driven by light emitting diodes (LEDs) or by injection laser diodes (ILDs). The use of LEDs are widely used over short distances up to about one kilometer with signals up to 10 Mbps. The ILDs is more suited for digital transmissions because the emitted light is more intense and directional, resulting in less scattering. Using the ILDs requires fewer repeaters for long haul communications. The major problem with ILDs is that they are heat sensitive and require special temperature compensation circuitry.

Fiber optic receivers are photodiodes that convert light to electrical current. Photodiodes are small, inexpensive, and require little power to drive them. There are two types of photodiodes: the PIN diode; and the avalanche PIN diode, or APD. The PIN diode generates a single pair of electrons for every photon of light absorbed to generate a current. The APD generates an avalanche of electrons to every absorbed photon of light. This process produces a larger gain in current than the standard PIN diode. A larger gain will alleviate problems of interference from background noise, allowing higher transmission speeds. ADPs are temperature sensitive and require temperature compensation circuitry.[23]

Teleports

A teleport is a local communications center serving a multitenant facilities with access to public networks via satellite or cable. It is used to enhance real estate values by providing common telecommunications services to all tenants residing in the facility. Services could include basic switching, computer services, teleconferencing, and direct satellite networking. The purpose of teleports is to lower telecommunication costs by bypassing the local telephone facilities and by sharing costs of advanced communication equipment. Most services can be provided by a central Computer Branch Exchange (CBX) for voice, data, and video communications.

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[23]Ibid., pp. TC41-007A-204 to 206.

System Characteristics

Most teleports of a multitenant facility will have access to a the central teleprocessing center such as a CBX. As shown in figure A-13, the central teleprocessing center is the hub of a local area network that links all locations throughout the multitenant facility. Off-premises access is provided by a satellite or microwave link and by a series of trunks or cables to a public or private network.

The local area network can provide the capability to perform simultaneous voice and data communications, format and protocol conversion between uncommon teleprocessing machines, and interfacing between computers and distributed processing control. The network can be cabled with standard copper wire for voice and data communications, coaxial cable for wideband communications, or fiber optics for advanced applications such as teleconferencing.

Outside access from the teleport is available through its earth station, providing tenants with access to satellites for intracity, regional and worldwide communications. The type of satellite communications governs the size of the antenna. Satellite transmission in the KU band would require a 2-meter antenna that could be installed on the rooftop. Satellite transmission in the KA band would require an antenna 15 meters in diameter that would be installed on the ground at most facilities.

Other access methods can be in the form of microwave, direct trunk, cable networks. Microwave can be used to connect directly to a long haul carrier. Trunks can be used to connect to the public telephone network. Coaxial cable can be used to connect into a local business or institutional network.

Services Offered

A teleport facility can enhance the value of real estate to a group of tenants by providing advanced enhanced low cost bulk

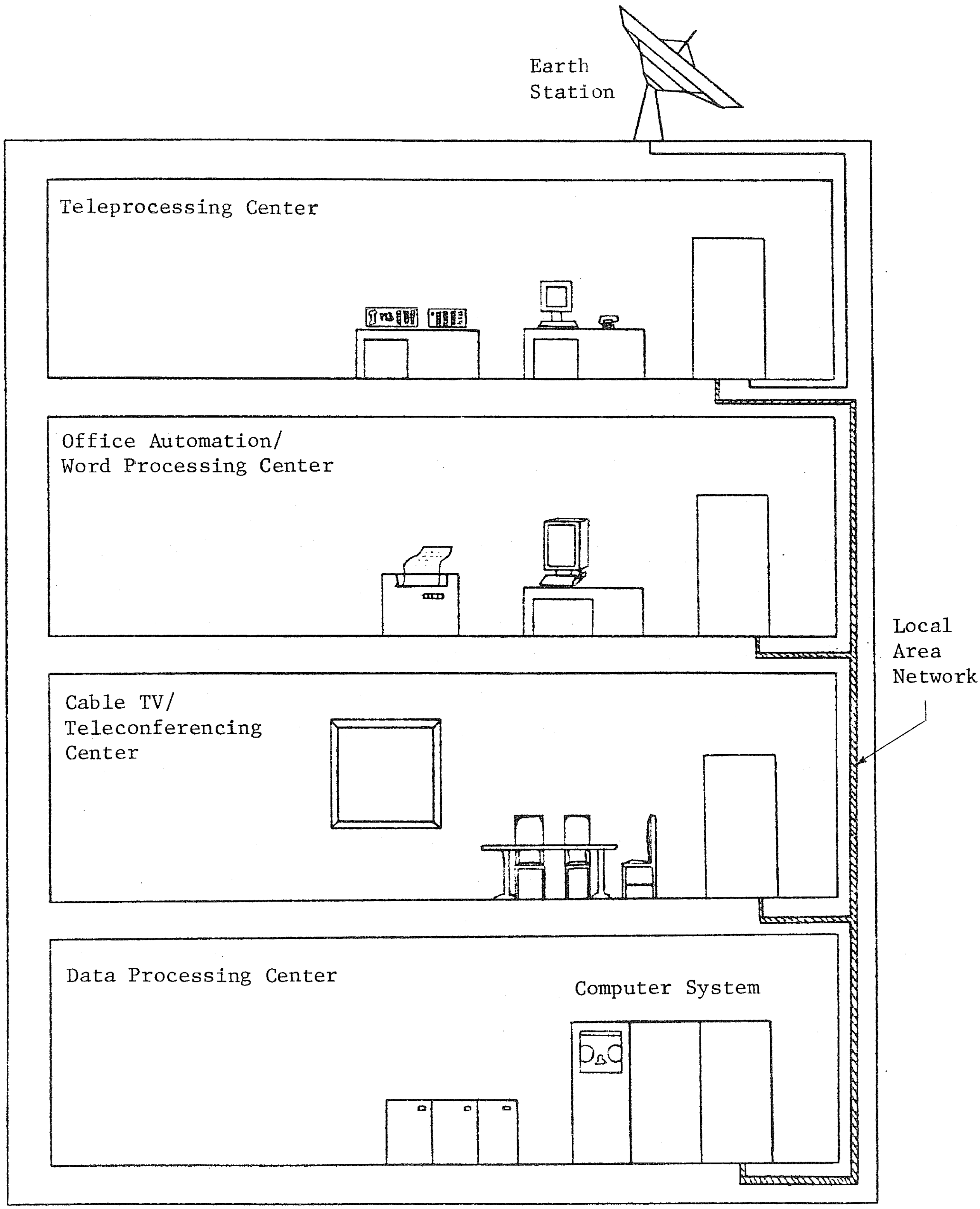

Fig. A-13. Teleport with shared services for a multitenant facility telecommunication facilities normally found only in large installations. The real estate might even be located in an underdeveloped area where access to telecommunication facilities is essential to lure businesses. Some of the following services could be provided:[24]

- Common PBX
- Electronic mail
- Voice store and forward
- Message center
- Telephone resale service
- Local high speed data services
- Local cable TV networks
- Local computer networks
- Teleconferencing facilities
- Centralized facilities management
- Direct connection to a long haul toll carrier

Central communication processing in a multitenant facility has many advantages, reducing costs by joint ownership or shared usage. It allows a facility to share technical services, to have joint access to leased telecommunication facilities, and to improve facilities management. Sharing technical services will allow a larger pool of talent for tenants such as telecommunications, information processing, and facility management specialists. Many facilities can be made more affordable through joint leasing of facilities such as a teleconferencing studio and a computer center. Telecommunication costs can also be reduced with better resource management such as telephone resale, transponder brokerage, and earth station resale. This concept of centralization is very similar to the operation of many corporate data processing and telecommunication centers, where higher efficiency and lower costs are gained by centralizing the functions.

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[24]Lucas, Telephone Bypass Technologies pp. 5-1 to 5-11.

Cellular Mobile Telephone

Over the past decade, mobile radios or telephone have provided telephone service to a small segment of the public. As shown in table A-5, most uses of mobile service have included public safety radio services, special emergency radio services, industrial radio services, and land transportation radio services. Mobile telephone service lacked the number of radio channels and the signal quality required to serve many public users. Usually, mobile systems had only one transmitter with a limited range and capacity.

Cellular mobile telephone system applies new technology to overcome the factors of heavy congestion and few radio channels that have limited mobile telephones in the past. Techniques such as frequency re-use and cell splitting are used to increase the frequency spectrum efficiency. This allows cellular services to serve a large number of mobile units while using the same amount of spectrum.

The FCC has allocated 40 MHz of bandwidth for cellular mobile service. For each geographic service area such as Chicago, mobile services will be provided by a wireline and a nonwireline telecommunications company. (An ordinary telephone company that provides wire local loops is considered a wireline company.) Each company will be allocated 20 MHz of bandwidth. The nonwireline company will be allocated the frequencies 825 to 835 MHz for mobile transmit and 870 to 880 MHz for mobile receive. The wireline company will be allocated the frequencies 835 to 845 MHz for mobile transmit and 880 to 890 MHz for mobile receive.[25]

Cellular System

A cellular mobile telephone system provides voice communications to mobile telephone units within a geographic service area. It

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[25]"Cellular Radio--A Management Overview," (Delran, New Jersey: Datapro Research Corporation, October 1983), p. TC41-007B-203.

TABLE A-5

PRIVATE MOBILE RADIO SERVICES

Category	Mobile Radio Service
Public safety	Local government radio service
	Police radio service
	Fire radio service
	Highway maintenance radio service
	Forestry conservation radio service
Special emergency	Medical services
	Rescue organization
	Veterinarians
	Handicapped persons
	Disaster relief organizations
	School buses
	Emergency repair of public communication facilities
Industrial	Power radio service
	Petroleum radio service
	Forest products radio service
	Motion picture radio service
	Relay press radio service
	Special industrial radio service
	Business radio service
	Manufacturers radio service
	Telephone maintenance radio service
Land transportation	Motor carrier radio service
	Railroad radio service
	Taxicab radio service
	Automobile emergency radio service

Source: FCC, Future Private Land Mobile Telecommunications Requirements (Washington, D.C.: International Transcription Services, August 1983), pp. 1-4 controls all mobile units by dividing the geographic service area into cells where each cell represents a transmission area. The system is comprised of cell base stations, a mobile telephone switching office (MTSO), and mobile telephone equipment as shown in figure A-14. Leased lines link the base stations of the cells to the MTSO using a star topology. Other leased lines carry traffic from the MTSO to a local telephone company central office for local or toll access.

The radius of a cell is between 1 and 14 miles depending on its design characteristics. Each cell contains a low powered base station to transmit and receive radio transmissions from mobile telephone units within the cell. Low power transmitters allow frequencies to be re-used at nonadjacent (but not very distant) cells without interference. The base station performs demand assignment of transmission channels to mobile telephone units. It also relays conversations and control data to the MTSO.

The MTSO is the central coordinator for system operation and call processing. Its main purpose is to transfer voice transmissions from one cell base station to another cell base station as the mobile telephone unit travels in the service area. This is initiated when a cell base station notifies the MTSO that a mobile unit has entered an adjacent cell. The call transfer is spontaneous and is invisible to the caller. The MTSO also provides access to the local telephone network and long haul toll networks through a local central office. The basic MTSO subelements are:

1. System control switcher and associated interfaces
2. System operational and diagnostic software
3. Normal network switching and distribution frames
4. Cell interfacing equipment

A mobile telephone unit consists of a control unit, transceiver, a logic unit, and two antennas. The control unit contains user interfaces such as a handset and selection buttons with indicators lights. The transceiver uses a frequency synthesizer to tune into any

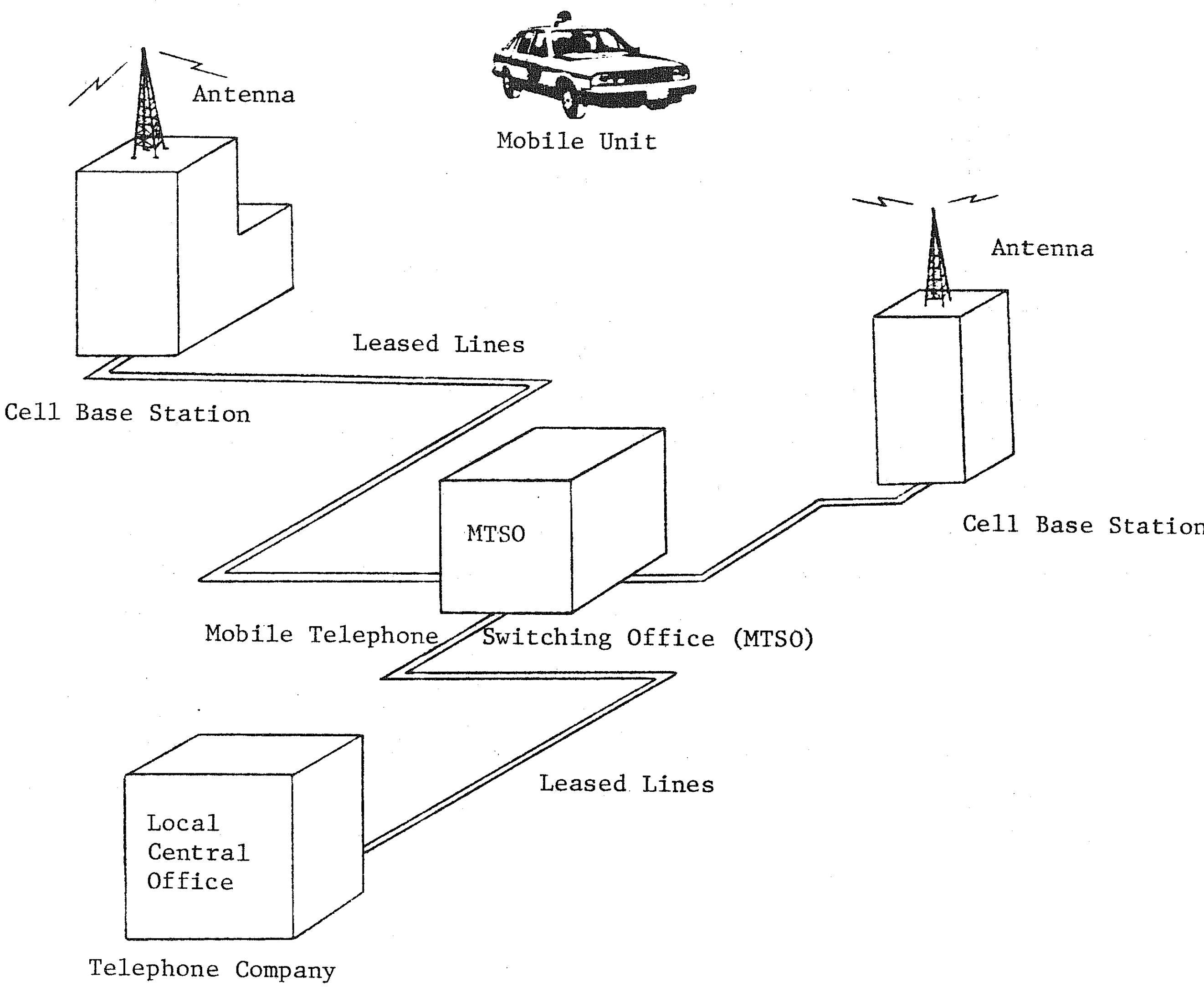

Fig. A-14. Cellular system configuration allocated channel. The logic unit interprets customer action and system commands and sends instructions to the transceiver and control units. A single antenna is used for transmission and two antennas together are used to improve reception.

The cellular concept allows a mobile telephone system to serve a geographic area more efficiently as the size of the service area and the amount of traffic congestion grow. As the service area expands, more cells are added to the system and frequencies are re-used. If the service area becomes more congested, the cell splitting technique is used. A cell with congested traffic conditions will subdivide into smaller cells without increasing the amount of the radio spectrum required. Each new cell will have a low powered base station with the same channel capacity as the original cell. Frequency re-use is applied during cell splitting to eliminate radio interference. This will increase the number of channels available in the original transmission area.[26]

Frequency Re-Use

As mentioned, frequency re-use is an important frequency allocation process that allows a cellular system to expand. It is used over the geographical service area by insuring that no two adjacent cells operate at the same frequency, as shown in figure A-15. The Bell system plans to implement a seven-cell re-use pattern with frequencies divided into seven groups. This plan allows a frequency to be re-used every fourth cell and have up to forty-five channels per cell. Each channel can serve between twenty-five to thirty mobile units. In theory, a system could expand indefinitely by re-using frequencies.[27]

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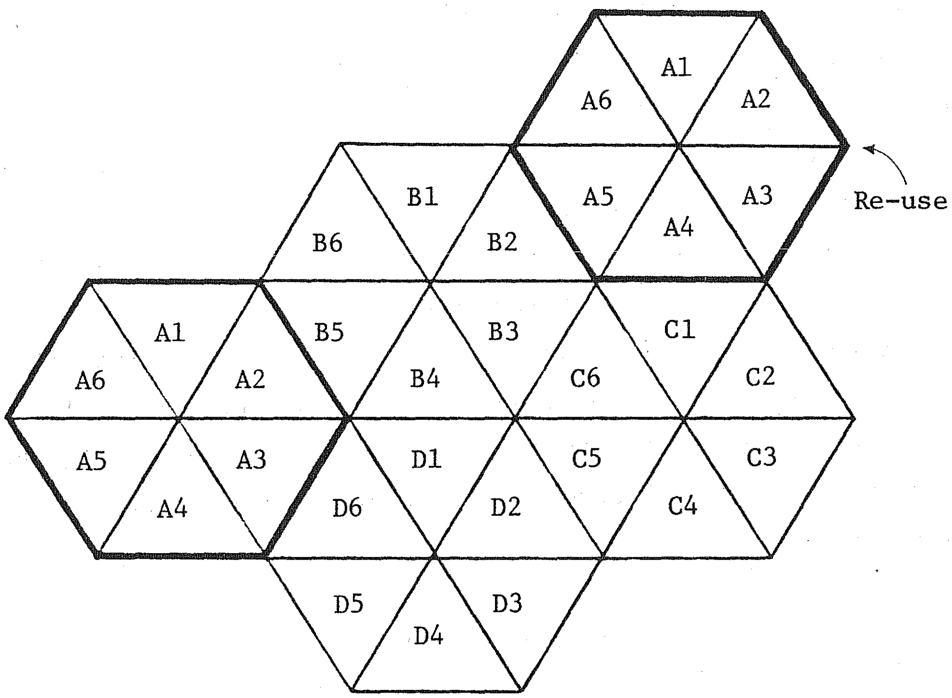
[26]Ibid., pp. TC41-007B-204 to 205.

[27]FCC, Future Private Land Mobile Telecommunications Requirements (Washington, D.C.: International Transcription Services, August 1983), p. 5-6.



A, B, C, D = Frequency Groups
1, 2, 3, 4, 5, 6 = Cell Sectors

Fig. A-15. A seven-cell frequency re-use plan

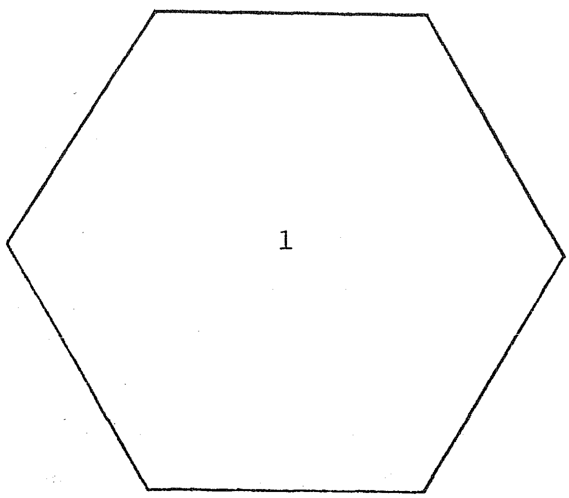
Cell Splitting

Limitations are placed on the cellular mobile telephone system by the maximum number of mobile units served per cell. This density is increased by cell splitting. Each new cell has a base station and a re-used frequency. The new base station has a lower transmitting range and power because of a smaller cell. Each cell division increases the service density in the original cell because the channel capacity of the new cells are equivalent to the original cell capacity, but are servicing a smaller transmission area. The smallest cells usually have a radius of 1 mile.

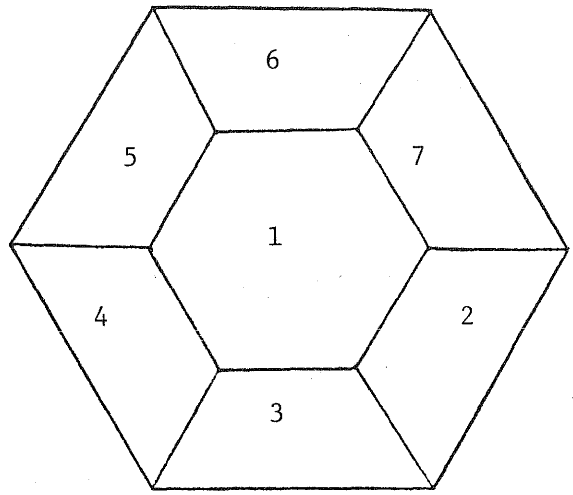
For an example of cell splitting, suppose a cell has an original radius of 8 miles and the minimum radius of a new cell is 1 mile. The 8-mile cell, using 45 channels and 27 cellular units per channel, could save up to 1,215 mobile telephone units before cell splitting is necessary as shown in figure A-16a. Each transmitter is numbered 1 through 7, representing its frequency group.

The first split would create new 4-mile cells (half the length of the original cell) and would theoretically serve 4 times as many telephones as the original cell, or 4,860 units. Six new transmitters would be added and the system would be capable of serving 76,290 units, utilizing all 312 voice channels within the original cell as shown in figure A-16a. The second split would create 21 2-mile cells requiring 14 additional transmitters as shown in figure A-16c. The original cell can now serve up to 25,515 cellular units.

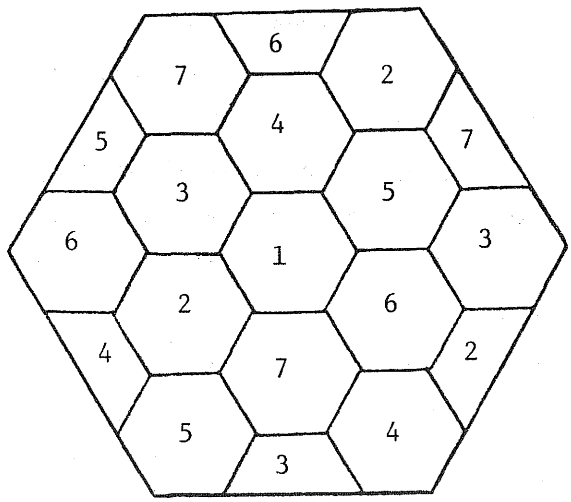
The third split would create the smallest cells with radii of 1 mile as shown in figure A-16d. A minimum of 61 cells must be created to cover the original 8-mile cell that serves 74,115 units. This would require 40 additional transmitters. Since the smallest cell size possible has a cell radius of 1 mile, the system is considered mature.



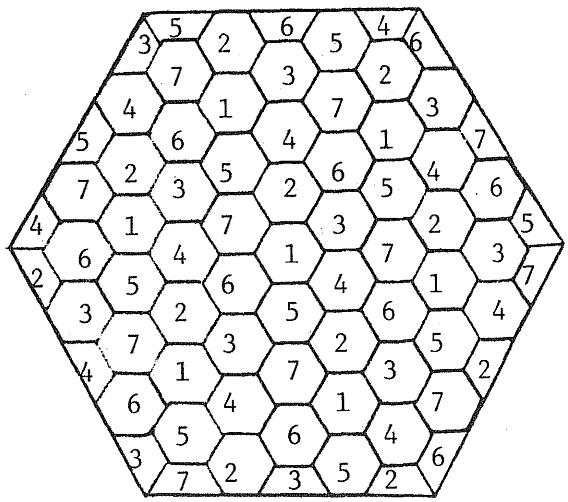
(a) Original 8-mile Radii Cell



(b) First Stage 4-mile Cells



(c) Second Stage 2-mile Cells



(d) Final Stage 1-mile Cells

1, 2, 3, 4, 5, 6, 7 = Frequency Groups

Fig. A-16. Three-stage cell splitting

For a mature system as described above, the density of subscribers is approximately 387 units per square mile. With a wireline and a nonwireline company operating in the same service area, the maximum density would reach 774 subscriber units per square mile. Only when this density is exceeded would additional frequencies need to be allocated to the cellular radio service.[28]

[28] Ibid., pp. 5-6 to 5-7.

APPENDIX B

INSTRUCTIONS FOR INTERVIEWERS

The telephone survey of large manufacturers and financial institutions was conducted by the Polimetrics Laboratory at The Ohio State University. (See Chapter 3)

This appendix contains the general instructions given to all interviewers at Polimetrics. It also contains the instructions specific to the survey conducted for this report. This latter set of instructions was written by Mr. Mark Teare, of Polimetrics Laboratory.

INTRODUCTION

Telephone interviewing is a critical phase in survey research. The objective of a telephone interview is to accurately and consistently elicit the thoughts and opinions of people on various topics of interest. Since the responses you record on the questionnaires serve as the data for subsequent statistical analyses, it is imperative that your work conform to the guidelines below (throughout this document you will be referred to as the interviewer and the person you talk to as the respondent).

For the most part these principles have an intuitive appeal and will be easily learned. Sometimes you will find that two or more of the guidelines conflict. In those cases you may have to exercise some discretion in determining the best resolution. The governing principle should be not to deviate from the guidelines unless told to do so by the supervisor, or unless it becomes impossible to conform to one without sacrificing another.

Finally it should be noted that the interview process should be as unobtrusive as possible--that is, what you say or do as an interviewer should not affect what the respondent says. We want to draw out the respondent's views, but without influencing those views in any significant way. To this end we have listed the following areas of interviewer conduct: (1) insure the validity and the reliability of the interview procedure, (2) be responsible and honest in your work, (3) be reasonably efficient and productive, and (4) be considerate of the respondent. The last section offers some ways to deal with common problems.

INTERVIEW VALIDITY AND RELIABILITY ISSUES

Asking the Question

In order to insure the accuracy of the data collected it is important that questions be asked according to the following guidelines. Throughout this section the following abbreviations are used: R=RESPONDENT and I=INTERVIEWER.

Types of Questions: There are two types of questions:

1. Closed or precoded questions which have predetermined response categories from which the R must choose.

> 33. How long have you been a resident of this community?
>
> 1. Less than 2 years
> 2. 2-5 years
> 3. 6-10 years
> 4. Over 10 years
> 8. DK
> 9. NA

2. <u>Open questions</u> that ask the R to express reasons and opinions in his/her own words.

> 1. What do you feel is the most urgent problem facing the state of Ohio today?
>
> ____
>
> ____

<u>Question Wording</u>: Survey questionnaires are designed to get accurate and complete information from R's. To obtain such information, two criteria must be met:

1. The questions must be designed to stimulate appropriate responses (this is our responsibility though you are welcome to make suggestions).

2. The questions must be asked in a uniform manner so that all R's are asked the same questions in the same way. Given these criteria it is imperative that you adhere to the following:

> Read each question in its entirety exactly as it is worded on the questionnaire.

- Do <u>not</u> make any additions, deletions, or substitutions to the question wording.

- Choose the appropriate word or phrase within parentheses. For example, (male/female).

- Read the entire question before accepting the R's answer. This allows the R to hear the question and discourages future interruptions.

Question Order: Not only does the wording of the question affect the response, but also the order in which questions are read. Responding to a question on the state of Ohio's economy could influence (or in technical jargon "contaminate") the R's response to a subsequent evaluation of the Governor of the state. These effects can not be eliminated entirely, but we have tried to minimize them by establishing a particular ordering of the questions. It is therefore essential that you abide by the following:

> Each question must be read, and read in the order in which it appears on the questionnaire unless specific instructions direct you to do otherwise.

- Occasionally you will be instructed to skip one or more questions (e.g. SKIP Q3) or to go to a particular question (e.g. GOTO Q6) depending on what the R answers.

- Don't skip a question because the answer was given earlier or because you "know" the answer.

- If the answer given is not what you expected (given previous responses) do not remind the R of the previous response(s) or try to force consistency.

Interviewing Style: In addition to the above guidelines it is important that the manner in which you deliver the questions (1) is conducive to a pleasant interview session, and (2) elicits an appropriate response. Please keep the following in mind:

- Emphasize underlined words to enhance meaning.

- Use a pleasant tone of voice which conveys assurance, interest, and a professional manner.

- Read at about two words per second.

INSURING INTEGRITY IN YOUR WORK

1. abide by the usual standards of employment:

   - arrive and leave on time

   - take only the allotted break (15 minutes)

   - report a late arrival or absence to the Polimetrics supervisory personnel at 422-1061 (the earlier the notification the better).

2. do not deviate from the general or specific instructions given you without first clearing it with the supervisor. We encourage helpful suggestions about the work, but in order to insure that everyone does things the same way and that the principles of validity and reliability are not violated, it is imperative that all changes be made by the supervisor.

3. any changes in procedure will be posted near the time sheets. Be sure to read any notices in that area.

4. be responsible for the materials you take to your calling station--especially completed questionnaires and call sheets (folders). Be sure, at the end of the evening, to give the supervisor any completed questionnaires which were not collected earlier.

5. record information honestly and consistently.

6. do not use phones for personal use. You will be charged for any personal long-distance calls made.

EFFICIENCY AND PRODUCTIVITY

We have made every effort to maintain an informal work atmosphere while insuring an appropriate degree of professionalism. The following guidelines are given in the spirit of insuring a good product and are not intended to intimidate.

1. do not instigate or encourage unproductive conversations with respondents. Don't be rude but at the same time don't allow any unnecessary conversation to interupt the interview process.

2. be conscientious:

   - work at a constant rate

   - minimize time between interviews

- do not spend time talking with other interviewers
- challenge yourself to complete as many interviews as you can

3. make sure you are thoroughly prepared to interview:
   - review the questionnaire until you are familiar with it
   - be aware of problem areas
   - review all changes and instructions each day

4. maintain a balance between male and female respondents throughout the interviewing process. Efficiency is greatly reduced when you are forced to get a number of respondents from one gender. Typically this means getting as many males as possible early on.

5. you may take up to fifteen minutes in break time during any four-hour shift. That is you may take one fifteen minute break, or two or more shorter breaks not to exceed fifteen minutes.

CONSIDERATION FOR THE RESPONDENT

1. remember that the respondent is doing us a favor by participating and is sacrificing their time. Treat him or her with the utmost respect. You can encourage their participation by telling them how important their responses are to the project.

2. if the respondent is suspicious or hostile, remain polite. Explain the nature and purpose of the interview as stated in the introduction. If necessary refer the person to the supervisor.

3. make the respondent feel at ease:
   - use your normal conversation voice
   - emphasize the absence of right or wrong answers--insure them that their ability to respond does not depend on particular knowledge

4. maintain complete confidentiality with respect to the respondent and their answers. Strive to minimize the intrusion on their privacy.

COMMON PROBLEMS AND HOW TO DEAL WITH THEM

1. If the respondent asks who is conducting the survey, simply repeat the introduction.

2. If the respondent wants more information about the project sponsor you may refer them to the supervisor.

3. If the respondent would like to verify the legitimacy of the project you may refer them to the supervisor or simply give them the Polimetrics Lab number: 422-1061.

4. If the repondent wonders why he or she is being interviewed or how they were selected you might say: "Your telephone number was selected at random from all of the phone numbers in your area in order to get a representative set of opinions." If someone questions how their unlisted number was selected, say: "Because part of the telephone number was generated at random by a computer, we occasionally pick up an unlisted number such as yours. Since we have only your telephone number and not your name, your privacy will not be compromised." If necessary refer them to the supervisor.

5. If the respondent claims not to have enough time, insure her or him that the interview will last only a few minutes and emphasize our interest in their opinions.

6. If the respondent is concerned about their ability to answer the questions reassure them by noting that there are no right or wrong answers; we simply want ot know how they feel about each item.

7. If the respondent is concerned about the anonymity of their responses, you may tell them that their answers will be combined with those of hundreds of other respondents and will be analyzed statistically. Their answers will not be used individually.

8. Sometimes a respondent will question the wording of a particular question or claim that it is redundant. Tell them that you are required to ask the questions just as they are written in order to insure the accuracy of the interview.

9. If a respondent refuses to answer a question remind them that the information will be kept both confidential and anonymous. Tell them that their response is important to the accuracy of the results. If they still refuse, do not press the issue but simply record the appropriate code.

10. Sometimes a respondent will want to have results of the interview sent to them (either to verify the legitimacy of

the project or because they are interested in the subject matter). The information we collect belongs jointly to Polimetrics and the sponsoring client, and the release of that information requires approval of both parties. Tell the respondent that you will take down their name and address and give it to the supervisor, and that the supervisor will determine whether results may be sent. Do not promise them a copy of the results.

INTERVIEWER TRAINING

To insure the validity and reliability of the results of the NRRI Bypass study interviewers hired by the Polimetrics Lab were trained both in terms of general interviewing techniques and in terms of the specific requirements of the Bypass project.

General Training

The standard Polimetrics Lab document "Guidelines for Interviewers" was used as a general background in interviewing techniques (see attachment). Each interviewer was given a copy of the guide and the relevant sections of the document were read and discussed in the formal training session.

Survey Instrument

As part of the formal training session each interviewer was given a copy of the survey instrument (questionnaire) and each item (including the introductory comments) were read together and where appropriate discussed. The supervisor noted important instructions to the interviewers (e.g. DON'T READ RESPONSES), skip patterns, and potential problem areas (e.g. difficult or technical language). The interviewers were then instructed to pair off and practice presenting the survey instrument to one another.

Special Considerations for the Bypass Project

The final portion of the formal training session was devoted to a number of concerns specific to this project:

- In order to get the necessary information interviewers were given phrases which could be used to identify and contact the appropriate telecomminications person in a sample firm.

- Since it was likely that a firm might be called multiple times before an appropriate disposition was reached, interviewers were instructed to use the Background Information and Call Disposition Sheets to record the result of each attempted contact. For each call the date, what happened, and necessary future action was recorded.

- Each interviewer became familiar with the DUNS cards which represented the sample. Information which was to be transferred to the disposition sheets was identified.

- Call back procedures were established to insure that every firm was given an appropriate opportunity to participate (see final section).

INTERVIEWING PROCEDURE

Each interviewer was given a batch (25) of the DUNS cards from which to complete interviews. The interviewer was responsible for seeing that each firm represented on the cards was contacted until appropriately disposed of. Appropriate dispositions included (1) a completed interview, (2) a partially completed questionnaire in which case the interviewer attempted to complete the interview at a subsequent time, (3) a refusal, (4) an inelligible firm (i.e. one with fewer than 500 employees), or (5) a refusal to conduct the interview over the phone in which case a questionnaire was mailed to the firm.

1. Take next available DUNS card in batch

2. Record information from DUNS card on Call Disposition Sheet (e.g. seq. no., name and address of firm)

3. Call firm and ask to speak with individual in charge of telecommunications

   - If person is available ask "How many employees work at this location?"

     * If less than 500 terminate and record INELLIGIBLE (GOTO STEP 1)

     * If 500 or more record number (GOTO STEP 4)

   - If unavailable ask when they might be available, record call back information (GOTO STEP 1)

4. Read introduction to questionnaire and proceed with questions

   - If person indicates that there is a policy against telephone interviews, tell him or her that a questionnaire will be mailed and record necessary information (name, address) (GOTO STEP 6)

   - If person refuses to participate (e.g. not enough time etc.) try to overcome their reason for refusal (e.g. suggest an alternative time etc.); if this fails ask if a questionnaire may be mailed

     * If yes (GOTO STEP 6)

     * If no, record REFUSED (GOTO STEP 1)

   - If person is unable to adequately respond to questions ask "Is there someone else who might be better able to answer these questions?"

* If person is available ask to be connected with them (GOTO STEP 4)

* If person is unavailable record call back information (GOTO STEP 1)

- If person is unable to complete entire questionnaire try to make a subsequent appointment to complete the remaining questions

  * If appointment possible record date and time (GOTO STEP 1)

  * If appointment impossible or unlikely, ask if the partially completed questionnaire may be mailed for completion

    - If yes (GOTO STEP 6)

    - If no, record PARTIAL (GOTO STEP 1)

5. After the interview is completed:

   - Attach disposition sheet to completed interview schedule

   - Check over document to insure that all information has been collected and correctly recorded (call back to obtain missing information)

   - Turn in completed document for coding and data entry (GOTO STEP 1)

6. For mail surveys:

   - For partially completed questionnaires: mail photocopy of partially completed interview schedule with cover letter.

   - For initial mail interviews: stamp disposition sheet and mail interview schedule with corresponding number, send interview schedule with cover letter

CALL BACK PROCEDURE

Each interviewer was responsible for insuring that all call backs in their batch were made. As batches neared completion the supervisor would verify the disposition of each firm, collect any call backs and assign the remaining call backs to an interviewer for completion.

APPENDIX C

DESCRIPTION OF DUN'S SAMPLING POPULATION

The results of a telephone survey of a nationwide random sample of large manufacturers and financial institutions are reported in this study. This appendix contains a letter from Dun's Marketing Service that describes the population from which the sample was drawn. Chapter 3 contains additional discussion regarding the selection of the population from which the sample was drawn.

Dun's Marketing Services

a company of
The Dun & Bradstreet Corporation

Dun's Marketing Services 4400 North High Street, 2nd Floor, Columbus, OH 43214
614-267-8662

October 11, 1984

Dr. Jane L. Racster
Senior Research Specialist
Telecommunications Research Division
The National Regulatory Research Institute
The Ohio State University
2130 Neil Ave.
Columbus, Ohio 43210

Dear Dr. Racster:

The purpose of this letter is to explain the selection procedure we used in providing you with 2000 Dun's Market Identifier records in April, 1984:

1. <u>Manufacturing Industry; locations with 100-500 employees.</u>

   We randomly selected 700 business locations from our entire data base of this universe of approximately 48,400 locations.

2. <u>Manufacturing Industry; locations with 501+ employees.</u>

   We randomly selected 700 business locations from our entire data base of this universe of approximately 9,200 locations.

3. <u>Financial Industry; locations with 100-500 employees.</u>

   We randomly selected 300 business locations from our entire data base of this universe of approximately 7,600 locations.

4. <u>Financial Industry; locations with 501+ employees.</u>

   We randomly selected 300 business locations from our entire data base of this universe of approximately 1,460 locations.

In the above selections the universe of businesses selected were from the entire U.S. except for Alaska and Hawaii.

Dr. Racster, it's difficult to say what percentage of the total universe we would have in our data base. It's my belief, however, that we probably have 90-95% of the total universe of the businesses in the industries and of the size criteria which was used to produce your sample.

If I can be of further assistance to you please do not hesitate to let me know.

Sincerely,

Jack A. Clair

Jack A. Clair
Senior Account Executive

APPENDIX D

SURVEY QUESTIONNAIRE

This appendix contains the questionnaire used by the interviewers at Polimetrics to conduct and record the interviews reported in this study.

I.D. Number: 423 ______________ Phone Number: ______________

Time in: ______ : ________ Interviewer Initials: ______________

City: ______________ Batch Number: ______________

NRRI: BYPASS STUDY - JUNE 1984

Hello, my name is ______________ and I'm calling from the Polimetrics Laboratory at the Ohio State University. We have been hired by The National Regulatory Research Institute (NRRI) to conduct a survey of large businesses regarding their telecommunications systems. We are collecting this information to accurately assess the changing needs of telecommunications users. Of course all of your responses will be confidential and only aggregate results will be reported. Your participation in this project will help insure its success.

1. First, I have been told that you are responsible for handling telecommunications services for your employer. Is this correct?

   1. Yes
   2. No (REQUEST APPROPRIATE INDIVIDUAL OR TERMINATE)

2. In addition to voice communications what other forms of telecommunications is your company engaged in at this location? Are you engaged in ________ (READ ITEMS FROM LIST)?

   ____ Data telecommunications

   ____ Video telecommunications

3. What are your responsibilities within the organization? Are you responsible for: (READ ITEMS FROM LIST)

   ____ Telecommunications Operations

   ____ Telecommunications Management

   ____ Telecommunications Planning

   ____ Some other telecommunications area (SPECIFY) ______________

4a. How many locations including this one does your firm have? ________

(IF Q4a IS "1" SKIP Q4b, Q4c, Q4d, AND CIRCLE ONE IN Q5)

4b. How many of these locations including this one are in your city? ________

4c. How many of these locations are in your state but not in your city? ________

4d. How many of these locations are in adjacent states? ________

5. Where are the major telecommunications decisions for this company made? Are they made at: (READ LIST)

   1. The headquarters
   2. The branch
   3. The headquarters and the branch
   8. DK (DON'T READ)

6. Does your company own or lease its customer premises equipment?

   1. Own
   2. Lease
   3. Both
   8. DK

7. About what percentage of employees at this location use the telephone in their daily work?

_______ %   98. DK

8. About what percentage of your organization's phone calls at this location are incoming, and what percentage are outgoing? (RECORD INCOMING PERCENTAGE)

_______ %   98. DK

9. About what percentage of your organization's data transmissions at this location are incoming, and what percentage are outgoing? (RECORD INCOMING PERCENTAGE)

_______ %   98. DK

10. How much of the company's total telecommunications bill would you say is generated at this location?

_______ %   98. DK

We are particularly interested in the growing use of bypass facilities. By bypass we mean the origination and/or termination of telecommunications traffic without the use of local telephone company facilities. Some examples of bypass facilities are: a privately owned "point to point" microwave system, a privately owned or TV company's cable network, a privately owned inter-office communications network, or a direct connection between a customer's premise and an interexchange carrier. Bypass does not mean the use of a non-AT&T carrier such as MCI or SPRINT, unless that carrier is directly connected to the customer's premises rather than indirectly connected through the local telephone company.

	Yes	No	Refused	DK
11a. As I've defined it does your company currently use any type of bypass facilities at this location?	1	2	7	8
11b. Has your company made a firm commitment to install any type of bypass facilities at this location which are not yet operational? A firm commitment is considered to be at a minimum, the securing of bids for the installation of bypass facilities.	1	2	7	8

(IF IN Q11a AND Q11b: THERE IS AT LEAST ONE YES - GO TO PART II,
THERE ARE NO YES'S BUT AT LEAST ONE NO - GO TO PART III,
THERE ARE NO YES'S AND NO NO'S - GO TO Q47)

PART II

TO BE ASKED OF THOSE WHO EITHER USE BYPASS FACILITIES OR WHO HAVE MADE A FIRM COMMITMENT TO DO SO. QUESTIONS IN THIS SECTION SHOULD BE ASKED ABOUT EXISTING BYPASS FACILITIES IF "YES" IN Q11a ONLY, AND ABOUT FUTURE BYPASS FACILITIES IF "YES" IN Q11b. WHERE A CHOICE OF WORDING IS GIVEN, USE THE FIRST CHOICE FOR THE FORMER SITUATION AND THE SECOND CHOICE FOR THE LATTER.

12a. (IF "YES" IN Q11a) In what year did your initial bypass facilities become operational?   19_____

12b. (IF "YES" IN Q11b) In what year will your future bypass facilities become operational?   19_____

13. Of the total traffic carried by your bypass facilities, what percentage do you estimate (is/will be) for data communications?

_______ %   98. DK

14. Of the total data traffic carried by your bypass facilities, what percentage do you estimate (is/will be) for high speed data?

_______ %   98. DK

15. Of the total traffic carried by your bypass facilities, what percentage do you estimate (is/will be) for long-distance traffic?

________ %   98. DK

16. Of the total long-distance traffic carried by your bypass facilities, what percentage do you estimate (is/will be) for interstate long-distance?

________ %   98. DK

17. Of the total traffic carried by your bypass facilities what percentage do you estimate (is/will be) for video transmissions?

________ %   98. DK

18. Of the total traffic carried by your bypass facilities what percentage do you estimate (is/will be) for within-company communications at this location?

________ %   98. DK

19. Of the total traffic carried by your bypass facilities what percentage do you estimate (is/will be) with other units of your company at other locations?

________ %   98. DK

20. Now I would like to read a list of factors that might be considered in making the decision to bypass. Please tell me for each if that consideration was very important, somewhat important, or not important in your decision to use bypass facilities. How important was ________ (READ ITEMS FROM LIST)?

	VI	SI	NI	DK
Inability of phone company to provide desired services (AVAIL)	1	2	3	8
Greater reliability of bypass facilities (RELIABILITY)	1	2	3	8
Greater flexibility of bypass facilities (FLEXIBILITY)	1	2	3	8
Concern about control, security, and/or privacy (SECURITY)	1	2	3	8
Price of telephone company services (PRICE)	1	2	3	8
Stability of prices over time (STABILITY)	1	2	3	8

21. Were there any other considerations in your decision to bypass? How important was ____________ ? (PROBE: "ANY OTHERS" UP TO THREE)

________________________	(01)	1	2	3	8
________________________	(02)	1	2	3	8
________________________	(03)	1	2	3	8

22. Now I would like you to rank order the considerations you said were either somewhat or very important in your decision to bypass. Which consideration was ________ (READ RANKINGS) in importance? (RECORD APPROPRIATE CODEWORD IN CORRESPONDING BLANK. IF NECESSARY REMIND RESPONDENT OF FACTORS THEY CONSIDERED IMPORTANT.)

First ____________	Fourth ____________	Seventh ____________
Second ____________	Fifth ____________	Eighth ____________
Third ____________	Sixth ____________	Ninth ____________

23. (IF PRICE WAS SOMEWHAT OR VERY IMPORTANT) Please tell me which telephone company price(s) were most significant in your decision to bypass. Were ____________ (READ ITEMS FROM LIST) significant?

____ State MTS Rates

____ Interstate MTS Rates

____ State WATS Rates

____ Interstate WATS Rates

____ State Private Line Rates

____ Interstate Private Line Rates

____ Proposed State End-User or Customer Access Line Charges (CALC)

____ Proposed Interstate End-User or Customer Access Line Charges (CALC)

____ Centrex Rates

____ PBX Trunk Rates

____ Within-company trunks, tie lines, off premise extensions rates

____ Local Measured Rates

____ Other prices (SPECIFY) ____

____ Other prices (SPECIFY) ____

24. (IF AVAILABILITY WAS SOMEWHAT OR VERY IMPORTANT) Please tell me what services you wanted that were not available through the telephone company? (PROBE: "ANY OTHERS" UP TO THREE)

____

____

____

25. (IF RELIABILITY WAS SOMEWHAT OR VERY IMPORTANT) Please tell me which, if any, of the following service reliability concerns were significant in your decision to bypass? Was ________ (READ ITEMS FROM LIST) significant?

____ Quality of telephone company service

____ Quality of telephone company maintenance

____ Speed of telephone company maintenance

____ Installation time

____ Quality of installation

____ Some other reliability factor (SPECIFY) ______________________________

26. (IF FLEXIBILITY WAS SOMEWHAT OR VERY IMPORTANT) Please describe in what ways bypass facilities (provide/will provide) greater flexibility. (PROBE: "ANY OTHERS" UP TO THREE)

____

____

____

27. (IF SECURITY WAS SOMEWHAT OR VERY IMPORTANT) Please describe what control, security, and/or privacy concerns you (had/have). (PROBE: "ANY OTHERS" UP TO THREE)

____

____

____

28. (IF PRICE STABILITY WAS SOMEWHAT OR VERY IMPORTANT) Please describe what concerns about price stability you (had/have). (PROBE: "ANYTHING ELSE" UP TO THREE)

____

____

____

29. Is there anything else that influenced your decision to bypass? If so please describe it? (PROBE: "ANYTHING ELSE" UP TO THREE)

____

____

____

30. (Did/Does) the local telephone company offer services which (were/are) technologically equivalent to your bypass facilities? (IF "YES") Did you consider obtaining such services?

1. Yes - did consider obtaining them
2. Yes - did not consider obtaining them
3. No
8. DK

31. Now I would like to ask you about various bypass technologies. (Do/Will) you use ______ (READ ITEMS FROM LIST)?

_____ Private microwave

_____ Local area network

_____ Satellite/customer premises earth station

_____ Digital termination systems

_____ Fiber optics

_____ Coaxial cable

_____ Teleports

Any other bypass technology (SPECIFY)

_____ ______________________________

_____ ______________________________

32. Have you installed fiber optics, coaxial cable, microwave, laser, or some other technology to extend transmissions from your premises directly to the facilities or switch of an interexchange carrier?

1. Yes
2. No
7. Refused
8. DK

I would like to ask you about the ways in which you use your bypass facilities. For each level of telecommunications; intra-location, local, state, and interstate I would like to know if you use your bypass facilities to transmit any of the following: voice communications, voice grade data, high speed data, or video.

33a. First, with respect to intra-location telecommunications, that is transmissions within the confines of this location, do you use your bypass facilities for ________ (READ ITEMS FROM LIST) transmissions?

_____ Voice

_____ Voice grade data (i.e. 9.6 kilobits per second or less)

_____ High speed data (i.e. more than 9.6 kilobits per second)

_____ Video

33b. With respect to local telecommunications, do you use your bypass facilities for ________ (READ ITEMS FROM LIST) transmissions?

_____ Voice

_____ Voice grade data (i.e. 9.6 kilobits per second or less)

_____ High speed data (i.e. more than 9.6 kilobits per second)

_____ Video

33c. With respect to state long distance telecommunications, do you use your bypass facilities for ________ (READ ITEMS FROM LIST) transmissions?

_____ Voice

_____ Voice grade data (i.e. 9.6 kilobits per second or less)

_____ High speed data (i.e. more than 9.6 kilobits per second)

_____ Video

33d. With respect to interstate long-distance telecommunications, do you use your bypass facilities for ________ (READ ITEMS FROM LIST) transmissions?

_____ Voice

_____ Voice grade data (i.e. 9.6 kilobits per second or less)

_____ High speed data (i.e. more than 9.6 kilobits per second)

_____ Video

34. Prior to the installation of your bypass facilities was your outgoing toll traffic carried by (READ ITEMS FROM LIST)

_____ Private line

_____ Foreign exchange

_____ WATS line

_____ MTS service (ASK Q34a)

_____ Some other service (SPECIFY) ________________________________

_____ DK (DON'T READ)

34a. (IF "MTS" CHECKED IN Q34) What percentage of this toll traffic prior to the installation of your bypass facilities was carried by MTS service?

________ % 98. DK

35. Now I would like to ask about your use of various services provided by the telephone company. The (first/next) service is ________ (READ ITEMS FROM LIST).

(1) Did you use this service prior to the installation of your bypass facilities? (CHECK IF "YES")

(2) (Do/Will) any of your bypass facilities provide the same service? (CHECK IF "YES")

(3) (Has/Will) your use of this service <u>from the telephone company</u> decrease(d) as a result of your bypass facilities or not? ("D" FOR DECREASE - "NC" FOR NO CHANGE)

(4) What (was/will be) the percentage decrease in use?

Service	(1)	(2)	(3)	(4)
Interstate private lines (Analog)	_____	_____	_____	________ %
(Digital w. bit rate of 9.6 kbps or less)	_____	_____	_____	________
(Digital w. bit rate of 56 kbps)	_____	_____	_____	________ %
(Digital w. bit rate of 1.544 mbps or T1/T2 carrier channels)	_____	_____	_____	________ %
State private lines (Analog)	_____	_____	_____	________ %
(Digital w. bit rate of 9.6 kbps or less)	_____	_____	_____	________
(Digital w. bit rate of 56 kbps)	_____	_____	_____	________ %
(Digital w. bit rate of 1.544 mbps or T1/T2 carrier channels)	_____	_____	_____	________ %
Interstate WATS lines (in-WATS)	_____	_____	_____	________ %
(out-WATS)	_____	_____	_____	________ %
State WATS lines (in-WATS)	_____	_____	_____	________ %
(out-WATS)	_____	_____	_____	________ %
Interstate foreign exchange lines	_____	_____	_____	________ %
State foreign exchange lines	_____	_____	_____	________ %
Interstate MTS	_____	_____	_____	________ %
State MTS	_____	_____	_____	________ %
Intra-company trunks, tie lines, off premise extensions	_____	_____	_____	________ %
Centrex lines	_____	_____	_____	________ %
PBX trunks	_____	_____	_____	________ %
Other local trunks or lines	_____	_____	_____	________ %
Is there any other telephone company service which you have used?				
______________________________	_____	_____	_____	_____
______________________________	_____	_____	_____	_____

35a. What do you estimate (is/will be) the <u>monthly</u> percentage savings in telephone company bills as a result of your bypass facilities?

________ % 98. DK (GO TO PART IV <PAGE 11>)

PART III

FOR RESPONDENTS WHO DO NOT CURRENTLY USE ANY BYPASS FACILITY AND WHO HAVE NOT MADE A FIRM COMMITTMENT TO INSTALL A BYPASS SYSTEM.

36. In the past did you ever consider using any type of bypass facilities and reject that alternative?

    1. Yes
    2. No (GO TO Q37)
    7. Refused (GO TO Q37)
    8. DK (GO TO Q37)

36a. For what reasons did you decide against using a bypass system? (PROBE: "WHAT OTHER REASONS")

____ Lack of traffic concentration

____ Price of the system

____ Maintenance costs and related problems

____ Unavailability of bypass

____ Reliability of the telephone company

____ Other (SPECIFY) ________________________________

____ Other (SPECIFY) ________________________________

____ Other (SPECIFY) ________________________________

37. Are you now considering the use of bypass facilities?

    1. Yes
    2. No (GO TO Q47)
    7. Refused (GO TO Q47)
    8. DK (GO TO Q47)

38. For which of the following reasons are you considering the use of bypass facilities? (READ LIST)

____ Inability of telephone company to provide desired services (AVAILABILITY)

____ Greater reliability of bypass facilities (RELIABILITY)

____ Greater flexibility of bypass facilities (FLEXIBILITY)

____ Concern about control, security, and/or privacy (SECURITY)

____ Price of telephone company services (PRICE)

____ Stability of prices over time (STABILITY)

39. Are there other considerations in your decision to bypass? What are they? (PROBE: "ANY OTHERS" UP TO THREE)

____

____

____

40. (IF PRICE IS AN IMPORTANT FACTOR) Please tell me which telephone company price(s) would be most significant in your decision to bypass. Would ____________ (READ ITEMS FROM LIST) be significant?

____ State MTS Rates

____ Interstate MTS Rates

____ State WATS Rates

____ Interstate WATS Rates

____ State Private Line Rates

____ Interstate Private Line Rates

____ Proposed State End-User or Customer Access Line Charges (CALC)

____ Proposed Interstate End-User or Customer Access Line Charges (CALC)

____ Centrex Rates

____ PBX Trunk Rates

____ Within-company trunks, tie lines, off premise extensions rates

____ Local Measured Rates

____ Other prices (SPECIFY) ______________________________

____ Other prices (SPECIFY) ______________________________

41. (IF AVAILABILITY IS AN IMPORTANT FACTOR) Please tell me what services you want that are not available through the telephone company? (PROBE: "ANY OTHERS" UP TO THREE)

____

____

____

42. (IF RELIABILITY IS AN IMPORTANT FACTOR) Please tell me which, if any, of the following service reliability concerns are signifcant in your decision to bypass? Is ________ (READ ITEMS FROM LIST) significant?

____ Quality of telephone company service

____ Quality of telephone company maintenance

____ Speed of telephone company maintenance

____ Installation time

____ Quality of installation

____ Some other reliability factor (SPECIFY) ______________________

43. (IF FLEXIBILITY IS AN IMPORTANT FACTOR) Please describe in what ways bypass facilities would provide greater flexibility. (PROBE: "ANY OTHERS" UP TO THREE)

____

____

____

44. (IF SECURITY IS AN IMPORTANT FACTOR) Please describe what control, security, and/or privacy concerns you have. (PROBE: "ANY OTHERS" UP TO THREE)

____

____

____

45. (IF PRICE STABILITY IS AN IMPORTANT FACTOR) Please describe what concerns about price stability you have. (PROBE: "ANYTHING ELSE" UP TO THREE)

____

____

____

46. Is there anything else that would influence your decision to bypass? What would that be? (PROBE: "ANYTHING ELSE" UP TO THREE)

____

____

____

47. What percentage of your <u>total traffic</u> do you estimate is for data communication?

_______ % 98. DK

48. What percentage of your <u>total traffic</u> do you estimate is for video transmissions?

_______ % 98. DK

49. What percentage of your <u>total data traffic</u> do you estimate is high speed data?

_______ % 98. DK

50. Of your <u>total telecommunications traffic</u> what percentage do you estimate is toll traffic?

_______ % 98. DK

51. Is your outgoing toll traffic carried by (READ ITEMS FROM LIST)

_____ Private line

_____ Foreign exchange

_____ WATS line

_____ MTS service (ASK Q51a)

_____ Some other service (SPECIFY) ______________________________

_____ DK (DON'T READ)

51a. (IF "MTS" CHECKED IN Q51) What percentage of this <u>toll traffic</u> is carried by MTS service?

_______ % 98. DK

52. Of your <u>total telecommunication traffic</u> what percentage do you estimate is within-company traffic?

_______ % 98. DK

53. What percentage of your total telecommunication traffic is with other units of your company at other locations?

________ %   98. DK

PART IV

ALL RESPONDENTS

54. What do you estimate your average monthly bill from the telephone company was in 1983 for this location (excluding customer premises equipment)? (BE SURE TO RECORD ANY TIME OR SPACE SPECIFICATIONS OTHER THAN THOSE INCLUDED IN THE QUESTION)

$ ____________________   97. Refused   98. DK

55. Now I would like to ask you about telephone services your company purchased in 1983. For each service I mention please tell me the average number of trunks or lines your company purchased from the local telephone company during 1983. How many ________ (READ ITEMS FROM LIST) did your company use in 1983? (CIRCLE "T" FOR TRUNKS AND "L" FOR LINES; IF RESPONDENT DOES NOT KNOW RECORD "DK" IN BLANK)

Service	Lines/Trunks	
Interstate private lines		
(Analog)	________	L T
(Digital w. bit rate of 9.6 kbps or less)	________	L T
(Digital w. bit rate of 56 kbps)	________	L T
(Digital w. bit rate of 1.544 mbps or T1/T2 carrier channels)	________	L T
State private lines		
(Analog)	________	L T
(Digital w. bit rate of 9.6 kbps or less)	________	L T
(Digital w. bit rate of 56 kbps)	________	L T
(Digital w. bit rate of 1.544 mbps or T1/T2 carrier channels)	________	L T
Interstate WATS lines		
(in-WATS)	________	L T
(out-WATS)	________	L T
State WATS lines		
(in-WATS)	________	L T
(out-WATS)	________	L T
Interstate foreign exchange lines	________	L T
State foreign exchange lines	________	L T
Intra-company trunks, tie lines, off premise extensions	________	L T
Centrex lines	________	L T
PBX trunks	________	L T
Other local trunks or lines	________	L T
What other services were purchased?		
____________________	________	L T
____________________	________	L T

55a. For each of the following services please indicate your use of that service during 1983 in terms of average monthly minutes of use. What was your average monthly number of minutes for _______ (READ ITEMS FROM LIST) transmissions?

Service	Minutes
Interstate WATS	________
State WATS	________
Interstate MTS	________
State MTS	________

56. Do you have any additional comments you feel are relevant to helping us understand your company's telecommunications needs?

57. Do you have any comments regarding the effects of current or future telecommunications policies on your company?

Time out: _____ : _______

Elapsed time: __________ minutes

Date: ____________________

APPENDIX E

RESPONSES FROM NONBYPASS LOCATIONS

This appendix contains the responses of nonbypass locations to a set of questions which were asked of all respondents. The responses are categorized according to nonbypassers who are considering bypass and nonbypassers who are not considering bypass. The responses are reported here for those readers who wish to make comparisons between bypassers and nonbypassers. Some of these data were used for the statistical analyses reported in chapter 4 regarding the significance of differences between bypassers and nonbypassers.

TABLE E-1

NUMBER AND PERCENT OF NONBYPASSERS THAT ARE HEADQUARTERS VERSUS BRANCH LOCATIONS

	Headquarters	Percent of Headquarters Locations	Branch	Percent of Branch Location	No Response	Total
Nonbypass locations considering bypass	59	26.3	31	13.0	0	90
Nonbypass locations not considering bypass	165	73.6	207	87.0	10	382
Total	224	100.0	238	100.0	10	472

Source: Survey results

TABLE E-2

NUMBER OF NONBYPASSERS BY TOTAL NUMBER OF COMPANY LOCATIONS

	1	2-10	11-25	26-50	51-100	101-500	501-700	No Response
Nonbypass locations considering bypass	6	22	14	14	9	17	3	5
Nonbypass locations not considering bypass	29	142	57	42	26	24	1	61
Total	35	164	71	56	35	41	4	66

Source: Survey results

TABLE E-3

NUMBER OF NONBYPASSERS BY NUMBER OF EMPLOYEES

	500-700	701-1,000	1,001-1,200	1,201-1,500	Over 1,500	No Response
Nonbypass locations considering bypass	27	22	4	9	28	0
Nonbypass locations not considering bypass	147	117	29	25	64	0
Total	174	139	33	34	92	0

Source: Dun's Marketing Service

TABLE E-4

NUMBER OF NONBYPASSERS BY PERCENTAGE OF EMPLOYEES WHO USE THE TELEPHONE IN THEIR WORK

	Percent					No
	0-25	26-50	51-75	76-100	100*	Response
Nonbypass locations considering bypass	13	10	18	46	11	3
Nonbypass locations not considering bypass	117	78	51	128	38	8
Total	130	88	69	174	49	11

*These numbers are included in the column at the left.
Source: Survey results

TABLE E-5

NUMBER OF NONBYPASSERS BY PERCENTAGE OF COMPANY'S TOTAL TELECOMMUNICATIONS BILL GENERATED AT THE NONBYPASSER'S LOCATION

	Percent				No
	0-25	26-50	51-75	76-100	Response
Nonbypass locations considering bypass	22	11	26	19	12
Nonbypass locations not considering bypass	90	39	52	93	108
Total	112	50	78	112	120

Source: Survey results

TABLE E-6

NUMBER OF NONBYPASSERS BY PERCENTAGE OF CALLS THAT ARE INCOMING

	Percent				No
	0-25	26-50	51-75	76-100	Response
Nonbypass locations considering bypass	2	42	23	3	20
Nonbypass locations not considering bypass	13	204	67	9	89
Total	15	246	90	12	109

Source: Survey results

TABLE E-7

NUMBER OF NONBYPASSERS BY INCOMING DATA TRANSMISSIONS AS A PERCENT OF TOTAL DATA TRANSMISSIONS

	Percent				No
	0-25	26-50	51-75	76-100	Reponse
Nonbypass locations considering bypass	19	38	7	7	19
Nonbypass locations not considering bypass	69	159	35	33	86
Total	88	197	42	40	105

Source: Survey results

TABLE E-8

NUMBER OF NONBYPASSERS BY PERCENTAGE OF TOTAL TRAFFIC THAT IS DATA TRANSMISSION

	Percent					No
	0	1-25	26-50	51-75	76-100	Response
Nonbypass locations considering bypass	2	43	22	5	2	16
Nonbypass locations not considering bypass	20	206	75	11	4	66
Total	22	249	97	16	6	82

Source: Survey results

TABLE E-9

NUMBER OF NONBYPASSERS BY PERCENTAGE OF DATA TRAFFIC THAT IS HIGH SPEED DATA TRANSMISSION

	Percent					No
	0	1-25	26-50	51-75	76-100	Response
Nonbypass locations considering bypass	24	26	3	6	17	14
Nonbypass locations not considering bypass	93	54	20	13	71	131
Total	117	80	23	19	88	145

Source: Survey results

TABLE E-10

NUMBER OF NONBYPASSERS BY PERCENTAGE OF TOTAL TRAFFIC THAT IS VIDEO TRAFFIC

	Percent					No
	0	1-5	6-10	11-15	16-30	Response
Nonbypass locations considering bypass	79	5	0	2	0	4
Nonbypass locations not considering bypass	356	10	3	2	2	9
Total	435	15	3	4	2	13

Source: Survey results

TABLE E-11

NUMBER OF NONBYPASSERS BY PERCENTAGE OF TOTAL TRAFFIC THAT IS LONG DISTANCE TRAFFIC

	Percent					No
	0	1-25	26-50	51-75	76-100	Response
Nonbypass locations considering bypass	2	20	27	15	18	8
Nonbypass locations not considering bypass	7	93	86	88	65	43
Total	9	113	113	103	83	51

Source: Survey results

TABLE E-12

NUMBER OF NONBYPASSERS BY PERCENTAGE OF TOTAL TRAFFIC THAT IS INTRALOCATION TRAFFIC

	Percent					No
	0	1-25	26-50	51-75	76-100	Response
Nonbypass locations considering bypass	0	23	30	8	4	25
Nonbypass locations not considering bypass	2	98	122	47	25	88
Total	2	121	152	55	29	113

Source: Survey results

TABLE E-13

NUMBER OF NONBYPASSERS BY PERCENTAGE OF TOTAL TRAFFIC THAT IS INTRACOMPANY, INTERLOCATION TRAFFIC

	Percent					No
	0	1-25	26-50	51-75	76-100	Response
Nonbypass locations considering bypass	6	33	22	8	8	13
Nonbypass locations not considering bypass	17	168	97	28	17	55
Total	23	201	119	36	25	68

Source: Survey results

TABLE E-14

NUMBER OF NONBYPASSERS BY THEIR AVERAGE MONTHLY BILL
FROM THE TELEPHONE COMPANY IN 1983

	Less than $10,000	$10,000-$49,000	$50,000-$99,999	$100,000-$999,999	$1,000,000-$4,500,000	No Response
Nonbypass locations considering bypass	10	23	14	20	4	19
Nonbypass locations not considering bypass	113	96	35	24	2	112
Total	123	119	49	44	6	131

*i.e. The average monthly bill in 1983, excluding CPE
Source: Survey results

APPENDIX F

RESULTS OF t-TESTS FOR SIGNIFICANCE OF DIFFERENCES BETWEEN BYPASSERS AND NONBYPASSERS

This appendix contains the computer output for t-test analyses for differences. The first set of analysis is between bypassers and those considering bypass. The second comparison is between bypassers and nonbypassers who are not considering bypass. The third set of analyses is between bypassers and all nonbypassers, including those who are considering bypass. The final comparison is between those nonbypassers considering bypass and those nonbypassers not considering bypass.

Results of t-Test Analyses between
Bypassers and Nonbypassers
Who Are Considering Bypass

The definitions of terms used are as follows:

V_o = Nonbypassers considering bypass

V_1 = Bypassers

NLT = Number of locations

NLC = Number of locations in city

NLS = Number of locations in the state

NLA = Number of locations in adjacent states

Conc2 = Number of locations in the state but not in the city, as a percentage of the total number of locations

OWEQ = Ownership of customer-premises equipment

PTUE = Percentage of employees who use the telephone

PINC = Percentage of telephone calls that are incoming as opposed to outgoing

PIDT = Percentage of data transmissions that are incoming as opposed to outgoing

PTBL = Percentage of the company's total telecommunications bill generated at the location

BILL = Average monthly bill from the telephone company in 1983 excluding customer-premises equipment

TTEST PROCEDURE

VARIABLE: NLT TOTAL NUMBER OF LOCATIONS Q4A

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	85	77.49411765	128.06430895	13.89052459	1.00000000	650.00000000	UNEQUAL	0.1078	161.4	0.9143
1	80	75.30000000	133.03405864	14.87365992	1.00000000	700.00000000	EQUAL	0.1079	163.0	0.9142

FOR HO: VARIANCES ARE EQUAL, F'= 1.08 WITH 79 AND 84 DF PROB > F'= 0.7301

VARIABLE: NLC NUMBER OF LOCATIONS IN CITY Q4B

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	90	14.36666667	60.14391915	6.33972573	1.00000000	550.00000000	UNEQUAL	1.5289	92.0	0.1297
1	88	4.59090909	7.78391558	0.82976819	0.00000000	60.00000000	EQUAL	1.5123	176.0	0.1322

FOR HO: VARIANCES ARE EQUAL, F'= 59.70 WITH 89 AND 87 DF PROB > F'= 0.0001

VARIABLE: NLS NUMBER OF LOCATIONS IN STATE Q4C

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	88	26.97727273	69.70891486	7.43099529	0	400.00000000	UNEQUAL	1.4149	132.7	0.1594
1	84	15.04761905	36.50842608	3.98339586	0	240.00000000	EQUAL	1.3962	170.0	0.1645

FOR HO: VARIANCES ARE EQUAL, F'= 3.65 WITH 87 AND 83 DF PROB > F'= 0.0001

VARIABLE: NLA NUMBER OF LOCATIONS IN ADJ. STATES Q4D

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	83	7.96385542	20.52508625	2.25292290	0	100.00000000	UNEQUAL	-0.9673	81.4	0.3363
1	78	21.00000000	117.34918478	13.28717869	0	996.00000000	EQUAL	-0.9962	159.0	0.3207

FOR HO: VARIANCES ARE EQUAL, F'= 32.69 WITH 77 AND 82 DF PROB > F'= 0.0001

VARIABLE: CONC2

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	85	0.24313809	0.30068493	0.03261386	0	1.00000000	UNEQUAL	-0.5289	158.7	0.5976
1	77	0.26803330	0.29780337	0.03393784	0	0.98412698	EQUAL	-0.5287	160.0	0.5978

FOR HO: VARIANCES ARE EQUAL, F'= 1.02 WITH 84 AND 76 DF PROB > F'= 0.9346

TTEST PROCEDURE

VARIABLE: OWEQ OWNERSHIP OF EQUIPMENT Q6

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	90	2.15555556	0.76306760	0.08043439	1.00000000	3.00000000	UNEQUAL	-0.4219	160.6	0.6736
1	89	2.21348315	1.04958769	0.11125607	1.00000000	8.00000000	EQUAL	-0.4227	177.0	0.6730

FOR HO: VARIANCES ARE EQUAL, F'= 1.89 WITH 88 AND 89 DF PROB > F'= 0.0030

VARIABLE: PTUE PERC. EMPL. USING TELEPH. Q7

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	87	71.10344828	28.67623377	3.07441497	8.00000000	100.00000000	UNEQUAL	1.4188	172.0	0.1578
1	87	64.96551724	28.38786519	3.04349861	1.00000000	100.00000000	EQUAL	1.4188	172.0	0.1578

FOR HO: VARIANCES ARE EQUAL, F'= 1.02 WITH 86 AND 86 DF PROB > F'= 0.9255

VARIABLE: PINC PERC. PHONE CALLS INCOMING Q8

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	70	52.08571429	12.10311118	1.44659847	10.00000000	85.00000000	UNEQUAL	0.9266	133.7	0.3558
1	71	49.95774648	15.02800873	1.78349651	25.00000000	90.00000000	EQUAL	0.9252	139.0	0.3564

FOR HO: VARIANCES ARE EQUAL, F'= 1.54 WITH 70 AND 69 DF PROB > F'= 0.0735

VARIABLE: PIDT PERC. DATA TRANS. INCOMING Q9

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	71	42.81690141	25.46331246	3.02193922	0	100.00000000	UNEQUAL	-0.3694	140.0	0.7124
1	71	44.40845070	25.87915734	3.07129093	0	100.00000000	EQUAL	-0.3694	140.0	0.7124

FOR HO: VARIANCES ARE EQUAL, F'= 1.03 WITH 70 AND 70 DF PROB > F'= 0.8925

VARIABLE: PTBL PERC. TOTAL COMP. BILL AT LOC Q10

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	78	53.98717949	31.29353844	3.54329549	1.00000000	100.00000000	UNEQUAL	0.5456	147.2	0.5861
1	72	51.20833333	31.04015459	3.65811730	0.00000000	100.00000000	EQUAL	0.5455	148.0	0.5863

FOR HO: VARIANCES ARE EQUAL, F'= 1.02 WITH 77 AND 71 DF PROB > F'= 0.9470

TTEST PROCEDURE

VARIABLE: BILL AVER. MONTHLY BILL Q54

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	71	286897.1830986	840265.297726	99721.1443359	700.00000000	4500000.00000	UNEQUAL	-0.5560	94.6	0.5795
1	65	410870.2461538	1607997.439651	199447.5356473	500.00000000	12000000.00000	EQUAL	-0.5703	134.0	0.5695

FOR HO: VARIANCES ARE EQUAL, F'= 3.66 WITH 64 AND 70 DF PROB > F'= 0.0001

VARIABLE: PDCT PERC. TOT. TR. DATA Q47

Results of t-Test Analyses between Bypassers and Nonbypassers Who Are Not Considering Bypass

The definitions of terms used are as follows:

V_0 = Nonbypassers, not considering bypass

V_1 = Bypassers

NLT = Number of locations

NLC = Number of locations in city

NLS = Number of locations in the state

NLA = Number of locations in adjacent states

Conc2 = Number of locations in the state but not in the city, as a percentage of the total number of locations

OWEQ = Ownership of customer-premises equipment

PTUE = Percentage of employees who use the telephone

PINC = Percentage of telephone calls that are incoming as opposed to outgoing

PIDT = Percentage of data transmissions that are incoming as opposed to outgoing

PTBL = Percentage of the company's total telecommunications bill generated at the location

BILL = Average monthly bill from the telephone company in 1983 excluding customer-premises equipment

TTEST PROCEDURE

VARIABLE: NLT TOTAL NUMBER OF LOCATIONS Q4A

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	321	32.71339564	62.42023992	3.48395805	1.00000000	516.00000000	UNEQUAL	-2.7878	87.3	0.0065
1	80	75.30000000	133.03405864	14.87365992	1.00000000	700.00000000	EQUAL	-4.1858	399.0	0.0001

FOR HO: VARIANCES ARE EQUAL, F'= 4.54 WITH 79 AND 320 DF PROB > F'= 0.0001

VARIABLE: NLC NUMBER OF LOCATIONS IN CITY Q4B

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	374	2.74598930	7.14703279	0.36956427	0	100.00000000	UNEQUAL	-2.0311	123.3	0.0444
1	88	4.59090909	7.78391558	0.82976819	0	60.00000000	EQUAL	-2.1414	460.0	0.0328

FOR HO: VARIANCES ARE EQUAL, F'= 1.19 WITH 87 AND 373 DF PROB > F'= 0.2866

VARIABLE: NLS NUMBER OF LOCATIONS IN STATE Q4C

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	356	8.92977528	55.93621227	2.96461332	0	996.00000000	UNEQUAL	-1.2321	187.0	0.2195
1	84	15.04761905	36.50842608	3.98339586	0	240.00000000	EQUAL	-0.9551	438.0	0.3401

FOR HO: VARIANCES ARE EQUAL, F'= 2.35 WITH 355 AND 83 DF PROB > F'= 0.0001

VARIABLE: NLA NUMBER OF LOCATIONS IN ADJ. STATES Q4D

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	309	4.76051780	14.47840738	0.82364782	0	170.00000000	UNEQUAL	-1.2199	77.6	0.2262
1	78	21.00000000	117.34918478	13.28717869	0	996.00000000	EQUAL	-2.3709	385.0	0.0182

FOR HO: VARIANCES ARE EQUAL, F'= 65.69 WITH 77 AND 308 DF PROB > F'= 0.0001

VARIABLE: CONC2

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	310	0.22023336	0.27765324	0.01576964	0	1.00000000	UNEQUAL	-1.2773	111.1	0.2042
1	77	0.26803330	0.29780337	0.03393784	0	0.98412698	EQUAL	-1.3324	385.0	0.1835

FOR HO: VARIANCES ARE EQUAL, F'= 1.15 WITH 76 AND 309 DF PROB > F'= 0.4121

TTEST PROCEDURE

VARIABLE: OWEQ OWNERSHIP OF EQUIPMENT Q6

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	382	2.01832461	0.82428961	0.04217433	1.00000000	8.00000000	UNEQUAL	-1.6402	114.6	0.1037
1	89	2.21348315	1.04958769	0.11125607	1.00000000	8.00000000	EQUAL	-1.9036	469.0	0.0576

FOR HO: VARIANCES ARE EQUAL, F'= 1.62 WITH 88 AND 381 DF PROB > F'= 0.0022

VARIABLE: PTUE PERC. EMPL. USING TELEPH. Q7

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	374	53.54545455	32.93134980	1.70283956	1.00000000	100.00000000	UNEQUAL	-3.2746	145.0	0.0013
1	87	64.96551724	28.38786519	3.04349861	1.00000000	100.00000000	EQUAL	-2.9862	459.0	0.0030

FOR HO: VARIANCES ARE EQUAL, F'= 1.35 WITH 373 AND 86 DF PROB > F'= 0.0963

VARIABLE: PINC PERC. PHONE CALLS INCOMING Q8

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	293	50.28327645	13.36929216	0.78104239	2.00000000	99.00000000	UNEQUAL	0.1672	98.5	0.8676
1	71	49.95774648	15.02800873	1.78349651	25.00000000	90.00000000	EQUAL	0.1796	362.0	0.8575

FOR HO: VARIANCES ARE EQUAL, F'= 1.26 WITH 70 AND 292 DF PROB > F'= 0.1906

VARIABLE: PIDT PERC. DATA TRANS. INCOMING Q9

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	296	45.21959459	25.15772122	1.46226284	0	100.00000000	UNEQUAL	0.2385	104.1	0.8120
1	71	44.40845070	25.87915734	3.07129093	0	100.00000000	EQUAL	0.2426	365.0	0.8084

FOR HO: VARIANCES ARE EQUAL, F'= 1.06 WITH 70 AND 295 DF PROB > F'= 0.7333

VARIABLE: PTBL PERC. TOTAL COMP. BILL AT LOC Q10

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	274	52.85766423	34.37220579	2.07650089	1.00000000	100.00000000	UNEQUAL	0.3921	120.9	0.6957
1	72	51.20833333	31.04015459	3.65811730	0.00000000	100.00000000	EQUAL	0.3694	344.0	0.7120

FOR HO: VARIANCES ARE EQUAL, F'= 1.23 WITH 273 AND 71 DF PROB > F'= 0.3067

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TTEST PROCEDURE

VARIABLE: BILL AVER. MONTHLY BILL Q54

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	270	52618.5259259	152825.552800	9300.6669591	200.00000000	1500000.00000	UNEQUAL	-1.7943	64.3	0.0775
1	65	410870.2461538	1607997.439651	199447.5356473	500.00000000	12000000.00000	EQUAL	-3.5104	333.0	0.0004

FOR HO: VARIANCES ARE EQUAL, F'= 110.71 WITH 64 AND 269 DF PROB > F'= 0.0001

Results of t-Test Analyses between Bypassers and All Nonbypassers

The definitions of terms used are as follows:

V_0 = All nonbypassers

V_1 = Bypassers

NLT = Number of locations

NLC = Number of locations in city

NLS = Number of locations in the state

NLA = Number of locations in adjacent states

Conc2 = Number of locations in the state but not in the city, as a percentage of the total number of locations

OWEQ = Ownership of customer-premises equipment

PTUE = Percentage of employees who use the telephone

PINC = Percentage of telephone calls that are incoming as opposed to outgoing

PIDT = Percentage of data transmissions that are incoming as opposed to outgoing

PTBL = Percentage of the company's total telecommunications bill generated at the location

BILL = Average monthly bill from the telephone company in 1983 excluding customer-premises equipment

TTEST PROCEDURE

VARIABLE: NLT TOTAL NUMBER OF LOCATIONS Q4A

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	406	42.08866995	82.54017814	4.09640026	1.00000000	650.00000000	UNEQUAL	-2.1527	91.3	0.0340
1	80	75.30000000	133.03405864	14.87365992	1.00000000	700.00000000	EQUAL	-2.9295	484.0	0.0035

FOR HO: VARIANCES ARE EQUAL, F'= 2.60 WITH 79 AND 405 DF PROB > F'= 0.0001

VARIABLE: NLC NUMBER OF LOCATIONS IN CITY Q4B

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	464	5.00000000	27.52528780	1.27782941	0	550.00000000	UNEQUAL	0.2685	480.8	0.7884
1	88	4.59090909	7.78391558	0.82976819	0	60.00000000	EQUAL	0.1383	550.0	0.8901

FOR HO: VARIANCES ARE EQUAL, F'= 12.50 WITH 463 AND 87 DF PROB > F'= 0.0001

VARIABLE: NLS NUMBER OF LOCATIONS IN STATE Q4C

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	444	12.50675676	59.27494531	2.81306441	0	996.00000000	UNEQUAL	-0.5210	178.1	0.6030
1	84	15.04761905	36.50842608	3.98339586	0	240.00000000	EQUAL	-0.3793	526.0	0.7046

FOR HO: VARIANCES ARE EQUAL, F'= 2.64 WITH 443 AND 83 DF PROB > F'= 0.0001

VARIABLE: NLA NUMBER OF LOCATIONS IN ADJ. STATES Q4D

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	392	5.43877551	15.97476676	0.80684756	0	170.00000000	UNEQUAL	-1.1690	77.6	0.2460
1	78	21.00000000	117.34918478	13.28717869	0	996.00000000	EQUAL	-2.5209	468.0	0.0120

FOR HO: VARIANCES ARE EQUAL, F'= 53.96 WITH 77 AND 391 DF PROB > F'= 0.0001

VARIABLE: CONC2

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	395	0.22516223	0.28253195	0.01421573	0	1.00000000	UNEQUAL	-1.1651	104.4	0.2466
1	77	0.26803330	0.29780337	0.03393784	0	0.98412698	EQUAL	-1.2073	470.0	0.2279

FOR HO: VARIANCES ARE EQUAL, F'= 1.11 WITH 76 AND 394 DF PROB > F'= 0.5218

TTEST PROCEDURE

VARIABLE: OWEQ OWNERSHIP OF EQUIPMENT Q6

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	472	2.04449153	0.81397778	0.03746636	1.00000000	8.00000000	UNEQUAL	-1.4395	108.8	0.1529
1	89	2.21348315	1.04958769	0.11125607	1.00000000	8.00000000	EQUAL	-1.7096	559.0	0.0879

FOR HO: VARIANCES ARE EQUAL, F'= 1.66 WITH 88 AND 471 DF PROB > F'= 0.0009

VARIABLE: PTUE PERC. EMPL. USING TELEPH. Q7

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	461	56.85900217	32.86956552	1.53088829	1.00000000	100.00000000	UNEQUAL	-2.3795	133.4	0.0188
1	87	64.96551724	28.38786519	3.04349861	1.00000000	100.00000000	EQUAL	-2.1534	546.0	0.0317

FOR HO: VARIANCES ARE EQUAL, F'= 1.34 WITH 460 AND 86 DF PROB > F'= 0.0958

VARIABLE: PINC PERC. PHONE CALLS INCOMING Q8

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	363	50.63085399	13.13787221	0.68955946	2.00000000	99.00000000	UNEQUAL	0.3520	92.1	0.7255
1	71	49.95774648	15.02800873	1.78349651	25.00000000	90.00000000	EQUAL	0.3853	432.0	0.7002

FOR HO: VARIANCES ARE EQUAL, F'= 1.31 WITH 70 AND 362 DF PROB > F'= 0.1237

VARIABLE: PIDT PERC. DATA TRANS. INCOMING Q9

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	367	44.75476839	25.20006989	1.31543294	0	100.00000000	UNEQUAL	0.1037	97.4	0.9177
1	71	44.40845070	25.87915734	3.07129093	0	100.00000000	EQUAL	0.1055	436.0	0.9160

FOR HO: VARIANCES ARE EQUAL, F'= 1.05 WITH 70 AND 366 DF PROB > F'= 0.7403

VARIABLE: PTBL PERC. TOTAL COMP. BILL AT LOC Q10

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	352	53.10795455	33.67423532	1.79484277	1.00000000	100.00000000	UNEQUAL	0.4662	108.0	0.6420
1	72	51.20833333	31.04015459	3.65811730	0.00000000	100.00000000	EQUAL	0.4418	422.0	0.6589

FOR HO: VARIANCES ARE EQUAL, F'= 1.18 WITH 351 AND 71 DF PROB > F'= 0.4079

TTEST PROCEDURE

VARIABLE: BILL AVER. MONTHLY BILL Q54

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	341	101397.9530792	415831.654022	22518.5465748	200.00000000	4500000.00000	UNEQUAL	-1.5419	65.6	0.1279
1	65	410870.2461538	1607997.439651	199447.5356473	500.00000000	12000000.00000	EQUAL	-3.0690	404.0	0.0023

FOR HO: VARIANCES ARE EQUAL, F'= 14.95 WITH 64 AND 340 DF PROB > F'= 0.0001

VARIABLE: PDCT PERC. TOT. TR. DATA Q47

Results of t-Test Analyses between Nonbypassers Considering Bypass and Nonbypassers Not Considering Bypass

The definitions of terms used are as follows:

V_0 = Nonbypassers not considering bypass

V_1 = Nonbypassers considering bypass

NLT = Number of locations

NLC = Number of locations in city

NLS = Number of locations in the state

NLA = Number of locations in adjacent states

Conc2 = Number of locations in the state but not in the city, as a percentage of the total number of locations

OWEQ = Ownership of customer-premises equipment

PTUE = Percentage of employees who use the telephone

PINC = Percentage of telephone calls that are incoming as opposed to outgoing

PIDT = Percentage of data transmissions that are incoming as opposed to outgoing

PTBL = Percentage of the company's total telecommunications bill generated at the location

BILL = Average monthly bill from the telephone company in 1983 excluding customer-premises equipment

TTEST PROCEDURE

VARIABLE: NLT TOTAL NUMBER OF LOCATIONS Q4A

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	321	32.71339564	62.42023992	3.48395905	1.00000000	516.00000000	UNEQUAL	-3.1270	94.8	0.0023
1	85	77.49411765	128.06430895	13.89052459	1.00000000	650.00000000	EQUAL	-4.5547	404.0	0.0001

FOR HO: VARIANCES ARE EQUAL, F'= 4.21 WITH 84 AND 320 DF PROB > F'= 0.0001

VARIABLE: NLC NUMBER OF LOCATIONS IN CITY Q4B

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	374	2.74598930	7.14703279	0.36956427	0.00000000	100.00000000	UNEQUAL	-1.8299	89.6	0.0705
1	90	14.36666667	60.14391915	6.33972573	1.00000000	550.00000000	EQUAL	-3.5432	462.0	0.0003

FOR HO: VARIANCES ARE EQUAL, F'= 70.82 WITH 89 AND 373 DF PROB > F'= 0.0001

VARIABLE: NLS NUMBER OF LOCATIONS IN STATE Q4C

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	356	8.92977528	55.93621227	2.96461332	0	996.00000000	UNEQUAL	-2.2558	116.2	0.0260
1	88	26.97727273	69.70891486	7.43099529	0	400.00000000	EQUAL	-2.5737	442.0	0.0104

FOR HO: VARIANCES ARE EQUAL, F'= 1.55 WITH 87 AND 355 DF PROB > F'= 0.0061

VARIABLE: NLA NUMBER OF LOCATIONS IN ADJ. STATES Q4D

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	309	4.76051780	14.47840738	0.82364782	0	170.00000000	UNEQUAL	-1.3354	104.9	0.1846
1	83	7.96385542	20.52508625	2.25292090	0	100.00000000	EQUAL	-1.6254	390.0	0.1049

FOR HO: VARIANCES ARE EQUAL, F'= 2.01 WITH 82 AND 308 DF PROB > F'= 0.0001

VARIABLE: CONC2

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	310	0.22023336	0.27765324	0.01576964	0	1.00000000	UNEQUAL	-0.6323	126.0	0.5284
1	85	0.24313809	0.30068493	0.03261386	0	1.00000000	EQUAL	-0.6617	393.0	0.5086

FOR HO: VARIANCES ARE EQUAL, F'= 1.17 WITH 84 AND 309 DF PROB > F'= 0.3362

TTEST PROCEDURE

VARIABLE: OWEQ OWNERSHIP OF EQUIPMENT Q6

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	382	2.01832461	0.82428961	0.04217433	1.00000000	8.00000000	UNEQUAL	-1.5110	142.2	0.1330
1	90	2.15555556	0.76306760	0.08043439	1.00000000	3.00000000	EQUAL	-1.4405	470.0	0.1504

FOR HO: VARIANCES ARE EQUAL, F'= 1.17 WITH 381 AND 89 DF PROB > F'= 0.3806

VARIABLE: PTUE PEFC. EMPL. USING TELEPH. Q7

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	374	53.54545455	32.93134980	1.70283956	1.00000000	100.00000000	UNEQUAL	-4.9959	143.7	0.0001
1	87	71.10344828	28.67623377	3.07441497	8.00000000	100.00000000	EQUAL	-4.5843	459.0	0.0001

FOR HO: VARIANCES ARE EQUAL, F'= 1.32 WITH 373 AND 86 DF PROB > F'= 0.1209

VARIABLE: PINC PEFC. PHONE CALLS INCOMING Q8

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	293	50.28327645	13.36929216	0.78104239	2.00000000	99.00000000	UNEQUAL	-1.0964	112.8	0.2752
1	70	52.08571429	12.10311118	1.44659847	10.00000000	85.00000000	EQUAL	-1.0313	361.0	0.3031

FOR HO: VARIANCES ARE EQUAL, F'= 1.22 WITH 292 AND 69 DF PROB > F'= 0.3226

VARIABLE: PIDT PEPC. DATA TRANS. INCOMING Q9

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	296	45.21959459	25.15772122	1.46226284	0	100.00000000	UNEQUAL	0.7157	105.2	0.4758
1	71	42.81690141	25.46331246	3.02193922	0	100.00000000	EQUAL	0.7210	365.0	0.4714

FOR HO: VARIANCES ARE EQUAL, F'= 1.02 WITH 70 AND 295 DF PROB > F'= 0.8672

VARIABLE: PTBL PEFC. TOTAL COMP. BILL AT LOC Q10

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	274	52.85766423	34.37220579	2.07650089	1.00000000	100.00000000	UNEQUAL	-0.2750	134.5	0.7837
1	78	53.98717949	31.29353844	3.54329549	1.00000000	100.00000000	EQUAL	-0.2610	350.0	0.7942

FOR HO: VARIANCES ARE EQUAL, F'= 1.21 WITH 273 AND 77 DF PROB > F'= 0.3297

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TTEST PROCEDURE

VARIABLE: BILL AVER. MONTHLY BILL Q54

V	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM	VARIANCES	T	DF	PROB > |T|
0	270	52618.5259259	152825.5528002	9300.66695910	200.00000000	1500000.000000	UNEQUAL	-2.3392	71.2	0.0221
1	71	286897.1830986	840265.2977265	99721.14433586	700.00000000	4500000.000000	EQUAL	-4.3333	339.0	0.0001

FOR HO: VARIANCES ARE EQUAL, F'= 30.23 WITH 70 AND 269 DF PROB > F'= 0.0001